Bird and Bat Assessment

by Umwelt

umwelt
Environmental & Social Consultants

BIRD AND BAT ASSESSMENT ADDENDUM

Twin Creek Wind Farm

FINAL

January 2025

BIRD AND BAT ASSESSMENT ADDENDUM

Twin Creek Wind Farm

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
MasterPlan Pty Ltd

Project Director:	Alison Derry
Project Manager:	Ella West
Report No.	R05
Date:	January 2025

Environmental & Social Consultants

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
R01	E. West	17/11/2023	Dr. M. Louter	17/11/2023
R01	E. West	29/11/2023	A. Derry	23/01/2024
R03	E. West	19/09/2024	A. Derry	25/09/2024
R04	E. West	16/10/2024	Dr. M. Louter	23/10/2024
R05	E. West	09/01/2025	A. Derry	09/01/2025

Glossary and Abbreviation of Terms

BDBSA	Biological Databases of South Australia database search
DRMF	(Australian) Defence Risk Management Framework
DEW	Department for Environment and Water
Development Area	Area outlined **Figure 1.1**
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ha	Hectares
m	Meter(s)
km	Kilometer(s)
kV	KiloVolt(s)
MNES	Matters of National Environmental Significance, as defined under the EPBC Act
MW	Megawatt(s)
NPW Act	*National Parks and Wildlife Act 1972*
PMST	Protected Matters Search tool
Project	Twin Creek Wind Farm
RES	RES Australia Pty Ltd (the proponent)
RSA	Rotor Swept Area (48 m above ground level)
Search Area	a 5 km buffer surrounding the Development Area
sp.	Species (singular)
spp.	Species (plural)
ssp.	Subspecies
the Project	the proposed TCWF
TCWF	Twin Creek Wind Farm
Umwelt	Umwelt (Australia) Pty Ltd (formerly EBS Ecology)
WTG	Wind Turbine Generator

Executive Summary

The proposed Twin Creek Wind Farm (TCWF) is located approximately 90 kilometres (km) north east of Adelaide and is situated within the northern hills of the Mount Lofty Ranges. Umwelt (Australia) Pty Ltd (Umwelt) (formerly EBS Ecology) has been engaged by MasterPlan Pty Ltd on behalf of RES Australia Pty Ltd (RES) to prepare a Bird and Bat Risk Assessment Addendum for the proposed TCWF, as the design of Wind Turbine Generators (WTG) has changed since original risk assessments were undertaken for the Project.

Previously, Umwelt collated two reports that highlighted the bird/bat strike risk assessments across the proposed TCWF, which included data from the 2017 Flora and Fauna Assessment and the 2020 Bird Strike Risk Assessment Update. These previous assessments were based on an approved Project design which was based on up to 51 WTGs with a tip height of up to 180 meters (m) (45 m above ground level).

This Bird and Bat Risk Assessment Addendum is based on an optimised design for the proposed TCWF, which now includes up to 42 WTG with a tip height of up to 220 m and a Rotor Swept Area (RSA) of 48 m above ground level. The data analysed in this report is based on almost three years of survey work (February 2021 to January 2024). The Development Area includes the Wind Farm and the Transmission Line Route (3,672.33).

A risk assessment matrix was used to qualitatively define the risk of the proposed TCWF to common and threatened bird and bat species observed in the Development Area and was guided by the qualitative measures of likelihood and consequence used in the Australian Defence Risk Management Framework. The risk assessment matrix was used to qualitatively define the risk (low, medium, high or extreme) to threatened bird species as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *National Parks and Wildlife Act 1972* (NPW Act), observed during surveys or defined as "possibly" or "likely" to occur within the Development Area based on desktop database searches (Umwelt 2024). Bird species identified as having performed at-risk-movements (i.e. movements within the RSA) within the Development Area (such as raptors) were also assessed.

A risk assessment matrix was used to define the risk to all bat species identified during previous surveys as occurring within the Development Area, for threatened bats identified as potentially occurring in the region and other bat species determined as Possibly or Likely to occur in the Development Area (EBS 2017 and Umwelt 2024).

Other cumulative impacts such as presence of raptor nests within the Development Area were also included within the risk assessment.

The risk assessment identified that six raptors (Wedge-tailed Eagle, Brown Falcon, Nankeen Kestrel, Peregrine Falcon, Black Falcon, and Little Eagle) have a **medium** risk of collisions with a WTG. Two raptors (Spotted Harrier and Southern Boobook) have a **low** risk of collisions with a WTG.

A total of four threatened bird species were identified as being at a **medium** risk of collisions with a WTG (Southern-eastern Hooded Robin, Blue-winged Parrot, Diamond Firetail and Painted Honeyeater). No robust flight data is currently available for these species, however, due to their threatened status any impact to individuals is likely to have an impact on the local population.

A total of five threatened bird species were identified as having a **low** risk of collisions with a WTG (Southern Whiteface, Rainbow Bee-eater, White-winged Chough, Restless Flycatcher and Elegant Parrot).

Four common bird species (Australia Raven, Little Raven, Pink Galah and Australian Magpie) identified within the Development Area were assessed as having a **low** risk of collisions with a WTG.

The likelihood of collision with a WTG causing mortality was determined as likely for all bat species. As such the overall level of risk of collisions with a WTG or impact due to barotrauma for all bat species was determined as **medium**.

For those bird and bat species considered to have a medium risk level, all efforts have been made to mitigate against potential impact on these species. RES have taken into consideration the 200 m exclusion buffer around woodlands and have adopted this buffer where possible. Similarly, all efforts were made to minimise the impact to Wedge-tailed Eagle nesting sites within these woodlands and RES have taken into consideration the 500 m exclusion buffer around these nests. RES understands that TCWF is likely to require a referral under the EPBC Act.

Table of Contents

Figures

Tables

Appendices

1.0 Introduction

Umwelt (Australia) (Umwelt) (formerly EBS Ecology) has been engaged by MasterPlan Pty Ltd on behalf of RES Australia Pty Ltd (RES) to prepare a Bird and Bat Risk Assessment Addendum for the proposed Twin Creek Wind Farm (TCWF), as the design of Wind Turbine Generators (WTG) has changed since original risk assessments were undertaken for the Project.

Two previous assessments undertaken by Umwelt (EBS 2017, 2020a) identified the risk levels of birds and bat species colliding with WTGs within the TCWF. The initial assessment (EBS 2017) was based on indicative WTG dimensions of up to 112 m for the tower height and 67 m for the blade lengths with 45 m clearance from the ground and maximum tip height of 180 m. The subsequent assessment (EBS 2020a) reviewed previous data and assessed the impact to birds and bats of up to 51 WTGs with a 180 m maximum blade tip height.

This Bird and Bat Risk Assessment Addendum is based on the new optimised TCWF design, which includes a reduction in the number of WTGs from 51 to 42 (reduction of nine WTG) and an increase in tip height from 180 m to up to 220 m (increase of 40 m), an increase of Rotor Swept Area (RSA) by 3 m (increase from 45 to 48 m above ground level). This report will only assess “at-risk” species which include diurnal birds of prey (raptors) and threatened and common bird species from the last almost three years of survey data.

This includes data from the following field surveys:

- native vegetation assessment and bird utilisation surveys January 2024
- native vegetation assessment and bird utilisation surveys October/November 2023
- bird and bat monitoring survey February and April 2022
- bird and bat monitoring survey February, April, July and October 2021.

1.1 Development Area

The proposed TCWF is located approximately 90 kilometres (km) northeast of Adelaide and is situated within the northern hills of the Mount Lofty Ranges. The Project site is dominated by ridgelines in the north and plains or undulating hills in the south. The Development Area is approximately 3,672.33 ha (includes Wind Farm and the Transmission Line Route) with the main infrastructure area extending approximately 10 km (east to west) and 7.5 km (north to south) (**Figure 1.1**).

Please note, that this report only talks about the Wind Farm component of the Development Area, a 5 km search buffer around the entire Development Area was assessed for this Bird and Bat Assessment (**Appendix B**).

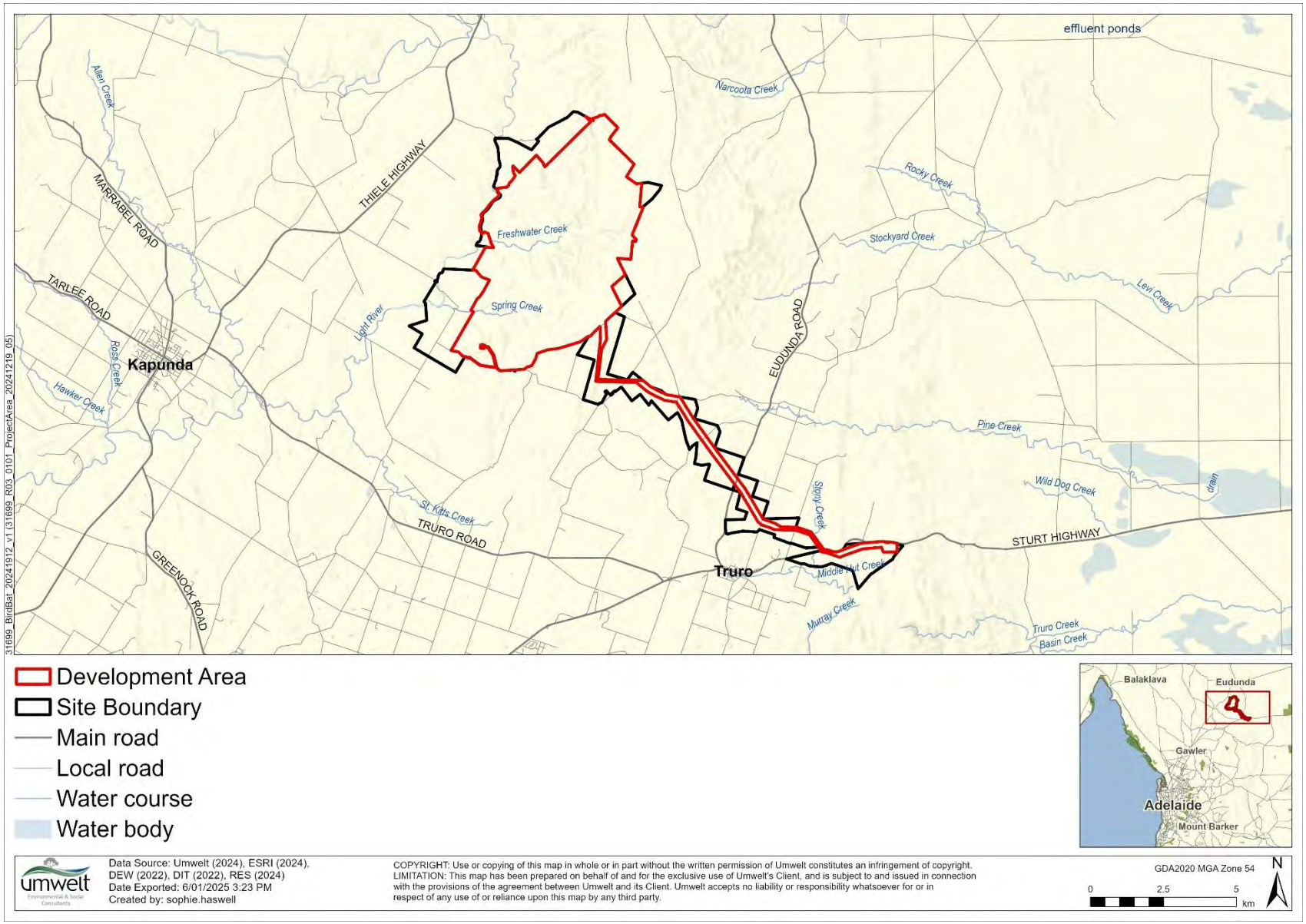


Figure 1.1 Location of the proposed Twin Creek Wind Farm and Transmission Line Route (Development Area)

2.0 Background Information

2.1 Project details

Initial design information for the TCWF was supplied to Umwelt on 6 November 2023 by RES. The optimised design for TCWF incorporates up to 42 WTG, which is a reduction of 9 WTG from the approved project design. The siting of the WTGs as part of the optimised design has been an interactive process and the final design provided to Umwelt in September 2024. (**Table 2.1**).

The Project has been developing since January 2015, where RES sought planning consent for TCWF, which was granted in October 2019. Since then, there have been major developments in wind and turbine technology. To take advantage of the evolution in wind turbine technology, RES has optimised the Project layout for the TCWF. Against this background, RES are seeking development authorisation for the updated design. **Table 2.1** shows a summary of the variations between the approved Project and the optimised Project. The optimised design for the proposed TCWF is presented in **Figure 2.1**.

Table 2.1 Comparison of Project designs

	Approved Project	Optimised Project
Number of WTG	Up to 51	Up to 42
WTG individual Generating Capacity	3.6 Megawatt (MW)	Up to 7.2 MW
Overall Generating Capacity	185 MW	Up to 270 MW
Tip height of WTG	180 m tip height	Up to 220 m tip height
Battery Energy Storage Capacity	215 MW indicative storage capacity	215 MW indicative storage capacity
Substation(s)	2 Substations (1 Project substation within the wind farm boundary and 1 cut-in terminal substation)	2 Substations (1 Project substation within the wind farm boundary and 1 cut-in terminal substation)
Point of Connection	ElectraNet 275 kV powerline (Robertstown to Tungkillo) via a cut-in terminal substation, east of Truro	ElectraNet 275 kV powerline (Robertstown to Tungkillo) via a cut-in terminal substation, east of Truro.

MasterPlan have engaged Umwelt on behalf of RES to provide advice on the potential impact to birds and bats based on the following design changes:

- the reduction in the number of WTG from 51 to up to 42 (reduction of nine WTG)
- the selected WTG tip height from 180 m to up to 220 m (increase of 40 m)
- an increase in the RSA from 45 m to 48 m (increase of 3 m above ground level).

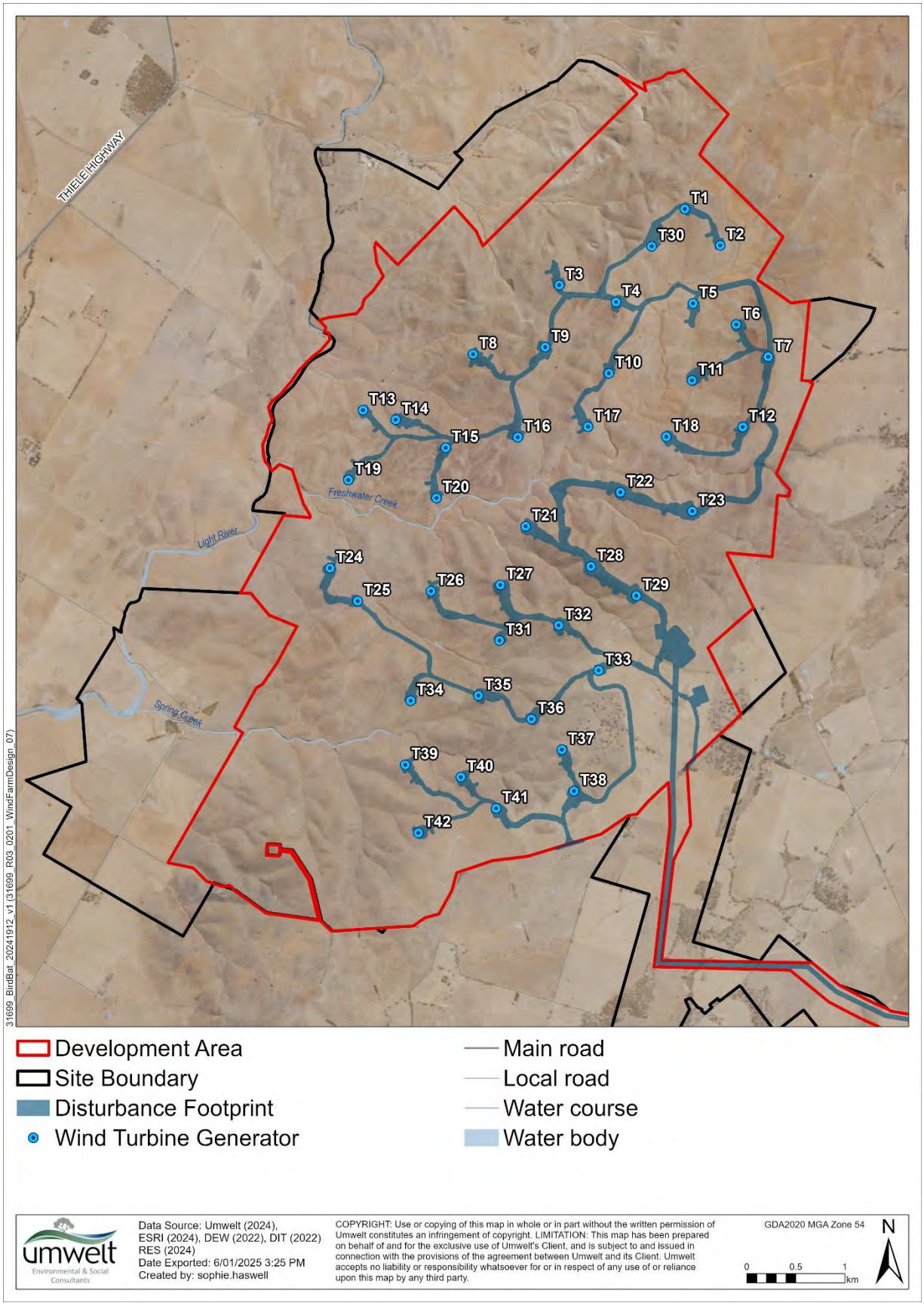


Figure 2.1 Location of the Wind Turbine Generators at Twin Creek Wind Farm

2.2 Current design plans

The optimised proposed design for the TCWF will consist of the following components (supplied to Umwelt in September 2024):

- an overall WTG blade tip height up to 220 m, a hub height of up to 134 m and a rotor diameter of up to 172 m
- up to 42 WTG
- each WTG has a name plate capacity of up to 7.2 MW, with a total installed generating capacity of up to 270 MW
- associated hard standing areas and access roads
- operations and maintenance building and compound with associated car parking
- two electrical substations (one project substation within the windfarm boundary and one cut-in terminal substation)
- a battery energy storage facility with an indicative capacity of 215 MW
- overhead and underground electrical cable reticulation
- overhead Transmission Line for approximately 15 km from the on-site substation to the existing overhead Robertstown – Tungkillo Transmission Line east of Truro
- temporary construction facilities including a borrow pit and concrete batching plant facilities.

2.2.1 Current land use

Land use within the Development Area is predominantly agricultural (e.g., grazing for sheep and cattle). Native vegetation has historically been extensively cleared, with most of the footprint containing grasslands. Woodland vegetation is generally restricted to creek lines and within small patches. The general region is open, low hills with occasional rocky outcrops that fall away to low foot slopes and drainage channels at regular intervals.

Vegetation cover is dominated by grasses and perennial herbaceous forbs, with sparse incidents of remnant woodland primarily comprised of *Eucalyptus leucoxylon* ssp. *pruinosa* (South Australian Blue-gum). Patches of *Eucalyptus odorata* (Peppermint Box) also occur in the transmission line (Umwelt 2024).

2.3 Wind Farm impacts on avifauna

The potential impacts of wind farms on avifauna and bats include:

- rotor strikes (bird mortality)
- barotrauma (bat mortality)
- clearance and degradation of habitat

- acoustic masking
- behavioural avoidance.

2.3.1 Rotor strikes

Bird species that regularly fly at heights that are swept by turbine rotors are prone to rotor strike. This includes raptors, which are one of the most at-risk groups of bird from wind farms due to their flight height, low fecundity and long lifespans (Beston *et al.* 2016), which means that the replacement of struck individuals within the population takes considerable time and energy, and population declines may occur (Dahl *et al*. 2012).

Worldwide, raptors and birds of prey have been extensively documented as a high-risk species for WTG collision (Thaxter *et al.* 2017). In Australia, collisions of raptors with WTG have been documented for Tasmania Wedge-tailed Eagle (*Aquila audax fleayi*) (Hull *et al.* 2015, Pullen 2023), Wedge-tailed Eagle (*Aquila audax*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) (Pullen 2023), Swamp Harrier (*Circus approximans*), Brown Falcon (*Falco berigora*), Black-shouldered Kite (*Elanus axillaris*), Australian Hobby (*Falco longipennis*), Brown Goshawk (*Accipiter fasciatus*), Collared Sparrowhawk (*Accipiter cirrocephalus*), Little Eagle (*Hieraaetus morphnoides*), Nankeen Kestrel (*Falco cenchroides*), Peregrine Falcon (*Falco peregrinus*), Whistling Kite (*Haliastur sphenurus*) and Black Falcon (*Falco subniger*) (Hull *et al* 2013; Maloney *et al.* 2019).

Bird collisions with (seemingly slow-moving) rotor blades occur as a result of the following possible reasons:

- Due to the optics of bird vision, as the bird approaches the spinning blades, the rate the image is transmitted to the bird's brain speeds up until the retina cannot keep up with it, creating a blur (called motion blur) that the bird likely translates as being safe air space (Hodos 2003). Birds could therefore assess this area as safe and risk colliding with the turbine blades.
- Due to birds narrow frontal field of view and expected high use of their lateral field of view for detecting prey, predators and other conspecifics, birds may not observe turbines while undertaking other activities, increasing their risk of collision (May *et al.* 2020).

2.3.2 Barotrauma

Bats succumb to barotrauma at wind farm turbines whereby the rapid air-pressure reduction near moving turbines causes tissue damage to air-containing structures (Baerwald *et al*. 2008). High rates of bat mortality at wind farms have been noted in e United States, Canada, Europe, South America, Africa, Asia and Oceana (Whitby *et al.* 2024)).

In Australia, at Ararat Wind Farm, Victoria 44 bat were carcasses identified within one year of monthly monitoring over 25 turbines (BL&A 2019). The true number of bat mortalities across these 25 turbines would be significantly higher than 44 deaths, as scavenging rates and surveyor error (failed detection during searches) was not accounted for. Bat monitoring at McArthur Wind Farm in south-western Victoria found annual bat mortality per turbine to be 1.41 ± 0.65 and 3.08 ± 1.68 in 2013 and 2014, respectively (AERS 2015).

2.3.3 Clearance and degradation of habitat

The proposed TCWF will result in the direct clearance of habitat for WTG hardstands, access tracks, Transmission Line poles and substations. For the construction of wind farms, some clearance of remnant native vegetation is expected to be required and can contribute to habitat loss, fragmentation and degradation of habitat. In particular, habitat loss is expected to be unfavourable to small passerine species with specific habitat preferences and favourable to large generalist species (Szabo *et al*. 2011). If any hollow bearing trees, are to be cleared, this contributes to the loss of roosting and nesting habitat for bird and bat species with those specific habitat requirements. Furthermore, where native vegetation borders the infrastructure footprint, habitat is at a higher risk of becoming degraded from weed invasion, erosion and other edge effects.

2.3.4 Acoustic masking

The noise associated with a wind farm may have adverse impacts on songbirds (Zwart *et al*. 2016). Acoustic masking caused by wind farm noise may affect the ability of individuals with established territories to deter a rival (Zwart *et al*. 2016). As such, increased time and energy would need be spent for maintaining territories, which could result in reduced breeding success of sedentary territorial bird species (Zwart *et al*. 2016).

2.3.5 Behavioural avoidance

Raptors are known to substantially reduce their presence within an area following the construction of a wind farm. While this reduces the number of individuals that succumb to rotor strike, it may displace pairs from their established territories, which can reduce breeding success. The impact of rotor strike and displacement of individuals is considered to have reduced the breeding success of White-tailed Eagles (*Haliaeetus albicilla*) within occupied territories from 48% before wind farm construction to 22% post construction (Dahl *et al*. 2012). Displacement of raptors at a wind farm also occurred in Wisconsin, United States of America, where a 47% reduction in raptor abundance was recorded following wind farm construction (Garvin *et al*. 2011). At two wind farms in Tasmania, flight tracks and behaviour of Wedge-tailed Eagles were recorded over two years, which demonstrated that Wedge-tailed Eagles had avoidance rates of 81% to 97% higher compared to pre-construction, although this varied between sites and in different weather conditions (Hull & Muir 2013).

2.4 Previous risk assessments

Previously, Umwelt have prepared two reports for the proposed TCWF:

- TCWF Flora and Fauna Assessment (EBS 2017).
- TCWF Bird Strike Risk Assessment Update (EBS 2020a).

An initial risk assessment was conducted as part of the Flora and Fauna Assessment Report (EBS 2017). A second assessment was conducted a part of a Bird Strike Risk Assessment update (EBS 2020a). The WTG dimensions used in the previous risk assessment were as follows:

- A maximum tip of blade height of up to 180 m
- up to 112 m for the tower height

- 67 m for the blade lengths. The risk assessment was based on the lowest extent of a rotating blade tip, which was 45 m from the ground.

The likelihood of a collision event was determined as “unlikely” for two species (Brown Falcon and Wedge-tailed Eagle), “rarely” for four species (Australian Hobby, Black-shouldered Kite, Spotted Harrier and Blue-winged Parrot) and “likely” for Australian Kestrel. Previous assessments were based on knowledge of their size and flight behaviours as well as information about flight behaviour from surveys undertaken at the TCWF site. The consequence of mortality at a species/population level was determined as “minor” for six species (Australian Hobby, Black-shouldered Kite, Brown Falcon, Spotted Harrier, Wedge-tailed Eagle and Blue-winged Parrot) and “insignificant” for Australian Kestrel, a species that is locally common in the area.

The overall level of risk of impacts by WTG was determined as **low** for all species (EBS 2017, 2020a).

3.0 Methods

3.1 Bird and bat monitoring

Bird and bat monitoring was undertaken by Umwelt four times per year (one survey per season) starting in July (winter) 2020 and concluding in April (autumn) 2022 for a total of eight surveys. Morning (AM) and afternoon (PM) bird surveys were undertaken at 16 dedicated point count sites during each survey period, for a total of 255 surveys or 127.5 hours of bird survey work (EBS 2020b, EBS 2021, EBS 2021a, EBS 2021b, EBS 2021c, EBS 2022).

3.2 Risk assessment

A risk assessment was undertaken to determine the potential impact of the proposed wind farm on bird and bat species where the risk element of concern was collision. The risk assessment was performed for raptor species, threatened and common bird species known from the Development Area and those species determined as Possible, Likely and High Likely/Known to occur from the Native Vegetation Data Report (Umwelt 2024).

3.2.1 Assessment of the likelihood of species utilising the Development Area

A PMST Report was generated on the 12 September 2024 to identify threatened fauna that occur within 5 km of the Development Area. A likelihood of occurrence rating was assigned to each threatened bird and bat species identified in the Protected Matters Search Tool (PMST (Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2024). A Biological Databases of South Australia (BDBSA) database search (DEW 2023 Recordset number: DEWNRBDBSA231031-4) was obtained. The BDBSA database search is comprised of an integrated collection of species records from the South Australian Museum, conservation organisations, private consultancies, Birds SA, Birdlife Australia and the Australasian Wader Study Group.

This likelihood of occurrence rating, 'Highly Likely/Known', 'Likely', 'Possible' takes the following criteria into consideration:

- proximity of the records (distance to the Development Area)
- date of the records
- landscape features, vegetation remnancy and vegetation type at the location of the record (taking into consideration similarities within the Development Area)
- knowledge of species' habitat preferences, causes of decline, and local population trends.

Common bird and bat species that are known to occur in the Development Area and that were assessed as at risk of flying within the RSA of 48 m above ground level were included in the assessment.

Other cumulative impacts that have been taken into account in the risk assessment are the location of known raptor nests within the Development Area. Presence of nests within the Development Area increases the likelihood of an event causing mortality, which can elevate the risk level. Furthermore, the placement of WTG in relation to areas of higher ecological value (such as woodlands) have been

taken into account in the risk assessment process, as the placement of WTG in these areas exacerbates the risk to at-risk species (such as woodland bird species) that occupy such areas.

3.2.2 Level of risk

A risk assessment matrix was used to qualitatively define the risk of the proposed TCWF on common and threatened bird and bat species observed in the Development Area and threatened bird species defined as Possible, Likely and High Likely/Known occur within the Development Area (Umwelt 2024). Bird species identified as having performed at-risk movements within the Development Area (such as raptors) were also assessed.

A risk assessment matrix was used to define the risk to all bat species identified during previous surveys as occurring in the Development Area, threatened bats identified and potentially in the region and other bat species determined as Possible, Likely and High Likely/Known occur to occur in the Development Area (Umwelt 2024).

The assessment was guided by the qualitative measures of likelihood and consequence used in the Australian Defence Risk Management Framework (Gaidow and Boey 2005). This framework provides generic guidance on the introduction and ongoing implementation of a risk management process; it may be applied to different activities or operations of any corporate, community or public sector organisation (Gaidow and Boey 2005). The risk assessment matrix considers the risk consequences (impact or magnitude of effect) and likelihood (measured by frequency or probability) of risk occurrence and combines both into the overall level of risk.

The risk assessment methodology used within the Australian Defence Risk Management Framework was adapted to include likelihood and consequence of an event on (1) a species or (2) a local population. Umwelt used the matrix to qualitatively define the risk of a proposed WTG on birds within numerous proposed wind farms located in the mid-north of South Australia and this approach has been accepted (when previously used by Umwelt) by the Environment, Resources and Development Court.

Likelihood was defined as how likely mortality from collision is to occur, and consequence was defined by significance of associated impact on individuals, viability at a local population level, or viability at species level (**Table 3.1**):

- **Categories A to E** were used to define likelihood, ranging from chronic (the event is expected to occur in most circumstances) to rarely (where the event may occur only in exceptional circumstances).
- **Categories 1 to 5** were used to define consequence, where one equated to nil/insignificant (individuals may be affected, but viability of local population was not impacted) and five equated to catastrophic disaster (potential to lead to collapse of a species) (**Table 3.1**).

Table 3.2 outlines the qualitative risk analysis matrix, which summarises four levels of impact: low, medium, high and extreme:

- If the level of risk was determined to be high to extreme, then resulting impact on an individual species and local population may be unacceptable when considered through regulatory approval processes.
- If the level of risk was assessed as medium, then all efforts should be made to mitigate against potential impact on the species.
- If the level of risk was assessed as low, then impact would be restricted to an individual level and impact on a species would be unlikely to affect the viability of a local population.

Table 3.1 Qualitative measures of likelihood and consequence (adopted from AS/NZS 4360:1999, now superseded by AS ISO 31000:2018)

Likelihood (how likely is mortality from collision/barotrauma to occur)		Consequence (Significance of associated impact on species viability)	
Rating	Definition	**Rating**	Definition
Chronic	The event is expected to occur in most circumstances.	**Catastrophic/ Disaster**	Potential to lead to collapse of species.
Frequent	The event probably will occur in most circumstances (e.g., weekly to monthly).	**Major**	Critical event, very likely to have significant impact on species.
Likely	The event should occur at some time (i.e., once in a while).	**Moderate**	Likely to have impact on population, potential to impact on long-term viability under some scenarios.
Unlikely	The event could occur at some time.	**Minor**	May have impact on local population, no impact on species.
Rarely	The event may occur only in exceptional circumstances.	**Insignificant**	Individuals may be affected, but viability of local population not impacted.

Table 3.2 Qualitative Risk Analysis Matrix – Level of Risk (adopted from AS/NZS 4360:1999 [superseded by AS ISO 31000:2018] and HB 143:1999 [superseded by SA SNZ HB 436-2013])

Likelihood	Consequences				
	Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
A (Chronic)	High	High	Extreme	Extreme	Extreme
B (Frequent)	Medium	High	High	Extreme	Extreme
C (Likely)	Low	Medium	High	Extreme	Extreme
D (Unlikely)	Low	Low	Medium	High	Extreme
E (Rarely)	Low	Low	Medium	High	High

3.3 Limitations

The findings and conclusions expressed by Umwelt are based solely upon information available at the time of the assessment.

Existing flora and fauna records were sourced from the BDBSA. The BDBSA only includes verified flora and fauna records submitted to the Department for Environment and Water or partner organisations. Although much of the BDBSA data has been through a variety of validation processes, the lists may contain errors and should be used with caution.

There is limitation in determining the resulting impact of acceptability and significance with regard to the risk assessment matrix. The risk assessment matrix provides a guide to risk consequences and likelihood of risk occurrences, based on the bird/bat species that were identified at the site and as performing flights considered as 'at-risk' movements.

4.0 Bird and Bat Risk Assessment

The risk assessment was undertaken to determine the potential impact of the proposed Project on bird and bat species, where the risk element of concern (death due to collision/barotrauma) remains unchanged. The WTG dimensions used in this risk assessment are as follows:

- the maximum tip of blade height of up to 220 m
- up to 134 m for the hub height
- up to 86 m for the rotor radius.

The risk assessment was based on the lowest extent of a rotating blade tip being 48 m from the ground. Bird flight data that recorded flight above 48 m above ground level are considered at-risk movements, as this airspace corresponds with the rotor-swept area of the updated WTG design.

4.1 Raptors

Data from 2021, 2022 and 2023 bird surveys at the site shows that eight raptor species are known to utilise the Development Area (**Table 4.1**). Refer **Appendix A** for the locations of raptors within the Development Area since 2021.

Two of these species (Spotted Harrier and the Southern Boobook) have been assessed as having a **low** risk of collisions with a WTG. For the species of which risk was determined as low, individuals may be affected, but the viability of local populations and the species as a whole will not be impacted upon.

All other raptor species have been assessed as having a **medium** risk level. The raptor species that were assessed as having a medium level of risk are potentially being affected at the local population level, but not at the overall species level.

4.2 Threatened species

A total of six threatened species have been assessed as part of this risk assessment. Three threatened bird species are Known to occur within the Development Area, this includes:

- Blue-winged Parrot (*Neophema chrysostoma*) – Nationally and State Vulnerable
- Diamond Firetail (*Stagonopleura guttata*) – Nationally and State Vulnerable
- Rainbow Bee-eater (*Merops ornatus*) – Marine listed species.

An additional three species have been assessed as either Possibly or Likely occurring within the Development Area (Table 4.1), this includes:

- Southern Whiteface (*Aphelocephala leucopsis*) – Nationally Vulnerable
- South-eastern Hooded Robin (*Melanodryas cucullata cucullata*) – Nationally Endangered and State Rare
- Painted Honeyeater (*Grantiella picta*) – Nationally Vulnerable and State Rare.

An additional three State threatened species have been assessed as Likely or Possibly occurring within the Development Area (Table 4.1), this includes:

- White-winged Chough (*Corcorax melanorhamphos*) – State Rare
- Restless Flycatcher (*Myiagra inquieta*) – State Rare
- Elegant Parrot (*Neophema elegans elegans*) – State Rare.

Four of the species (Blue-winged Parrot, Diamond Firetail, Painted Honeyeater and South-eastern Hooded Robin) have been assessed as having a **medium** risk of collisions with a WTG. Although the likelihood of an event causing a mortality is unlikely for these species. If a mortality was to occur, it is likely to have impact on population due to the Nationally and State threatened status of these species.

Five other species (Southern Whiteface, Rainbow Bee-eater, White-winged Chough, Restless Flycatcher, Elegant Parrot) have been assessed as having a **low** risk of collisions with a WTG.

Refer to **Appendix B** for threatened species records within the Development Area.

4.3 Common species

A total of four common bird species (Australian Raven, Little Raven, Pink Galah and Australian Magpie) performed “at-risk” movements within the Development Area in the last two years. Collision for these species is likely, however, the consequence at a population was deemed insignificant. Therefore, these species have been assessed as having a **low** risk level (**Table 4.1**).

Table 4.1 Twin Creek Wind Farm avian risk assessment

Scientific name	Common name	Type	Max flight height (m) (Umwelt observations)	Conservation status		Likelihood of utilising Development Area (Umwelt 2024)	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
				Aus	SA				
Raptor species observed in the Development Area									
Aquila audax audax	Wedge-tailed Eagle	Raptor	400			Known	Likely	Minor	Medium
Circus assimilis	Spotted Harrier	Raptor	NA*			Known	Unlikely	Minor	Low
Falco berigora berigora	Brown Falcon	Raptor	150			Known	Likely	Minor	Medium
Falco cenchroides cenchroides	Nankeen Kestrel	Raptor	150			Known	Likely	Minor	Medium
Falco peregrinus	Peregrine Falcon	Raptor	NA*		R	Known	Likely	Minor	Medium
Falco subniger	Black Falcon	Raptor	15		R	Known	Unlikely	Moderate	Medium
Hieraaetus morphnoides	Little Eagle	Raptor	40		V	Known	Unlikely	Moderate	Medium
Ninox boobook	Southern Boobook	Raptor	4			Known	Unlikely	Minor	Low
Nationally threatened birds potentially occurring within the Development Area									
Aphelocephala leucopsis	Southern Whiteface	Woodland bird	NA	VU		Possible	Unlikely	Minor	Low
Melanodryas cucullata cucullata	South-eastern Hooded Robin	Woodland bird	NA	EN	R	Likely	Unlikely	Moderate	Medium
Neophema chrysostoma	Blue-winged Parrot	Woodland bird	NA*	VU	V	Known	Unlikely	Moderate	Medium

Scientific name	Common name	Type	Max flight height (m) (Umwelt observations)	Conservation status		Likelihood of utilising Development Area (Umwelt 2024)	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
				Aus	SA				
Stagonopleura guttata	Diamond Firetail	Woodland bird	NA*	VU	V	Known	Unlikely	Moderate	Medium
Merops ornatus	Rainbow Bee-eater	Woodland bird	NA*	Ma		Known	Unlikely	Minor	Low
Grantiella picta	Painted Honeyeater	Woodland bird	NA	VU	R	Possible	Unlikely	Moderate	Medium
State threatened birds assessed as potentially occurring within the Development Area									
Corcorax melanorhamphos	White-winged Chough	Woodland bird	NA*		R	Likely	Unlikely	Minor	Low
Myiagra inquieta	Restless Flycatcher	Woodland bird	NA		R	Likely	Unlikely	Minor	Low
Neophema elegans elegans	Elegant Parrot	Woodland bird	NA		R	Possible	Unlikely	Minor	Low
"At risk" common bird species that occur in the Development Area									
Corvus coronoides	Australian Raven	Woodland bird	350			Known	Likely	Insignificant	Low
Corvus mellori	Little Raven	Woodland bird	100			Known	Likely	Insignificant	Low
Eolophus roseicapilla	Pink Galah	Woodland bird	120			Known	Likely	Insignificant	Low
Gymnorhina tibicen	Australian Magpie	Woodland bird	100			Known	Likely	Insignificant	Low

Aus: *Australia (Environment Protection and Biodiversity Conservation Act 1999).* ***SA:*** *South Australia (National Parks and Wildlife Act 1972).* ***Conservation Codes: EN/E:*** *Endangered.* ***VU/V:*** *Vulnerable.* ***R:*** *Rare.* ***Mi****: Migratory. Ma: Marine – protected in Marine Protected Areas. *opportunistic bird record, no flight data provided. NA: No flight data available, however, known flying behaviour of this species has been used to make the assessment.*

Likelihood definitions (how likely is mortality from collision to occur):

- Chronic – the event is expected to occur in most circumstance
- Frequent - the event probably will occur in most circumstances
- Likely - the event should occur at some time
- Unlikely – the event could occur at some time
- Rarely – the event may occur only in exceptional circumstances.

Consequence definitions (significance of associated impact on species viability):

- Catastrophic disaster – the event has the potential to lead to collapse of species
- Major– critical event, very likely to have significant impact on species
- Moderate– likely to have impact on population, potential to impact on long term viability under some scenarios
- Minor – the event may impact on local population, no impact on species
- Nil/Insignificant - individuals may be affected, but viability of local population not impacted.

Level of risk (as per Table 3.2 **on** Page 11):

- low
- medium
- high
- extreme.

4.4 Bats

Umwelt has assumed that all bat species recorded during the surveys and determined as “likely” to occur within the TCWF are at risk to barotrauma.

There is a possibility of bats flying into the rotor-swept area as they traverse between areas at at-risk heights and between wooded habitats. Being nocturnal, bats need places to roost during the day that provide shelter from the weather and potential predators. Most microbats will roost in tree hollows or under bark. Flight height of bats as they leave their roosting sites and fly between areas may coincide with the revised rotor-swept area of the updated WTG design.

The risk assessment includes assessing eleven bat species (**Table 4.2**):

- Seven bat species are Known to occur at the site (confirmed through AnaBat surveys, EBS 2017).
- Three species determined as Likely occurring at the site, based on desktop assessment results (EBS 2017):

All eleven bat species have been assessed as having a **medium** risk to be impacted by the proposed TCWF.

Table 4.2 Twin Creek Wind Farm bat risk assessment

Scientific name	Common name	Conservation status		Likelihood of utilising Development Area (EBS 2017)	Likelihood of an event causing mortality	Consequence at a species / population level	Level of risk
		Aus	SA				
Bat species (ID AnaBat) identified as occurring within the Development Area							
Austronomus australis	White-striped Freetail-bat			Known	Likely	Minor	Medium
Chalinolobus gouldii	Gould's Wattled Bat			Known	Likely	Minor	Medium
Chalinolobus morio	Chocolate Wattled Bat			Known	Likely	Minor	Medium
Nyctophilus geoffroyi	Lesser Long-eared Bat			Known	Likely	Minor	Medium
Ozimops planiceps	Southern Free-tail Bat			Known	Likely	Minor	Medium
Vespadelus darlingtoni	Large Forest Bat			Known	Likely	Minor	Medium
Vespadelus regulus	Southern Forest Bat			Known	Likely	Minor	Medium
Other bat species determined as potentially occurring within the Development Area							
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat		R	Likely	Likely	Minor	Medium
Scotorepens balstoni	Inland Broad-nosed Bat			Likely	Likely	Minor	Medium
Vespadelus vulturnus	Little Forest Bat			Likely	Likely	Minor	Medium

Conservation status**: Aus:** Australia (*Environment Protection and Biodiversity Conservation Act 1999*). **SA:** South Australia (*National Parks and Wildlife Act 1972*). **Conservation Codes: VU/V:** Vulnerable. **R:** Rare.

Likelihood definitions (how likely is mortality from collision to occur):

- Chronic – the event is expected to occur in most circumstance
- Frequent - the event probably will occur in most circumstances
- Likely - the event should occur at some time
- Unlikely – the event could occur at some time
- Rarely – the event may occur only in exceptional circumstances.

Consequence definitions (significance of associated impact on species viability):

- Catastrophic disaster – the event has the potential to lead to collapse of species
- Major– critical event, very likely to have significant impact on species
- Moderate– likely to have impact on population, potential to impact on long term viability under some scenarios
- Minor – the event may impact on local population, no impact on species
- Nil/Insignificant - individuals may be affected, but viability of local population not impacted.

Level of risk (as per **Table 3.2** on **Page 11**):

- low
- medium
- high
- extreme.

5.0 Discussion

The level of risk was categorised as **medium** for nine bird species listed in **Table 4.1** and **medium** for all bat species listed in **Table 4.2**. The species with medium risk level assessments have a minor consequence at a species / population level. The risk assessment implies that there may be an impact on the local population of these species in the event of collision with a WTG.

For those bird and bat species considered to have a **medium** risk level, all efforts have been made to mitigate against potential impact on these species. RES have taken into consideration the 200 m exclusion buffer around woodlands and have adopted this buffer where possible. Similarly, all efforts were made to minimise the impact to WTE nesting sites within these woodlands with consideration of a 500 m buffer around these nests in the project design.

5.1 EPBC Act listed threatened species

Since in the approval of the TCWF design in 2019, four new bird species relevant to TCWF have been added to the EPBC Act list of threatened species:

- Southern Whiteface (*Aphelocephala leucopsis*) - EPBC Act: Vulnerable
- Blue-winged Parrot (*Neophema chrysostoma*) - EPBC Act: Vulnerable, NPW Act: Vulnerable
- Hooded Robin (*Melanodryas cucullata cucullata*) – EPBC Act: Endangered, NPW Act: Rare
- Diamond Firetail (*Stagonopleura guttata*) – EPBC Act: Vulnerable; NPW Act: Vulnerable.

All four newly listed species are woodland birds, and with the RSA of the updated WTG design being 48 m, the likelihood of these birds experiencing a collision has been reduced compared to the earlier WTG designs. All WTG are located outside of the 500 m buffer from known WTE nests.

5.2 Raptors

A total of six raptors, of which three are State threatened (Peregrine Falcon, Black Falcon and the Little Eagle) have been assessed at a **medium** impact level due to their flight behaviour (particularly while foraging) as they have been frequently recorded flying at heights or likely to fly within RSA of a WTG. Additionally, raptor species listed as a medium risk have been observed in the Development Area occurring near proposed turbine sites (**Figure B.1**). Raptors such as Wedge-tailed Eagles and Peregrine Falcons generally reside and nest in permanent home ranges. As such when these species intersect with wind farm locations there is a higher risk of WTG collision (Smales 2006). Raptors are particularly at risk during their breeding season as they are restricted to a nesting location and individuals are deemed to forage more regularly to feed their young. Given there are four known nest locations of Wedge-tailed Eagles within the proposed TCWF Development Area, Wedge-tailed Eagle have been assessed as having a **medium** risk level. Similarly, a Nankeen Kestrel nest was observed within the woodland during the 2023 surveys. Species observed below the RSA have been assessed as unlikely. However, due to the State threatened status of these species, they have been assessed as a **moderate** consequence (Black Falcon and Little Eagle). As mortality is likely to have impact on population level.

5.3 Woodland species

In general, the potential effects of a wind farm on woodland bird species are related to (1) possible loss of habitat and (2) disturbance and impacts from turbines situated close to woodlands. Direct interaction with turbine blades is assessed as Unlikely for woodland specific bird species (unless otherwise stated in **Table** 4.2), as the WTG height of blades is reduced. Common bird species were assessed for their potential to be impacted at the local population level by the proposed TCWF. Most of the common bird species that occur at wind farms such as Pink Galah and the Australian Magpie tend to forage and nest within wooded areas. The location of WTG 37 (40 m from woodland) may increase the risk of individual mortality. However, it has been assessed that for these common species individuals may be affected, but viability of local population not impacted. Therefore, these were assessed a **low** risk level.

5.4 Bats

All bats were assessed as having a **medium** risk level. Despite not having flight height data for bats, the **medium** risk level is based on the general knowledge of bat movements and on data from the study by Moloney *et al.* (2019). That study recorded mortality events for 13 bat species over 2 years, with some that extended to 3 or 3.5 years. Of the 13 species recorded, seven occur at the TCWF. Bats are more at risk of rotor strike/barotrauma when traversing between patches of woodland. Similar to woodland birds, the proximity of turbines to woodlands within TCWF and the RSA are likely to be the main risk factors for strikes/barotrauma impacts.

5.5 Conclusion

The location of the wind farm relative to bird species that may be present, the layout of the turbines, particular landscape features and the behaviour of bird species influence the likelihood that a bird flying through a wind farm will collide with a turbine (Krijgsveld *et. al* 2009, Erickson *et.al* 2014, Perold *et. al* 2020 and Santos *et al.* 2022). As such, features that increase the risk of birds colliding with turbines (such as placement of turbines near Wedge-tailed Eagle nest and Peregrine Falcon Nest, or placement of turbines near woodlands) should be considered in the design of wind farms. Collision risk models have also been used to determine the risk of collision of large raptors with wind turbines (Murgatroyd *et. al* 2020).

Exclusion buffers have been considered in the planning and design processes of TWCF, in order to reduce the likelihood of impacts to birds in the area proposed for development. In South Australia, exclusion buffers around known raptor nest's locations are currently primarily aimed at reducing the disturbance to raptors during breeding season and when juveniles are near fledging. The risks of collision for raptor species such as the Wedge-tailed Eagle and Peregrine Falcon are considered significant when assessing bird interactions with wind farms, as they conduct regular flights at heights coinciding with turbine rotor-swept areas of operating WTG.

The benefits of exclusion buffers around known nest locations of at-risk bird species are deemed as follows:

- Buffers are generally focussed around areas of high bird activity (e.g., woodland); these are areas where raptor species may potentially nest.
- During the construction of proposed wind farms, raptor species are more likely to be at risk of disturbance from activities conducted within close proximity to nest locations. By implementing

exclusion buffers, disturbance levels to these bird species would be avoided/minimized as much as possible.

- Raptors such as Wedge-tailed Eagles are territorial and typically return to the same area to nest each year. The placement of exclusion buffers around nest locations assists with lessening disturbance levels to this species.
- Juvenile raptors (and juvenile birds in general) are deemed to be more susceptible to collision with WTGs. Newly fledged juveniles would need to learn how to forage on their own and are deemed more naïve and thus less likely to avoid structures such as turbines during this learning process. The implementation of exclusion buffers around known nest sites assists in decreasing the risk of juvenile raptors/birds colliding with WTGs.

6.0 Recommendations

6.1 Design considerations

Based on the risk assessment, Umwelt has recommended to RES that the following exclusion zones be included:

- At a minimum, a 500 m exclusion buffer around Wedged-tailed Eagle nests to mitigate the likelihood of mortality from collision with a WTG.
- At a minimum, a 200 m exclusion buffer around woodland (including patches of scattered trees). This is aimed at minimising disturbance to wooded areas where woodland birds and bats are likely to roost.

These recommendations have been considered as part of the designs where possible.

6.2 EPBC assessment

The following EPBC Act listed threatened species have been assessed in this risk assessment:

- Blue-winged Parrot (*Neophema chrysostoma*) – EPBC Act: Vulnerable
- Diamond Firetail (*Stagonopleura guttata*) – EPBC Act: Vulnerable
- Painted Honeyeater (*Grantiella picta*) – EPBC Act: Vulnerable
- Rainbow Bee-eater (*Merops ornatus*) – EPBC Act: Marine
- South-eastern Hooded Robin (*Melanodryas cucullata cucullata*) – EPBC Act: Endangered
- Southern Whiteface (*Aphelocephala leucopsis*) – EPBC Act: Vulnerable.

The Hooded Robin, Diamond Firetail, Southern Whiteface and Blue-winged Parrot are newly listed species under the EPBC Act (date effective 31 March 2023). It is recommended that an EPBC self-assessment is undertaken to outline whether an ongoing bird monitoring survey will be required.

It is acknowledged by RES, that a EPBC Significant Impact Assessment and a EPBC referral is likely required by DCCEEW, for approval under the EPBC Act.

7.0 References

Australian Ecological Research Services (AERS). (2015). Bat activity at the Macarthur Wind Farm. Autumn and Spring 2014. Report to AGL Energy Limited. Macarthur Wind Farm Bat monitoring Autumn & Spring 2014 (agl.com.au)

AusWind. (2006). *Best Practice Guidelines: for implementation of wind energy projects in Australia*, Available from: www.AusWind.org/downloads/bestpractice/AUSWINDBestPracticeGuidelines.pdf. [Accessed November 2023].

Baerwald EF, D'Amours GH, Klug BJ, Barclay RMR. (2008) Barotrauma is a significant cause of bat fatalities at wind turbines. Curr Biol 18:R695–R696.

Brett Lane & Associates Pty Ltd (BL&A). (2019). Ararat Wind Farm – Bird and Bat Monitoring Program. Second year Annual Report April 2017 to March 2019. Title (ararat-windfarm.com)

Biosis Research Pty Ltd. (2006). Wind farm collision risk for birds Cumulative risks for threatened and migratory species. Report Prepared for the Australian Government Department of the Environment and Heritage by Biosis Research Pty Ltd. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.dcceew.gov.au/sites/default/files/documents/wind-farm-bird-risk.pdf [Accessed November 2023].

Dahl, E.L., Bevanger, K., Nygård, T., Røskaft, E. & Stokke, B.G. (2012). Reduced breeding success in white-tailed eagles at Smøla windfarm, western Norway, is caused by mortality and displacement. Biol. Conserv. 145, 79–85

Department for Environment and Water (DEW). (2021). Database extract sourced from the South Australian Biological Database of South Australia. Data Licence number 2785 Recordset number DEWNRBDBSA231031-4 [Obtained 30 October 2023].

Department for Environment and Water (DEW). (2023). Biological Databases of South Australia (BDBSA) data extract: Recordset number: DEWNRBDBSA231031-4. Adelaide.

Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). *EPBC Protected Matters Search*, http://www.environment.gov.au/erin/ert/epbc/index.html. [Accessed 12 September 2024].

EBS Ecology. (2017). TCWF Flora and Fauna Assessment. Report to RES. EBS Ecology, Adelaide.

EBS Ecology. (2020a). TCWF Bird Strike Risk Assessment. Report to RES. EBS Ecology, Adelaide.

EBS Ecology. (2020b) Twin Creek Wind Farm Bird and Bat Monitoring, July 2020. Report to RES. EBS Ecology, Adelaide

EBS Ecology. (2021) Twin Creek Wind Farm Bird and Bat Monitoring, December 2020. Report to RES. EBS Ecology, Adelaide

EBS Ecology. (2021a) Twin Creek Wind Farm Bird and Bat Monitoring, April 2021. Report to RES. EBS Ecology, Adelaide.

EBS Ecology. (2021b) Twin Creek Wind Farm Bird and Bat Monitoring, February 2021. Report to RES. EBS Ecology, Adelaide.

EBS Ecology. (2021c) Twin Creek Wind Farm Bird and Bat Monitoring, August 2021. Report to RES. EBS Ecology, Adelaide.

EBS Ecology. (2022) Twin Creek Wind Farm Bird and Bat Monitoring, October 2021. Report to RES. EBS Ecology, Adelaide.

Erickson WP, Wolfe MM, Bay KJ, Johnson DH, Gehring JL. (2014). A comprehensive analysis of small-passerine fatalities form collisions with turbines at wind energy facilities. PLoS ONE 9: e107491. A Comprehensive Analysis of Small-Passerine Fatalities from Collision with Turbines at Wind Energy Facilities | PLOS ONE

Gaidow, S. and Boey, S. (2005). Australian Defence Risk Management Framework: A comparative study. Commonwealth of Australia - DSTO Systems Sciences Laboratory.

Garvin, J.C., Jennelle, C.S., Drake, D. & Grodsky, S.M. (2011). Response of raptors to a windfarm. J. Appl. Ecol. 48, 199–209.

Hodos, W. (2003). Minimization of Motion Smear: Reducing Avian Collision with Wind Turbines; Period of Performance: July 12, 1999--August 31, 2002 (No. NREL/SR-500-33249). National Renewable Energy Lab.(NREL), Golden, CO (United States).

Hull, C. L., & Muir, S. C. (2013). Behavior and turbine avoidance rates of eagles at two wind farms in Tasmania, Australia. *Wildlife Society Bulletin*, **37**(1), 49-58.

Hull, C., Stark E., Peruzzo, S., & Sims, C. (2013). Avian collisions at two wind farms in Tasmania, Australia: taxonomic and ecological characteristics of colliders versus non-colliders, *New Zealand Journal of Zoology*, **40**:1, 47-62, DOI: 10.1080/03014223.2012.757243.

Hull, C., Sims, C., Stark, E., & Muir, S. (2015). Results and analysis of eagle studies from the Bluff Point and Studland Bay Wind Farms 2002–2012. *In Wind and Wildlife: Proceedings from the Conference on Wind Energy and Wildlife Impacts, October 2012, Melbourne, Australia* (pp. 95-111). Springer Netherlands.

Krijgsveld, K. L., Akershoek, K., Schenk, F., Dijk, F., & Dirksen, S. (2009). Collision risk of birds with modern large wind turbines. *Ardea*, ***97***(3), 357-366.

May, R., Nygård, T., Falkdalen, U., Åström, J., Hamre, Ø., & Stokke, B. G. (2020). Paint it black: Efficacy of increased wind turbine rotor blade visibility to reduce avian fatalities. *Ecology and Evolution*, **10**(16), 8927-8935.

Moloney, P. D., Lumsden, L. F., & Smales, I. (2019). Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates. Arthur Rylah Institute for Environmental Research Technical Report Series No. 302. *Department of Environment. Land, Water and Planning, Melbourne, Vic., Australia*.

Mugatroyd, M. Bouten, W and Amar, A. (2020). A predictive model for improving placement of wind turbines to minimise collision risk potential for large soaring raptor. Journal of Applied Ecology. 2021;58:857-868.

Perold, V., Ralston-Patonm S,m & Ryan, P.G. (2020). On a collision course? The large diversity of birds killed by wind turbines in South Africa. Ostrich, 91, 228-239. On a collision course? The large diversity of birds killed by wind turbines in South Africa (tandfonline.com)

Pullen, P. G. (2023). Eagle deaths in Tasmania attributed to energy assets, with a precautionary appeal to future development. *Australian Field Ornithology*, 40, 214-219. doi:10.20938/afo4021419.

Santos, D, C. Ramesh, H, Ferraz, R. Franco, M.A, A. Wikelski, M. (2022). Factors influencing wind turbine avoidance behaviour of a migrating soaring bird.

Smales, I. (2006). Impacts of avian collisions with wind power turbines: an overview of the modelling of cumulative risks posed by multiple wind farms. Biosis Research.

Szabo, K. J, Baxter, W.J.P, Vesk, P. Possingham, P. H. (2011). Paying the extinction debt: Woodland birds in the Mount Lofty Ranges, South Australia.

Umwelt (Australia) (2024). Native Vegetation Clearance Twin Creek Wind Farm and Energy Storage Project Data Report. Report to MasterPlan Pty Ltd. Umwelt, Adelaide.

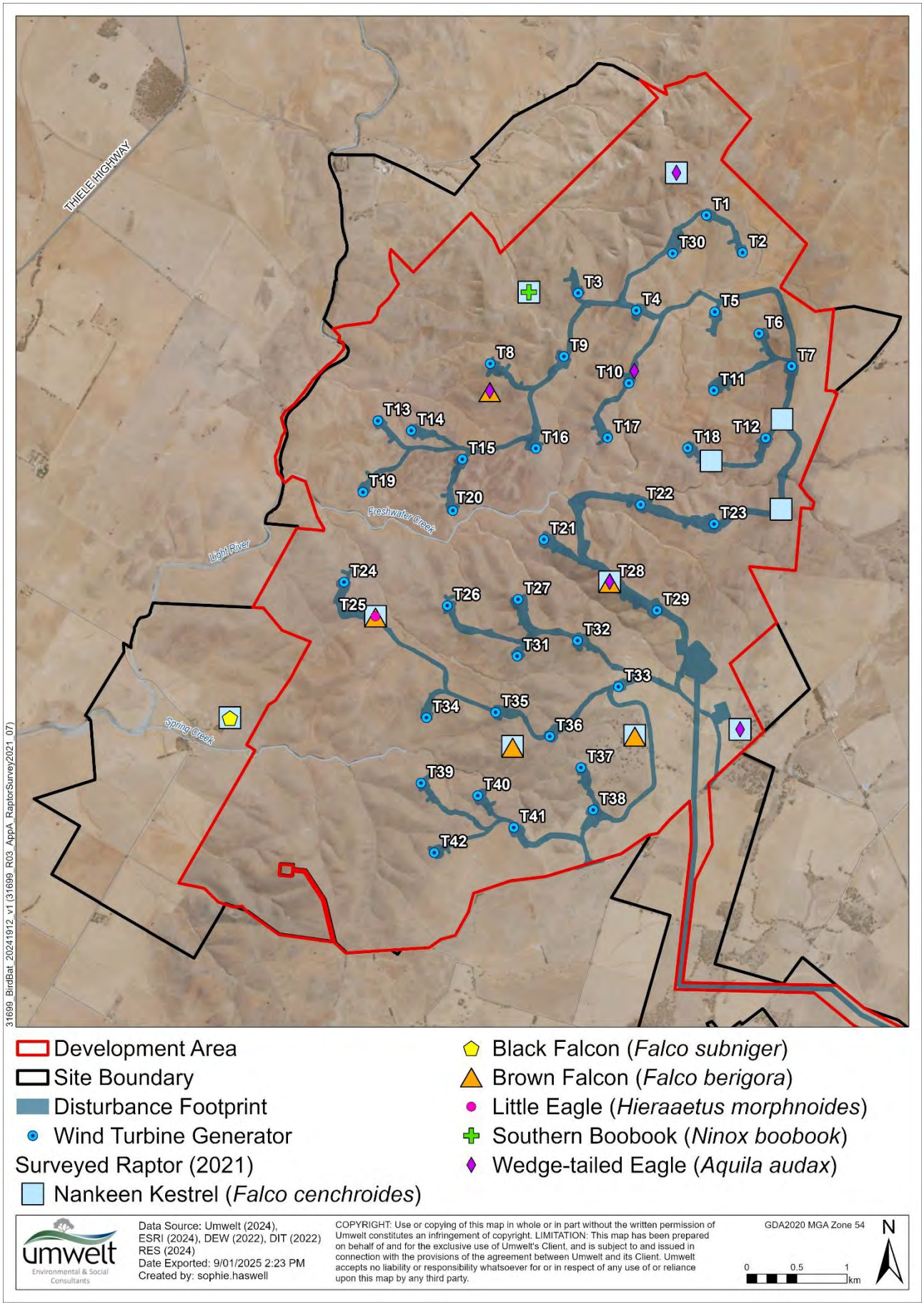
Thaxter, C. B., Buchanan, G. M., Carr, J., Butchart, S. H., Newbold, T., Green, R. E.,& Pearce-Higgins, J. W. (2017). Bird and bat species' global vulnerability to collision mortality at wind farms revealed through a trait-based assessment. *Proceedings of the Royal Society B: Biological Sciences,* **284**(1862), 20170829.

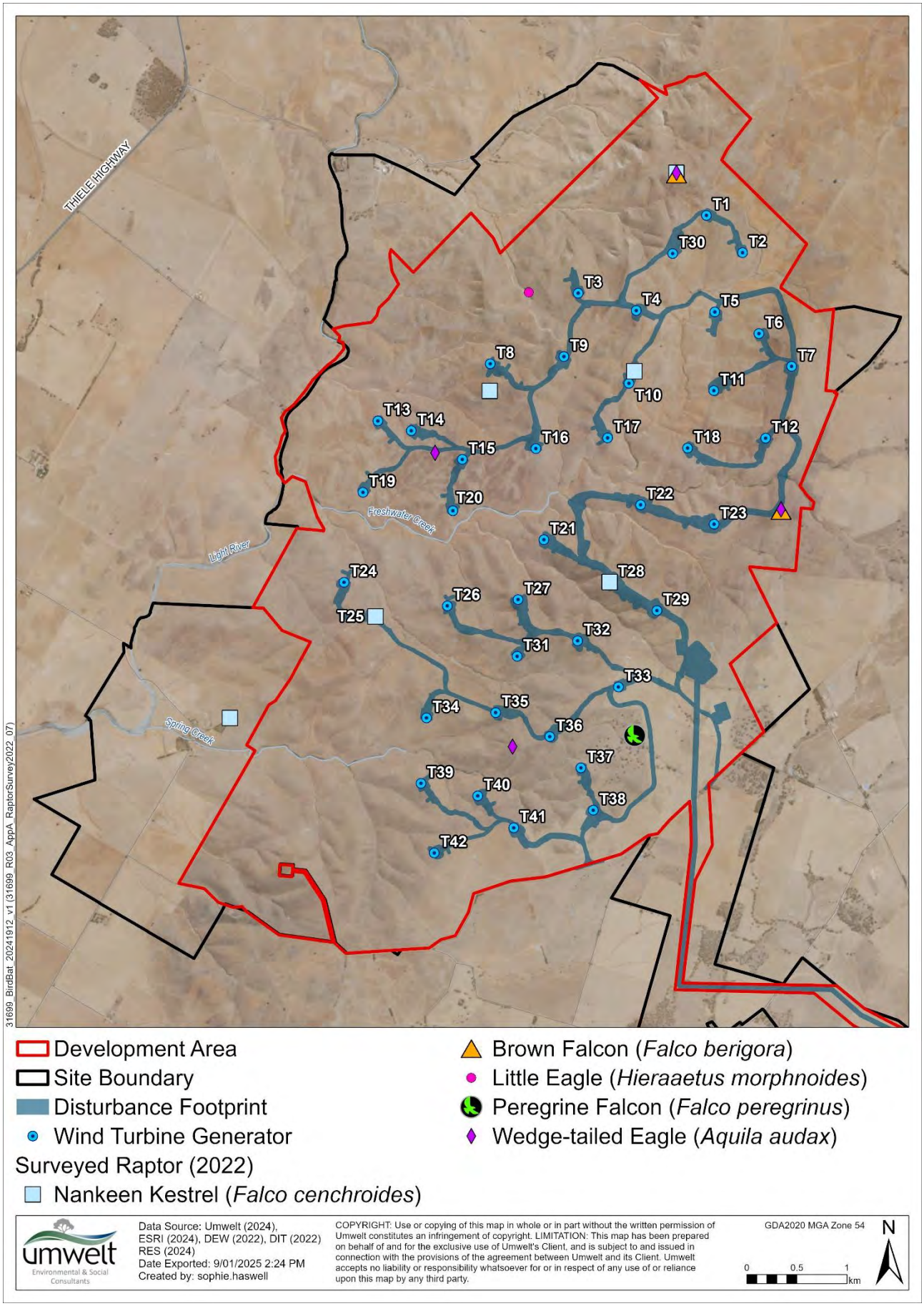
Whitby, M. D, O'Mara, Teague. M, Hein, D.C, Huso, M. Frick, F.W. (2024). A decade of curtailment studies demonstrates a consistent and effective strategy to reduce the bat fatalities at wind turbines in North America. *Ecological Solutions and Evidence*. 2024;5:e12321. A decade of curtailment studies demonstrates a consistent and effective strategy to reduce bat fatalities at wind turbines in North America - Whitby - 2024 - Ecological Solutions and Evidence - Wiley Online Library

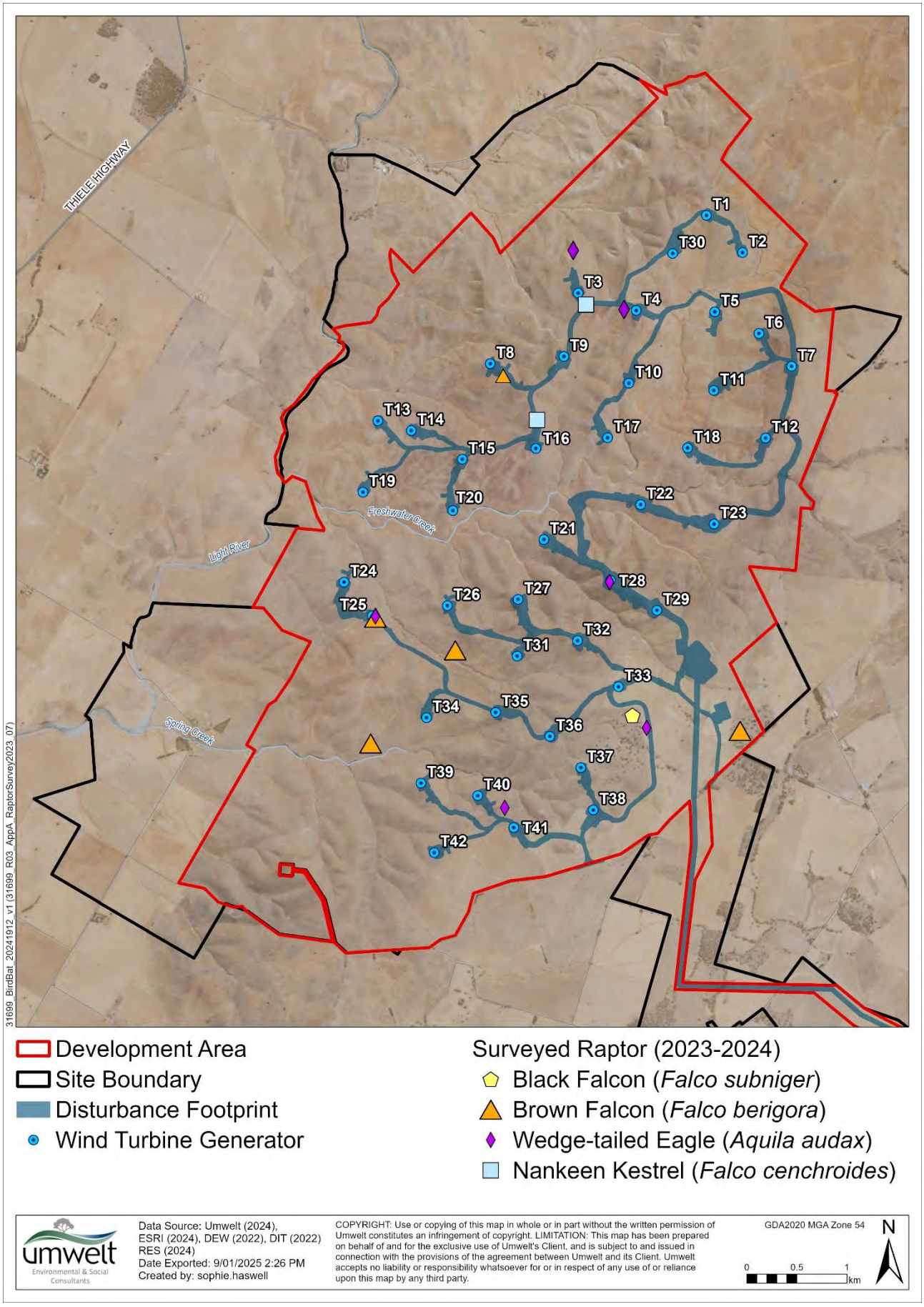
M.C. Zwart, J.C. Dunn, P.J.K. McGowan, M.J. Whittingham. (2016). Wind farm noise suppresses territorial defense behavior in a songbird. Behav. Ecol., 27 (2016), pp. 101-108, 10.1093/beheco/arv128

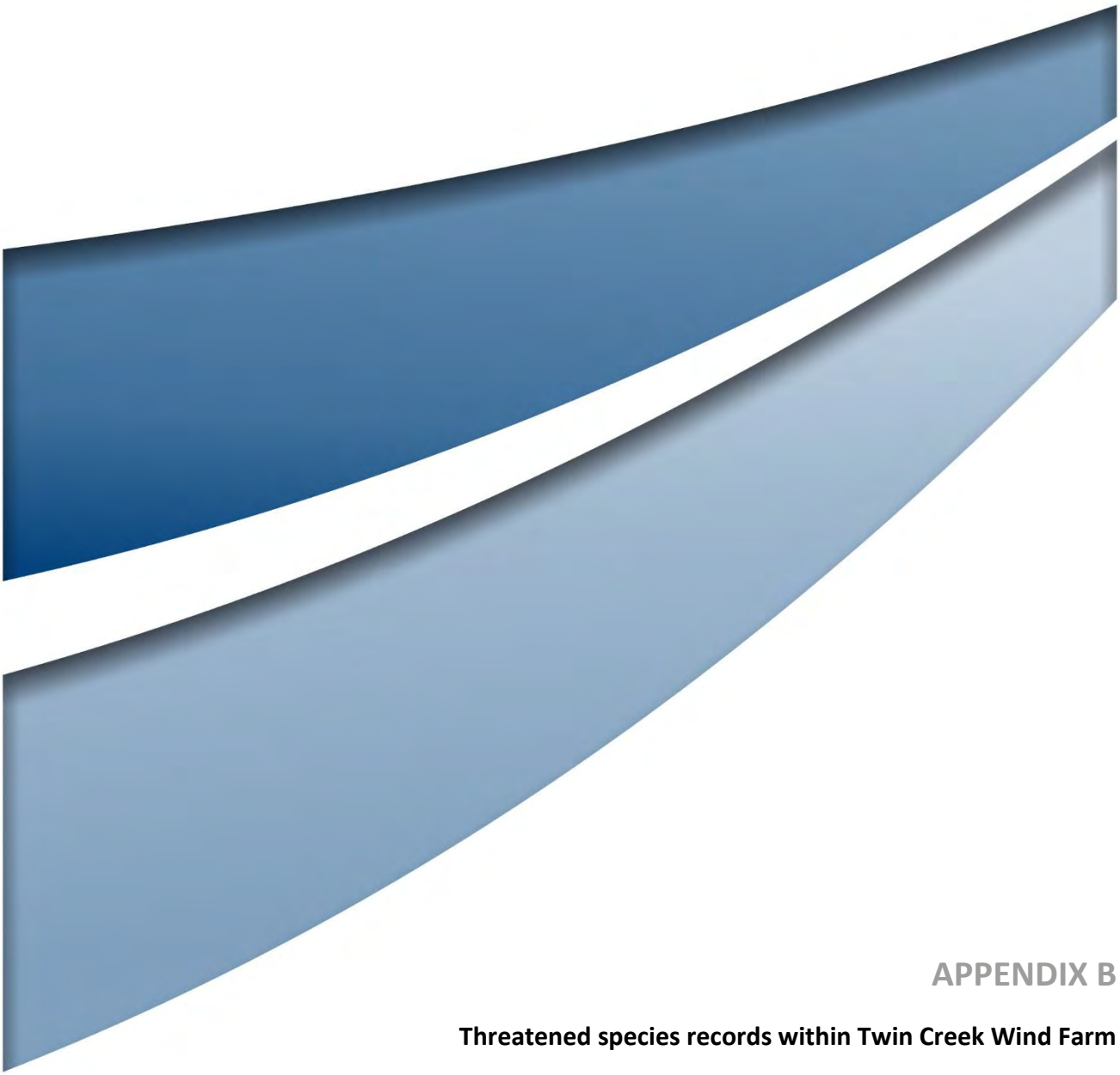
APPENDIX A

Raptors observations within the Development Area during 2021, 2022, 2023 and 2024 surveys


THIELE HIGHWAY
Freshwater Creek
Light River
Spring Creek
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
T21
T22
T23
T24
T25
T26
T27
T28
T29
T30
T31
T32
T33
T34
T35
T36
T37
T38
T39
T40
T41
T42
Development Area
Site Boundary
Disturbance Footprint
Wind Turbine Generator
Surveyed Raptor (2021)
Nankeen Kestrel (Falco cenchroides)
Black Falcon (Falco subniger)
Brown Falcon (Falco berigora)
Little Eagle (Hieraaetus morphnoides)
Southern Boobook (Ninox boobook)
Wedge-tailed Eagle (Aquila audax)
31699_BirdBat_20241912_v1 (31699_R03_AppA_RaptorSurvey2021_07)
umwelt
Environmental & Social Consultants
Data Source: Umwelt (2024), ESRI (2024), DEW (2022), DIT (2022) RES (2024)
Date Exported: 9/01/2025 2:23 PM
Created by: sophie.haswell
COPYRIGHT: Use or copying of this map in whole or in part without the written permission of Umwelt constitutes an infringement of copyright. LIMITATION: This map has been prepared on behalf of and for the exclusive use of Umwelt's Client, and is subject to and issued in connection with the provisions of the agreement between Umwelt and its Client. Umwelt accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this map by any third party.
GDA2020 MGA Zone 54
0
0.5
1
km
N

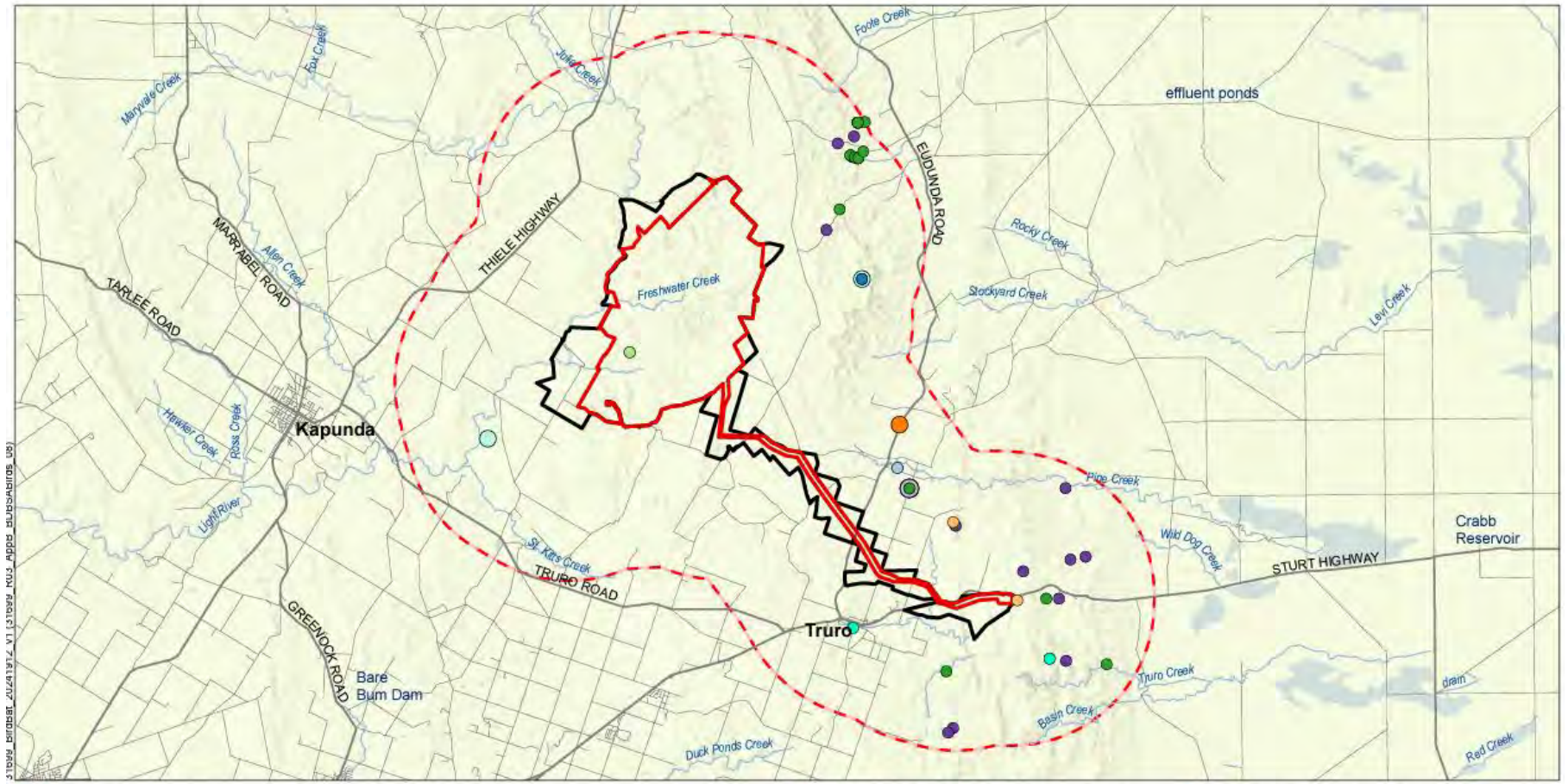

THIELE HIGHWAY
Freshwater Creek
Light River
Spring Creek
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
T21
T22
T23
T24
T25
T26
T27
T28
T29
T30
T31
T32
T33
T34
T35
T36
T37
T38
T39
T40
T41
T42
Development Area
Site Boundary
Disturbance Footprint
Wind Turbine Generator
Surveyed Raptor (2022)
Nankeen Kestrel (Falco cenchroides)
Brown Falcon (Falco berigora)
Little Eagle (Hieraaetus morphnoides)
Peregrine Falcon (Falco peregrinus)
Wedge-tailed Eagle (Aquila audax)
Data Source: Umwelt (2024), ESRI (2024), DEW (2022), DIT (2022) RES (2024)
Date Exported: 9/01/2025 2:24 PM
Created by: sophie.haswell
COPYRIGHT: Use or copying of this map in whole or in part without the written permission of Umwelt constitutes an infringement of copyright. LIMITATION: This map has been prepared on behalf of and for the exclusive use of Umwelt's Client, and is subject to and issued in connection with the provisions of the agreement between Umwelt and its Client. Umwelt accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this map by any third party.
GDA2020 MGA Zone 54
0
0.5
1
km
N
31699_BirdBat_20241912_v1 (31699_R03_AppA_RaptorSurvey2022_07)


THIELE HIGHWAY
Freshwater Creek
Light River
Spring Creek
T1
T30
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
T21
T22
T23
T24
T25
T26
T27
T28
T29
T31
T32
T33
T34
T35
T36
T37
T38
T39
T40
T41
T42
31699_BirdBat_20241912_v1 (31699_R03_AppA_RaptorSurvey2023_07)
Development Area
Site Boundary
Disturbance Footprint
Wind Turbine Generator
Surveyed Raptor (2023-2024)
Black Falcon (Falco subniger)
Brown Falcon (Falco berigora)
Wedge-tailed Eagle (Aquila audax)
Nankeen Kestrel (Falco cenchroides)
umwelt
Environmental & Social Consultants
Data Source: Umwelt (2024), ESRI (2024), DEW (2022), DIT (2022) RES (2024)
Date Exported: 9/01/2025 2:26 PM
Created by: sophie.haswell
COPYRIGHT: Use or copying of this map in whole or in part without the written permission of Umwelt constitutes an infringement of copyright. LIMITATION: This map has been prepared on behalf of and for the exclusive use of Umwelt's Client, and is subject to and issued in connection with the provisions of the agreement between Umwelt and its Client. Umwelt accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this map by any third party.
GDA2020 MGA Zone 54
0
0.5
1
km
N



APPENDIX B

Threatened species records within Twin Creek Wind Farm



Development Area
Site Boundary
Buffer (5 km)
Main road
Local road
Water course
Water body

BDBSA Threatened Birds
- Australian Bustard (*Ardeotis australis*) NPW: V
- Black Falcon (*Falco subniger*) NPW: R
- Blue-winged Parrot (*Neophema chrysostoma*) NPW: V, EPBC: VU
- Diamond Firetail (*Stagonopleura guttata*) NPW: V, EPBC: VU
- Elegant Parrot (*Neophema elegans elegans*) NPW: R
- Hooded Robin (YP, MN, AP, MLR, MM, SE) (*Melanodryas cucullata cucullata*) NPW: R, EPBC: EN
- Peregrine Falcon (*Falco peregrinus macropus*) NPW: R
- Plumed Egret (*Ardea intermedia plumifera*) NPW: R
- Restless Flycatcher (*Myiagra inquieta*) NPW: R
- Southern Whiteface (*Aphelocephala leucopsis leucopsis*) EPBC: VU

umwelt

Data Source: Umwelt (2024), ESRI (2024), DEW (2022), DIT (2022), RES (2024)
Date Exported: 9/01/2025 2:16 PM
Created by: sophie.haswell

GDA2020 MGA Zone 54
0 2.5 5 km
N

umwelt
Environmental & Social
Consultants

Umwelt (Australia) Pty Limited

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au