Appendix M

Flyers Creek Wind Farm – Draft NSW Wind Farm Guidelines Checklist

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Issue	Potential Issue for consideration	Status	Comments
Council planning controls	• Outline whether the proposal is consistent with any relevant provisions of the relevant council's Development Control Plan and justify any variation from the provisions.	✓	The proposal is consistent with these provisions; refer to Ch.5.3 of the EA
Consultation	• Form a Community Consultation Committee.	✓	Infigen advertised and sought nominations from the Orange/Blayney/Carcoar community to be representatives on the Flyers Creek Wind Farm Community Consultative Committee. The first meeting of the Flyers Creek CCC took place on December 6th, 2012.
	• Document the consultation process undertaken, including stakeholders consulted. Identify and tabulate issues raised by stakeholders during consultation. Describe how issues raised have been addressed.	✓	Refer to Ch.6 of the EA for a full summary of consultation that has been undertaken.
	• Consult with all neighbours with dwellings within 2km of a proposed wind turbine - Identify the neighbour issues and potential approaches to mitigate any adverse issues.	✓	All neighbours within 2km of a proposed wind turbine have received two mail outs concerning the project including a project overview, an invitation to attend the Flyers Creek Community Information Days, and the project manager's contact details. The proponent has spoken with the majority of these neighbours.
	• Consider seeking agreement with neighbours which have a dwelling within 2km of a proposed wind turbine.		This would not be practical this late in the planning assessment process.
Landscape and visual amenity	• Provide photomontages from all non-host dwellings within 2km of a proposed wind turbine.	✓	The majority of non-host dwellings within 2km of a proposed wind turbine were offered the opportunity to have a photomontage created for their property. Some residents withheld their consent for the photomontage pictures to be taken; the photomontages for those neighbours who agreed to have the them created appear in Appendix C1 of the EA.
	• Identify the zone of visual influence of the wind farm (no less than 10km) and likely impacts on community and stakeholder values.	✓	A zone of visual influence map is shown in Figure C.7 out to 10 kilometres.

Flyers Creek Wind Farm – Draft NSW Wind Farm Guidelines Checklist

Issue	Potential Issue for consideration	Status	Comments
	• Consider cumulative impacts on the landscape and views.	✓	Refer to Ch.17 of the EA.
	• Outline mitigation measures to avoid or manage impacts.	✓	Refer to Ch.9.15 of the EA.
Noise	• Undertake assessment based on separate daytime (7am to 10pm) and night-time periods (10pm to 7am).		A full noise assessment was undertaken based on the DGR's provided and compliance was achieved at all receivers as described in Ch. 12 of the EA.
	• Predict noise levels at all dwellings within 2km of a proposed turbine.	✓	Refer to Table 12.6 in the EA.
	• Consider special audible characteristics; including tonality, amplitude modulation, and low frequency noise (apply penalties where relevant).	✓	Consideration had been given to special audible characteristics (tonality, amplitude modulation) as described in Section 6 of Appendix G2 and for low frequency noise as described in Response to Submission Item 3aa.
	• Outline measures to avoid, minimise, manage and monitor impacts.	✓	Refer to Ch.12.11 of the EA.
Health	• Consider health issues consistent with the draft guidelines, focusing on neighbours' of dwellings within 2km of proposed wind turbines and documenting this in the EA.	✓	Refer to Ch. 16.11 of the EA and to Section 4 of the Responses to Submissions.
Aviation safety	• Outline current agricultural aerial uses on neighbouring properties.	✓	Refer to Section 16.2.4 of the EA.
	• Consider the potential for the proposed wind farm to impact on aviation safety associated with agricultural aerial uses consistent with the draft guidelines.	✓	Refer to Section 16.2.4 of the EA and response 12(a) in the Response to Submissions.
Bushfire hazard	• Consider bush fire issues consistent with the draft guidelines, including the risks that a wind farm will cause bush fire and any potential for the wind farm to impact on the aerial fighting of bush fires.	✓	Refer to Ch.16.5 of the EA and responses 12(g) and 12(i) in the Responses to Submissions.

Flyers Creek Wind Farm – Draft NSW Wind Farm Guidelines Checklist

Issue	Potential Issue for consideration	Status	Comments
Blade throw	• Assess blade throw risks consistent with the draft guidelines.	✓	Refer to Ch. 16.3 of the EA and response 12(n) in the Response to Submissions. In addition, Infigen can confirm that IEC 61400-23 *Wind Turbine Generator Systems – Full Scale Structural Testing of Rotor Blades* will be added to safety and building standards.
	• Outline measures to avoid, minimise, manage and monitor impacts.	✓	As above.
Mineral resources	• Consider potential to impact upon mining/petroleum leases and exploration licenses. If relevant, consult with the Minerals and Petroleum Division of the NSW Department of Trade and Investment, Regional Infrastructure and Services.	✓	Refer to Ch.4.4.5 of the EA.
Property values	• Consider whether the wind farm use is consistent with local or regional land use planning strategies.	✓	Refer to Chapter 5 of the EA.
	• Consider any potential impacts upon property values consistent with the draft guidelines, including properties within 2km.	✓	Refer to Section.7.8.2 of the EA and response 7c in the Responses to Submissions.
Decommissioning	• Include a Decommissioning and Rehabilitation Plan in the EA, including proposed funding arrangements.	✓	Plan included in the Responses to Submissions as Appendix N.
	• Confirm that the proponent not the landowner is responsible for decommissioning.	✓	This is confirmed in the Decommissioning Plan and elsewhere (including in the lease agreements with the landowners).
Ecological Issues	• Consider potential impacts on birds and bats, particularly migratory species and outline the proposed monitoring and mitigation strategy.	✓	Refer to Ch.10.3 and Appendices D & E of the EA.

Flyers Creek Wind Farm – Draft NSW Wind Farm Guidelines Checklist

Issue	Potential Issue for consideration	Status	Comments
Monitoring and compliance program	• Outline program to monitor and environment performance to ensure compliance including mechanisms for reporting outcomes and procedures to rectifying non-compliance – including any provisions for independent reviews.	✓	As with all of our NSW wind farms we will perform noise compliance testing once the wind farm is operational. Noise and other monitoring and compliance programs are included in the Statement of Commitments and/or will be developed and included in the various management plans to be written should the project be approved. Infigen will work with all stakeholders during compliance reviews, and if by chance there is non-compliance, measures will be taken to rectify the problem.

✓ = Compliance with the issue for consideration

✓ = Partial compliance with the issue for consideration

Appendix N

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FLYERS CREEK WIND FARM DECOMMISSIONING PLAN

Introduction

Flyers Creek Wind Farm Pty Ltd commits to restoring the land to its previous condition as per the decommissioning clause in the lease agreement (below) and in Chapter 3.7 of the EA. Infigen will also monitor repowering opportunities and is also very confident that the salvage value of the turbines will outweigh the decommissioning costs.

Infigen Energy recently engaged a quantitative surveyor to prepare a decommissioning cost estimate for our Woodlawn Wind Farm. This report[1] estimates that the current net shortfall in salvage value per turbine is $ 59,709. In our opinion this is quite conservative and excludes a lot of potential in recouping costs from recycling the blades and also from other components that can be used in other applications. Given that we own a significant number of turbines around the world, we have already engaged on our own study to determine alternative ways to reuse or recycle the turbines once they are decommissioned.

Infigen acknowledges that the draft wind farms guidelines require a decommissioning and rehabilitation plan to be provided in the EA. As we have already actively commenced our own research into the recycling potential of the turbines, we propose the following plan for decommissioning and rehabilitation that includes our existing programs.

Consultation

Prior to each lease being executed with the landowner, the decommissioning plan was discussed and agreed. Below is a copy of the decommissioning clause from the Flyers Creek Wind Farm lease agreement that all landowners have executed.

Fig. 1 Decommissioning clause from Flyers Creek Wind Farm lease agreement:

4.12 Removal of Wind Farm Plant and Equipment

(a) Within 180 days of the conclusion of the Term all Plant and Equipment whatsoever sited above the surface of the Lessor's Land and all Plant and Equipment sited on the surface of the Lessor's Land shall be removed by the Lessee. Plant and Equipment sited below the surface of the Lessor's Land shall be removed to a minimum depth of 400mm.

(b) Concrete foundations shall be expressly excluded from the requirement of clause 4.12(a) but only upon the condition that a smoothed even covering of good quality top soil is placed to a minimum depth of 750mm over such concrete foundations. The seeding utilised will be approved by the Lessor.

(c) Fences and gates constructed by the Lessee shall be removed at the request of the Lessor. Roads shall be expressly excluded from the requirement of clause 4.12(a); however, they can be covered in good quality top soil and re-seeded using seeding approved by the Lessor, upon request.

Operational life of the wind farm

It is expected that the wind farm will be in operation for between 20-25 years, unless it is repowered prior. Repowering a site means replacing the older wind turbines with newer, more efficient and higher capacity wind turbines. As stated earlier, Infigen believes it is probable that the Flyers Creek site will be repowered before the end of the first 25 years. If Infigen intends to repower the site, a completely new Development Application will be lodged and approval sought.

Dismantling

Unless the local electricity network operator or landowner requests that certain wind farm infrastructure be retained on land, it will be removed and restored to its previous condition.

Below is a summary of each component of wind farm infrastructure and how we propose to decommission and dismantle it.

- Removal of turbines and concrete foundation: Similar to the erection of the wind turbines, a crane will arrive on site and dismantle the wind turbine components. They will be taken down very carefully to maximise resale ability.

  Unless required somewhere else, the steel towers will be trucked straight to the scrap metal recycling plant. The location of this plant will be determined closer to the time of decommissioning (several options exist today). The remainder of the turbine will be dismantled into smaller components to allow for more efficient recycling. This procedure will take place either at the central lay down area or on the pad mount next to the turbine. The priority will be to reuse as many of the components as possible and recycling the remainder. This should maximise the salvage value and minimise the amount that is sent to landfill.

  The concrete foundation will be retained in the ground and covered with an appropriate level of top soil before reseeding.
- Removal of viewing facilities, maintenance shed and other facilities: The first option for decommissioning these facilities will be to assess whether they could be of any benefit to the local community. We envisage that we would be able to donate the sheds and equipment to a local group or farmer when the wind farm no longer requires it.
- Electrical Infrastructure: this type of infrastructure typically has a longer design life than a wind turbine. Prior to any decommissioning a thorough consultation will occur with the local network service provider (NSP) and landowners with easements on their property. It is possible that most of this infrastructure will remain beyond the decommissioning of the wind farm. For any items that the NSP does not wish to own, they will be removed and the recycled as scrap metal if they cannot be used elsewhere.
- Access roads: these roads have been designed with the farmer to ensure that they are of benefit to their farm as well as providing access to the turbine. For a number of locations, the Flyers Creek Wind farm access tracks are upgrades to existing farm tracks. It is envisaged that they will remain part of the on-farm infrastructure.

Transportation

All of the turbines will be dismantled on site and broken into smaller pieces to allow for easier transportation. They will be stored on the site lay down area and then trucked to the nearest scrap metal recycler. A portable shredder will be bought on site to shred the fibre glass blades. The traffic and transport management plan used for construction will be updated to reflect the decommissioning traffic movements. The two scrap metal merchants we have identified in the district who would be likely candidates are:

1. Orange Scrap Recyclers
   73 William Street
   Orange

2. Cleanaway
   22 Upfold Street
   Bathurst

The remainder of components will be either reused at various sites or landfill material will be disposed of through consultation with the Blayney Shire Council.

Waste minimisation strategy

Wind turbines primarily consist of steel, aluminium, copper, glass fibre, polyester, carbon fibre and epoxy. All resource recovery strategies will comply with the relevant guidelines at the time, which at the moment are the EPA Guidelines Assessment, Classification and Management of Liquid and Non-liquid Wastes.

Infigen is currently undertaking an extensive research project into how to maximise the salvage potential from its portfolio of wind turbines. The heart of this strategy is the ability to extract value through recycling and reusing turbine components. Through the onsite dismantling process this value will be maximised. All of the metal components will be recycled as scrap metal at various resource recovery centres located near the site.

Blade recycling – unlike the remainder of the wind turbine that is composed of metals, the blades require a more complex recycling process to recover the underlining materials. In Table 1 below, the four main processes for recovering the materials are discussed. During the lead up to decommissioning Infigen will determine the optimal solution.

Table 1. Composite recycling methods. Information sourced from (Producer Responsibility: Defining the incentive for recycling wind turbine blades in Europe, R Carrington et al. 2011)

Process	Description
Mechanical	The composite is broken down by shredding, crushing, milling or other similar processes. The resulting material can be separated into resin and fibrous products.
Pyrolysis	The composite is heated to 450°C to 700°C in the absence of oxygen; the polymeric resin is converted into a gas or vapour while the fibres remain inert and are later recovered.

Oxidation in Fluidised bed	The fluidised bed process is the most well-known implementation. It consists of combusting the polymeric matrix in a hot and oxygen-rich air flow of 450°C to 550°C.
Chemical	The polymeric resin is decomposed into oils which free the fibres for collection.

Rehabilitation of the land

Any land will that is disturbed during decommissioning will be rehabilitated to the specifications agreed with the landowner. As outlined earlier, the concrete foundations will not be removed; instead a layer of suitable top soil will be spread across the top and reseeded. The funds for this task will be provided from the funds allocated for decommissioning from project revenues.

Cost estimate

This section of the decommissioning and rehabilitation plan is broken into two sections; the cost estimate and the proposed funding arrangements.

On the following page is in exert from a independent report that was prepared for one of Infigen's operating NSW wind farm and is based on 23 wind turbines and associated infrastructure. Based on their assumptions of decommissioning costs and scrap value, there is a net shortfall of approximately $60,000 per wind turbine. As outlined above Infigen currently has an active research program being undertaken to increase the salvage value and hopefully make decommissioning the wind farm a positive cash flow.

Project Specifics	Unit	Qty	Rate	Cost
Preliminaries				312,675
Dismantling/Demolition/Making Good				1,243,210
Residual Scrap Value				-273,612
NETT BUILDING COST (N.B.C.) @ Feb '12				**1,282,273**
GROSS BUILD COST (G.B.C.) @ Feb '12				**1,282,273**
CONTINGENCIES				
Planning Contingency			G.B.C.	EXCL
Design Contingency			G.B.C.	EXCL
Staging Penalty			G.B.C.	EXCL
Construction Contingency		5.0%	G.B.C.	INCL
Locality Factor			G.B.C.	EXCL
				64,114
TOTAL BUILDING COST (T.B.C) @ Feb '12				**1,346,387**
Professional & Authority Fees Allowance		2.00%	T.B.C.	26,928
TOTAL PROJECT COST (T.P.C) @ Feb '12				**1,373,314**
ESCALATION CONTINGENCY				
Escalation Allowance				EXCL
TOTAL END COST (T.E.C) @ Feb '12				**1,373,314**

1) *The report is confidential to Woodlawn Wind Farm Pty Ltd and is still in draft form.*

Funding Arrangements

Current discussions with turbine suppliers and experience in the USA and Australian markets indicate that it is likely that the wind turbines may well have a full ten year warranty. During this period the risk of the project requiring decommissioning is very unlikely and the cost would be borne by the turbine supplier. Therefore, Infigen's proposed funding plan starts at the end of the warranty period on the 10th year anniversary. Upon reaching this anniversary, Infigen will undertake another independent quantitative survey on the cost to decommission the Flyers Creek Wind Farm. As outlined in Figure 2 below, this will be a decision point about whether a trust fund will be required. Infigen's opinion is that this will be unlikely. This opinion is due to the salvage potential and scrap value of the materials being higher the than cost to dismantle and decommission at the time of decommissioning. However, if there is still a shortfall, Infigen will create a trust fund that will be used to cover the costs for decommissioning. The formula for calculating the annual contribution for the trust fund will be 10% of the estimated shortfall amount between the end of the warranty period and the decommissioning year, with a regular five year review.

Timing
The proponent commits to undertaking the decommissioning and rehabilitation works within 18 months of the wind farm reaching the end of its life.

Consultation
As with all elements and stages of the wind farm, Infigen will undertake further community consultation to seek ideas to maximise the net benefit to the community during the decommissioning process.

Responsibility
Infigen can confirm that the wind farm proponent/owner will be responsible for all decommissioning costs and obligations.

Fig. 2 Outline of Decommissioning and Rehabilitation Plan:

Appendix O

AN ASSESSMENT OF THE BAT FAUNA IN OPEN AREAS REPRESENTING TURBINE LOCATIONS AT THE PROPOSED FLYERS CREEK WIND FARM, NSW

Prepared by Dr G.C. Richards

June 2011

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STANDARD DISCLAIMER[1]

The following report is explicitly the opinion of the consultant, and is based upon data available and assessments conducted according to the methods described. Greg Richards and Associates (GR&A) has had to rely on information from other sources in preparing this report (including the party for whom it is prepared) and is not in a position to, and has not, verified the accuracy or completeness of information so provided. Accordingly, GR&A takes no responsibility for and assumes no liability in respect of, any information provided by others for the purposes of preparing this report nor the consequences of using such information.

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CONTENTS

[1] This is a requirement of the consultant's insurance company.

EXECUTIVE SUMMARY

The consultant was commissioned by Aurecon Australia Pty Ltd to conduct an assessment of the bat fauna at the proposed Flyers Creek Wind Farm to coincide with the migration of Eastern Bentwing Bats from a maternity cave at Wee Jasper, NSW. The project area is located between the township of Carcoar and the Cadia mining operation in the central west of NSW, where the landscape generally consists of extensive areas of open pasture and woodland remnants. The assessment was conducted in three stages. Firstly at meteorological towers where bat activity at heights of 50-60 m was compared with that at ground level. The second stage involved surveys at a range of woodland remnants that varied in habitat quality. These surveys were undertaken in 2010.

The third stage, which involved surveys in open pasture areas that were representative of, and near, proposed turbine locations is the subject of this report.

The three stages of the bat fauna assessment was designed to obtain baseline data on bat fauna species that were utilising the study area and surrounds, and to target bat fauna species listed in the Schedules of the NSW *Threatened Species Conservation Act, 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.

The study reported here involved the monitoring of bat communities in open areas where turbines will be located. Six sampling sites were monitored with Anabat™ echolocation call detection systems and calls were recorded from dusk to dawn, with monitoring being conducted for nine consecutive nights.

During this survey, eight of the 15 microbats previously recorded in the region were detected in open areas during the current assessment, from a total of 1669 identifiable echolocation calls over 9 nights. None of the species recorded are listed in the NSW *Threatened Species Conservation Act*.

Species not recorded in open areas included the Little Broad-nosed Bat, the Eastern Forest Bat and the Little Forest Bat, all of which are regarded as common and widespread and hence are not listed in Threatened Species legislation.

Notably, also not recorded in open areas were the Large Bentwing Bat, the Large-footed Myotis, and the Yellow-bellied Sheathtail Bat, all of which are listed in the NSW *Threatened Species Conservation Act*. It was also apparent that even small numbers of Eastern Bentwing Bats did not commute across or otherwise utilise open areas during the study, timed to coincide with the migration period from the maternity cave at Wee Jasper.

The majority of the turbines proposed will be located in open areas, proven by this study to be of low quality for most bat species in the study area. This conclusion was supported by the field data, where the mean number of calls per night (over each entire survey period) in woodland remnants was 92.5, compared with the mean of 30.9 in open areas. In other words, the mean level of activity in woodland remnants was three times that of remnants. There appeared to be a differential response in utilisation of open areas versus remnants by each species present in the area. Most species were less active in open areas than in woodland remnants.

In general, the habitat utilization patterns observed in open areas indicated that there would be a lower impact on local bat populations than previously estimated .

A consideration of potential impacts relevant to EPBC Act matters has been undertaken and, with the incorporation of the mitigation measures below, it is considered that a referral under the Act is not warranted.

INTRODUCTION

The consultant was commissioned by Aurecon Australia Pty Ltd to conduct an assessment of the bat fauna at the proposed Flyers Creek Wind Farm to coincide with the migration of Eastern Bentwing Bats from a maternity cave at Wee Jasper, NSW. The project area is located between the township of Carcoar and the Cadia mining operation in the central west of NSW, where the landscape generally consists of extensive areas of open pasture and woodland remnants. The assessment was conducted in three stages: firstly at meteorological towers where bat activity at heights of 50-60 m was compared with that at ground level. The second stage involved surveys at a range of woodland remnants that varied in habitat quality. These surveys were undertaken in 2010.

The third stage, which involved surveys in open pasture areas that were representative of, and near, proposed turbine locations is the subject of this report. .

BACKGROUND INFORMATION

Background information specific to the region and available to the author included:

- 2001 – Bat fauna monitoring at Wire Gully, Ridgeway Gold Mine (Greg Richards and Associates Pty Ltd 2001)
- 2004 - Bat fauna assessment in infrastructure zones at the Ridgeway mining project (Cadia area) (Greg Richards and Associates Pty Ltd 2005)
- 2006 – Bat fauna assessment of an area extending the southern tailings dam at the Cadia mine (Greg Richards and Associates Pty Ltd 2007)
- 2007 – Assessment of habitat requirements of the Yellow-bellied Sheathtail Bat (within Greg Richards and Associates Pty Ltd 2007) in the south Orange district
- 2007 – Assessment of the bat fauna at a proposed tailings dam to the south of the Cadia gold mine (Richards 2007)

A species list for the region, generated from the background information, is shown in Table 1. This list also includes records from the NSW Wildlife Atlas.

Table 1: Bat species recorded since 2001 in the Cadia – Orange District in close vicinity to the proposed Flyers Creek Wind Farm. TSC Act = the NSW Threatened Species and Conservation Act, EPBC Act = Environment Protection and Biodiversity Conservation Act, V = listed as Vulnerable, CD = listed as Conservation Dependent. Nomenclature follows Churchill (2008).

Common Name	Taxon	Conservation Status	
		TSC Act	EPBC Act
Sheathtail Bats	**Emballonuridae**		
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V	-
Freetail Bats	**Molossidae**		
Inland Freetail Bat	*Mormopterus* sp.2	-	-
Southern Freetail Bat	*Mormopterus* sp.4		
White-striped Freetail Bat	*Austronomus australis*	-	-
Ordinary Bats	**Vespertilionidae**		
Gould's Wattled Bat	*Chalinolobus gouldii*	-	-
Chocolate Wattled Bat	*Chalinolobus morio*	-	-
Large Bentwing Bat	*Miniopterus schreibersii*	V	CD
Large-footed Myotis	*Myotis macropus*	V	
Lesser Longeared Bat	*Nyctophilus geoffroyi*	-	-
Gould's Longeared Bat	*Nyctophilus gouldi*	-	-
Little Broadnosed Bat	*Scotorepens greyii*		
Large Forest Bat	*Vespadelus darlingtoni*	-	-
Eastern Forest Bat	*Vespadelus pumilus*		
Southern Forest Bat	*Vespadelus regulus*	-	-
Little Forest Bat	*Vespadelus vulturnus*	-	-

METHODS

The bat fauna assessment was designed to obtain baseline data on bat fauna species that were utilising the study area and surrounds, and to target bat fauna species listed in the Schedules of the NSW *Threatened Species Conservation Act, 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*. The surveys closely followed the NSW Department of Environment and Conservation *Threatened Biodiversity Survey and Assessment Guidelines* (working draft dated November 2004). These guidelines require a minimum of four consecutive nights of detection, but experience in open and degraded pastures at other wind farm sites led to longer operating periods (9-11 nights) being used.

The previous study (Richards 2011) assessed bat activity in woodland remnants. The study reported here involved the monitoring of bat communities in open areas and followed the designation of turbine locations. Six sampling sites were selected in the vicinity of proposed turbine locations. Sampling sites were monitored with Anabat™ echolocation call detection systems which allowed data to be recorded onto a compact flash card for later analysis. Calls were recorded from dusk to dawn, with monitoring being conducted for nine consecutive nights.

RESULTS AND DISCUSSION

Sampling Sites and Weather Conditions

The location and a brief description of the six sampling sites is shown in Table 2. The layout of the wind farm, and the location of previous sampling sites, is shown in a previous report (Richards 2011). The location of sampling sites is shown in Figure 1.

During the survey period, weather conditions were suitable for generating a reasonable bat survey. Temperatures for the period, taken from the Bureau of Meteorology website, are shown in Table 3. There were no significant falls of rain. The survey period extended from 30 March to 8 April 2011. However, not all call detectors were installed on 30 March, so data from this night has been excluded from analysis to allow direct comparisons between sampling sites.

Table 2: Location and description of sampling sites used in the bat fauna assessment at open areas at the proposed Flyers Creek Wind Farm.

Sampling site	Latitude (S)	Longitude (E)	Habitat description
OP-1	33°34.022	149°04.225	Near a complex of farm buildings, pointing over open pasture and sown cropland
OP-2	33°34.482	149°04.545	Open grazing pasture
OP-3	33°33.030	149°03.608	On hillside pointing over open pasture and sown cropland, meteorological tower M2 in distance
OP-4	33°34.210	149°05.214	Open pasture and sown cropfields, roadside trees nearby
OP-5	33°33.289	149°05.601	At fence on roadside, pointing over open pasture, stock dam in vicinity
OP-6	33°32.181	149°03.693	Open grazing pasture

Table 3: Overnight minimum temperature data recorded by the Bureau of Meteorology at the Orange weather station during the period that bat activity was monitored at the proposed Flyers Creek Wind Farm. The 3pm wind gust is provided to give some idea of wind speed at dusk and afterwards. Rainfall data for 7 April was not available.

Date	Minimum temperature (°C)	Minimum temperature (°C)	Rainfall (mm)	3 pm relative humidity (%)	3pm wind speed (kph)
30-Mar	9.7	22.5	0	61	17
31-Mar	8.0	21.2	0	50	17
1-Apr	11.4	22.0	0	55	24
2-Apr	6.7	19.4	0	48	15
3-Apr	4.2	19.0	0	49	11
4-Apr	4.4	20.5	0	49	11
5-Apr	7.1	18.0	0	59	20
6-Apr	7.7	18.1	0	53	20
7-Apr	5.9	18.9	-	53	19
8-Apr	4.6	20.8	0	57	9
9-Apr	4.9	20.9	0.2	49	9

Bat Species Recorded in Open Areas

During this survey, eight of the 15 microbats previously recorded in the region (Table 1) were detected in open areas, from a total of 1669 identifiable echolocation calls over the 9 nights of survey when sites were sampled together[2] (Table 4). Raw data is provided in Appendix 1. None of the species recorded are listed in the NSW *Threatened Species Conservation Act*.

Species not recorded in open areas included the Little Broad-nosed Bat, the Eastern Forest Bat and the Little Forest Bat, all of which are regarded as common and widespread and hence are not listed in Threatened Species legislation.

Notably, also not recorded in open areas were the Large Bentwing Bat, the Large-footed Myotis, and the Yellow-bellied Sheathtail Bat, all of which are listed in the NSW *Threatened Species Conservation Act*. The Yellow-bellied Sheathtail Bat was recorded very infrequently during the previous survey of woodland remnants (Richards 2011), and it is noteworthy that none were recorded in the large open areas that were sampled during the current survey. This indicates that, if present, they are likely to commute between remnants that are linked by partly-wooded corridors.

Although the survey was timed to coincide with the migration period from the maternity cave at Wee Jasper, it was apparent that the Eastern Bentwing Bats did not commute across, or otherwise utilise, open areas during the study.

[2] During this survey, not all sites were set up in the field on the same day. Species lists were generated from all data, analyses to compare sites were based on a 9 night period when all call detectors were running concurrently

Figure 1: Aerial photograph of the sampling area and bat detections sites surveyed March-April 2011. The location of two meteorological towers (M1 and M2) is also shown.

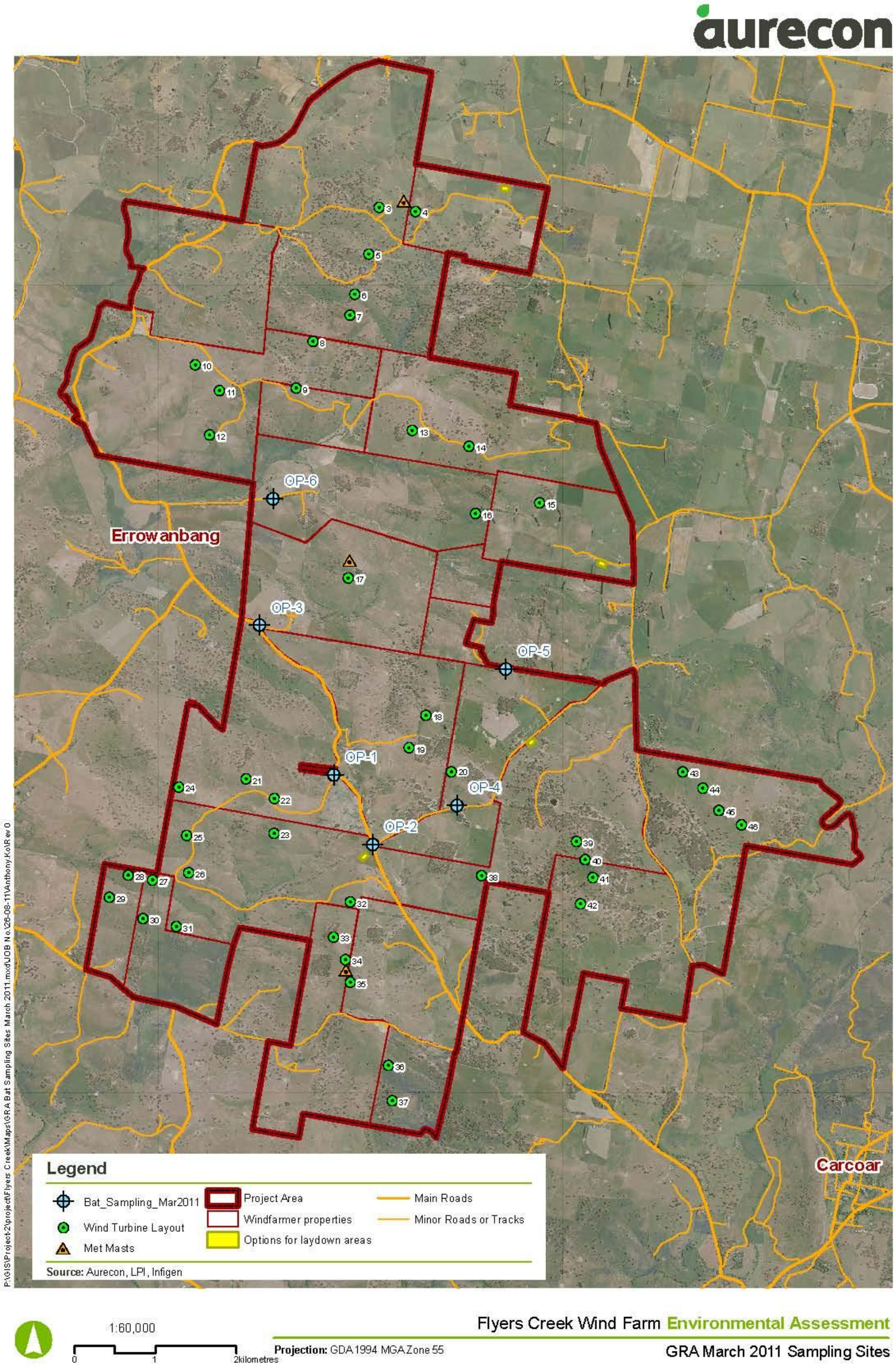

Table 4: Total calls recorded at open area sites during the 9 nights of survey.							
Common name	**OP-1**	**OP-2**	**OP-3**	**OP-4**	**OP-5**	**OP-6**	Totals
Gould's Wattled Bat	20	10	24	22	23	11	110
Chocolate Wattled Bat	28	12	51	16	27	21	155
Southern Freetail Bat	60	63	144	96	104	61	528
Inland Freetail Bat	3	0	4	3	0	0	10
Longeared bats	23	10	17	23	25	14	112
White-striped Freetail Bat	93	72	145	94	115	85	604
Large Forest Bat	20	7	35	17	7	9	95
Southern Forest Bat	16	7	9	8	8	7	55
Total calls	263	181	429	279	309	208	1669

With the exception of two, the activity of species recorded in open areas during the survey was very low, on average in the order of 1-3 calls per night over the entire survey. The exceptions were the White-striped Freetail Bat and the Southern Freetail Bat, with an overall average of 11.2 and 9.8 calls per night (respectively) for the survey period (Table 5).

Table 5: The average number of calls recorded at each site over the nine nights of survey, and the average calls per night for the entire survey period.							
Species	**Average number of calls at each site**						**Average number of calls over entire survey period**
	OP-1	OP-2	OP-3	OP-4	OP-5	OP-6	
Gould's Wattled Bat	2.2	1.1	2.7	2.4	2.6	1.2	**2.0**
Chocolate Wattled Bat	3.1	1.3	5.7	1.8	3.0	2.3	**2.9**
Southern Freetail Bat	6.7	7.0	16.0	10.7	11.6	6.8	**9.8**
Inland Freetail Bat	0.3	0.0	0.4	0.3	0.0	0.0	**0.2**
Longeared bats	2.6	1.1	1.9	2.6	2.8	1.6	**2.1**
White-striped Freetail Bat	10.3	8.0	16.1	10.4	12.8	9.4	**11.2**
Large Forest Bat	2.2	0.8	3.9	1.9	0.8	1.0	**1.8**
Southern Forest Bat	1.8	0.8	1.0	0.9	0.9	0.8	**1.0**
Total calls	29.2	20.1	47.7	31.0	34.3	23.1	**30.9**

Habitat Value of Open Areas compared with Woodland Remnants

It is highly relevant to compare the results of the two assessments that were carried out in the two significantly different habitats in the project area. The Richards (2011) bat fauna assessment was initially focused upon woodland remnants because proposed turbine locations had not been decided at the time, and it was therefore considered prudent to assess habitat known elsewhere to be of the highest value to bats (Richards 2001).

The majority of the turbines proposed will be located in open areas, proven by this study to be of low quality for most bat species in the study area. This conclusion was supported by the field data (shown in Table 6). The average number of calls per night, over the entire survey period, was 92.5 in woodland remnants compared with 30.9 in open areas. In other words, the mean level of activity in remnants was about three times that of open areas.

Table 6: Comparison between average bat activity in woodland remnants and open areas at the proposed Flyers Creek Wind Farm, based upon the average number of calls per night over each survey.

Species	Mean calls per night	
	Remnants	Open areas
Gould's Wattled Bat	11.3	2.0
Chocolate Wattled Bat	11.7	2.9
Southern Freetail Bat	10.8	9.8
Inland Freetail Bat	1.6	0.2
Longeared bats	5.2	2.1
White-striped Freetail Bat	5.0	11.2
Large Forest Bat	7.4	1.8
Southern Forest Bat	35.1	1.0
Yellow-bellied Sheathtail Bat	0.1	0.0
Little Forest Bat	4.3	0.0
Overall total	**92.5**	**30.9**

Furthermore, there appears to be a differential response in utilisation of open areas versus remnants by each species present in the area. This assessment is shown in Table 7. Salient points include:

- The Yellow-bellied Sheathtail Bat, a threatened species, was rarely recorded at woodland remnants and was absent from open areas. This was also the case for the Little Forest Bat, which is not listed a threatened species.
- Activity in open areas was far less evident than in woodland remnants for a number of common species; *viz*. Gould's Wattled Bat, the Chocolate Wattled Bat, the Inland Freetail Bat which is marginally distributed in this part of NSW, the Large Forest Bat and the Southern Forest Bat.

- Activity of the two Longeared bats (most likely the Lesser Longeared Bat *Nyctophilus geoffroyi* and Gould's Longeared Bat *N.gouldi*) was above the average calls per night (for the entire survey period) in open areas.
- Activity of the Southern Freetail Bat was similar in open areas to its activity in woodland remnants.
- The White-striped Freetail Bat was more than twice as active in open areas than it was in woodland remnants.

Table 7: Differences in activity patterns of bats that were recorded in woodland remnants (Richards 2011) compared with their activity in open areas proposed for turbine sites. The overall mean number of calls per night was used in this analysis.

No activity in open areas	Yellow-bellied Sheathtail Bat
	Little Forest Bat
Lower than the overall average	Gould's Wattled Bat
	Chocolate Wattled Bat
	Inland Freetail Bat
	Large Forest Bat
	Southern Forest Bat
Above the overall average	Longeared bats
Similar to the overall average	Southern Freetail Bat
Higher than the overall average	White-striped Freetail Bat

IMPACT ASSESSMENT

Impacts that can potentially occur for bat species from wind farm developments include habitat loss or disturbance during the construction phase and once operational, collision of bats with turbines or air turbulence or pressure effects that result in injury or mortality (barotrauma).

The habitat utilization patterns observed in open areas indicate that there would be a lower impact, in general, upon local bat populations. Because the proponent has proposed that turbines will generally be located on cleared ridges and significant remnants will be avoided, the previous (Richards (2011) impact assessment is revised as discussed in the following sections.

As indicated previously, the Yellow-bellied Sheathtail Bat, the Large Bentwing Bat and the Large-footed Myotis, are listed as Vulnerable under the TSC Act. Of these, only the Yellow-bellied Sheathtail Bat, was infrequently recorded in the woodland remnants of the site and none of the species were recorded in the large open areas.

All but one species had lower activity in open areas where turbines will be located than they did in woodland remnants, indicating that the better woodland habitats are focal points. The one species that appeared to favour open areas above woodland was the White-striped Freetail Bat. This species is renowned to forage over open areas (Churchill 2008) and would be a candidate for collision with turbine blades or through barotrauma when drawn into blade-tip vortices. This species is not listed as threatened in State or Federal legislation.

However, the proponent has indicated that although some large mature trees (potential roosts for hollow-roosting species) may be cleared, most will be avoided and retained wherever possible. If clearing of isolated trees is necessary then such clearing should be undertaken in conjunction with an appropriate ecologist.

A consideration of potential impacts relevant to EPBC Act matters has been undertaken and, with the incorporation of the mitigation measures below, it is considered that a referral under the Act is not warranted.

Notes on Barotrauma Issues

Considering that echolocating bats can detect moving objects better than stationary ones, and can especially detect small insects, it is difficult to understand why fatalities occur at turbines. It is highly likely that bats that suffer barotrauma (expansion of air in the lungs in zones of low air pressure) do in fact detect a moving turbine blade and swerve to avoid the tip. However, the zone of low pressure at the tip may extend quite a distance away, due to vortices that occur downwind from the blade.

Baerwald *et al* (2007) examined 87 bat carcasses found beneath turbines, that showed no external injuries. When the bats were dissected, they noted pulmonary haemorrhage and similar lung injuries, which are indicators of decompression. Pressure differences as low as 4 kPa are lethal to Norway rats (Dreyfuss *et al* 1985), and pressure drops at moving turbine blades can be in the range of 5-10 kPa (Baerwald *et al* 2007). Bats have larger lungs and hearts than most other mammals, and have blood-gas barriers that are also much thinner (Maina and King 1984), hence would be more susceptible to barotrauma.

It would seem to be extremely difficult to mitigate for bat barotrauma at any wind turbine, and although currently under development, deterrent devices using ultrasound are not currently commercially available.

MITIGATION MEASURES

It is recommended that the following measures be adopted for the project to mitigate its impact on bat species.

- Clearing of mature trees should be avoided by the project design
- Where clearing of mature trees cannot be avoided then a suitably qualified specialist should be consulted to assist with selection of procedures to encourage very little impact
- Consideration be given to monitoring of impacts in at least the first year of operation

REFERENCES

Baerwald, E.F., D'Armours, G.H., Klug, B.J. and Barclay, R.M.R. (2007) Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* 18: R695-R696.

Dreyfuss, D., Basset, G., Soler, P. and Saumon, G. (1985) Intermittent positive-pressure hyperventilation with high infiltration pressure reduces pulmonary microvascular injury in rats. *American Review of Respiratory Diseases* 132: 880-884.

Churchill, S. (2008) *Australian bats, second edition*. Allen and Unwin, Crows Nest, NSW

Greg Richards and Associates Pty Ltd (2000) *An Assessment of Bat Fauna in Infrastructure Zones at the Ridgeway Mining Project, Central New South Wales*. Attachment KC, Appendix K in Cadia Holdings Pty Ltd (2000) *Ridgeway Project Environmental Impact Statement*.

Greg Richards and Associates Pty Ltd (2001) *Insectivorous Bat Fauna Monitoring at Wire Gully, Ridgeway Gold Mine, NSW.* Report prepared for Cadia Holdings Pty Limited.

Greg Richards and Associates Pty Ltd (2005) Cadia East Study Area Bat Fauna Assessment. Report prepared for Cadia Holdings Pty Ltd, January 2005

Maina, J.N. and King, A.S. (1984) Correlations between structure and function in the design of the bat lung: a morphometric study. *Journal of Experimental Biology* 111: 43-61.

Richards, G.C. (2001) *Ecological and evolutionary determinants of bat community structure in southeastern Australian Forest.* PhD thesis, University of New South Wales, Sydney.

Richards, G.C. (2007) An Assessment of the Bat Fauna at a Proposed Tailings Dam, Cadia East, NSW. Unpublished report prepared by Greg Richards and Associates Pty Ltd for Resource Strategies Pty Ltd and Cadia Holdings Pty Ltd, February 2007.

Richards, G.C. (2011) An Assessment of the Bat Fauna at the Proposed Flyers Creek Wind Farm, NSW. Report prepared for Aurecon Pty Ltd by Greg Richards and Associates, Canberra, December 2010, revised March-April 2011.

APPENDIX 1: Tabulation of field data from the March-April 2011 bat fauna assessment in open areas representing turbine locations											
Site OP-1	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	2	4	2	1	2	1	1	5	2	20	2.2
Chocolate Wattled Bat	1	3	3	6	3	2	3	5	2	28	3.1
Southern Freetail Bat	7	8	7	4	7	6	8	5	8	60	6.7
Inland Freetail Bat	0	0	1	0	2	0	0	0	0	3	0.3
Longeared Bats	1	3	3	3	4	2	2	4	1	23	2.6
White-striped Freetail Bat	14	12	4	8	4	14	11	14	12	93	10.3
Large Forest Bat	1	3	2	1	1	0	4	5	3	20	2.2
Southern Forest Bat	3	2	1	3	1	3	1	1	1	16	1.8
Total calls	29	35	23	26	24	28	30	39	29	263	29.2
Site OP-2	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	1	2	1	0	1	0	2	1	2	10	1.1
Chocolate Wattled Bat	2	1	2	2	1	2	1	0	1	12	1.3
Southern Freetail Bat	8	9	8	7	7	8	5	4	7	63	7.0
Inland Freetail Bat	0	0	0	0	0	0	0	0	0	0	0.0
Longeared Bats	3	0	2	3	1	1	0	0	0	10	1.1
White-striped Freetail Bat	10	9	4	7	5	10	8	11	8	72	8.0
Large Forest Bat	1	0	2	0	1	0	1	2	0	7	0.8
Southern Forest Bat	1	0	1	0	1	0	1	0	3	7	0.8
Total calls	26	21	20	19	17	21	18	18	21	181	20.1
Site OP-3	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	3	8	2	1	3	0	2	3	2	24	2.7
Chocolate Wattled Bat	1	11	6	13	2	2	4	8	4	51	5.7
Southern Freetail Bat	11	10	20	22	16	22	10	15	18	144	16.0
Inland Freetail Bat	0	1	1	0	2	0	0	0	0	4	0.4
Longeared Bats	1	3	3	2	2	1	1	3	1	17	1.9

White-striped Freetail Bat	20	21	7	11	9	19	17	19	22	145	16.1
Large Forest Bat	1	4	8	7	1	0	6	5	3	35	3.9
Southern Forest Bat	1	2	0	3	1	0	1	0	1	9	1.0
Total calls	38	60	47	59	36	44	41	53	51	429	47.7
Site OP-4	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	0	2	2	3	3	1	3	5	3	22	2.4
Chocolate Wattled Bat	0	3	3	2	1	1	1	3	2	16	1.8
Southern Freetail Bat	12	10	16	10	10	9	9	11	9	96	10.7
Inland Freetail Bat	1	0	1	0	1	0	0	0	0	3	0.3
Longeared Bats	2	2	2	4	2	2	4	3	2	23	2.6
White-striped Freetail Bat	9	13	14	9	8	8	11	10	12	94	10.4
Large Forest Bat	1	2	2	3	1	3	2	2	1	17	1.9
Southern Forest Bat	1	0	1	0	1	2	1	0	2	8	0.9
Total calls	26	32	41	31	27	26	31	34	31	279	31.0
Site OP-5	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	1	5	2	1	3	1	5	2	3	23	2.6
Chocolate Wattled Bat	3	2	3	4	3	3	4	3	2	27	3.0
Southern Freetail Bat	13	14	9	11	12	15	14	8	8	104	11.6
Inland Freetail Bat	0	0	0	0	0	0	0	0	0	0	0.0
Longeared Bats	3	3	2	2	4	3	4	2	2	25	2.8
White-striped Freetail Bat	21	14	12	11	11	10	12	11	13	115	12.8
Large Forest Bat	1	1	0	1	0	2	0	2	0	7	0.8
Southern Forest Bat	0	2	1	0	1	3	0	1	0	8	0.9
Total calls	42	41	29	30	34	37	39	29	28	309	34.3
Site OP-6	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	Total calls	Average calls/night
Gould's Wattled Bat	2	2	2	1	0	1	1	0	2	11	1.2
Chocolate Wattled Bat	1	2	3	4	3	0	3	3	2	21	2.3
Southern Freetail Bat	9	8	9	5	7	7	8	4	4	61	6.8

Inland Freetail Bat	0	0	0	0	0	0	0	0	0	0	0.0
Longeared Bats	1	3	0	3	4	0	2	0	1	14	1.6
White-striped Freetail Bat	11	9	7	6	7	11	10	12	12	85	9.4
Large Forest Bat	0	1	2	0	1	0	0	5	0	9	1.0
Southern Forest Bat	1	2	1	0	1	0	1	0	1	7	0.8
Total calls	25	27	24	19	23	19	25	24	22	208	23.1

Appendix P

SURVEY FOR THE SUPERB PARROT
FLYERS CREEK WIND FARM, SHIRE OF BLAYNEY
CENTRAL TABLELANDS, NEW SOUTH WALES

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for

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November 2011
11/30

Document Reference

Kevin Mills & Associates (2011). Survey for the Superb Parrot, Flyers Creek Wind Farm**,** Shire of Blayney, Central Tablelands, New South Wales**.** Prepared for Infigen Energy Pty Limited, Sydney, November.

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Cover Photograph: Male Superb Parrot feeding on the flowers of Yellow Box *Eucalyptus melliodora*, Flyers Creek valley, October 2011. Photograph: K. Mills.

Contents

1.0 INTRODUCTION

The flora and fauna associated with the land proposed for the Flyers Creek Wind Farm has been studied by Kevin Mills & Associates (KMA) (2011). That investigation found that the Superb Parrot occurs in the general area of the wind farm.

The Department of Planning and Infrastructure considered the Environmental Assessment (EA), which included the above flora and fauna report, adequate to be placed on public exhibition subject to certain matters being addressed. One of these matters was for additional targeted surveys for the Superb Parrot within the wind farm site. This report documents the additional targeted surveys for the Superb Parrot on the Flyers Creek wind farm site and the surrounding land.

2.0 SURVEY METHODS

The survey methods are set out in the recommendations made by KMA (2011). One further matter was added by the Department of Planning and Infrastructure (DPI) in their correspondence dated 8 July 2011. The following are the survey methods that are to be undertaken for the Superb Parrot at Flyers Creek; note that updated government department names are used here, where relevant.

Prior to the beginning of the construction phase of the project, a field survey for the Superb Parrot should be undertaken by a qualified biologist. The following methods should be employed in this survey.

- The survey must be carried out in the breeding season of the parrot (i.e. September to December).
- Local land owners shall be interviewed to gain information about where the parrots have been seen, particularly in the current season.
- General observations in the areas where the parrots were seen on previous visits should be carried out to identify any areas where the parrots are present in that season.
- The targeted surveys will be carried out along those ridges and other places where trees may be removed by the wind farm infrastructure.
- Where Superb Parrots are observed in the target areas, they will be intensively studied to determine if they are nesting in the trees that may be removed. This will include watching parrot activity to determine if nesting is occurring (e.g. the sex of birds in flocks and attempting to follow parrots to nest trees).
- If nest trees are located in the target area, these trees will be documented, marked and discussions with the Office of Environment and Heritage (OEH) undertaken as to the mitigation measures that should be undertaken.
- A report will be furnished to the DPI for forwarding to the OEH, outlining the studies undertaken and the results of those studies, including any consultation with OEH during the study period.

The DPI added the following item: The targeted field surveys for the Superb Parrot are to be expanded to include the associated forage area and flight paths for the parrots (should nesting sites be identified during the surveys).

The Superb Parrot has a distinctive silhouette and call. Surveys initially involved driving slowly along the roads, tracks and relevant ridges in the study area to locate birds. Once birds were located, time was then spent in the area to determine if it was a key habitat area, the use and movement of birds in the area, sex of the birds and potential nesting areas.

Hundreds of kilometres were driven during the various surveys in the study area. Although the total distance was not recorded in the earlier years, during surveys in October 2011 transects totalled 400 kilometres, while in November 2011 the figure was 260 kilometres. The latter was lower because more time was spent on foot in the areas where birds were concentrated.

The following survey periods were undertaken at Flyers Creek between 2008 and 2011; all but the February date are within the recorded breeding season for the parrot; i.e. October to December.
2008: 10 to 11 November 2008;
2009: 23 to 25 February 2009;
2010: 6 to 8 October 2010;
2011: 17 to 19 October 2011 and 22 to 24 November 2011.

3.0 THE STUDY AREA

The study area is located on the central tablelands of New South Wales. The Flyers Creek Wind Farm site is located between Forest Reefs in the north, Carcoar in the south-east and Flyers Creek in the west. The study area is delineated in **Figure 1**, which shows the general layout of the proposed wind farm and the main transects targeted during this study.

The primary study area, where the wind farm would be located, extends for about 13 kilometres north to south and about eight kilometres east to west. Infrastructure associated with the wind farm would primarily be located on the ridges. The study area also includes a substation site and a transmission line route extending from the wind farm to the west and northwest.

The study area is located on undulating to moderately steep ridge country at an altitude of from around 800 metres to about 950 metres. Drainage is to Flyers Creek in the west and the Belubula River in the south. The underlying geology in the north is Tertiary basalt, while in the south the geology is mainly a complex of Ordovician sedimentary rocks. The soils, reflecting the geology, are mostly deep, clayey soils, rocky in some places, with alluvial soils along the valley floors. The land has been extensively cleared because of its high value for farming.

Much of the land is completely cleared of native vegetation cover, although stands of mature trees do occur in some places. There is very little natural forest or woodland vegetation remaining. Most paddocks have been pasture improved, and some cropping occurs on the more level topography. Patches of woodland occur here and there, mainly in the far southeast part of the area, although very few areas support an understorey dominated by native plants.

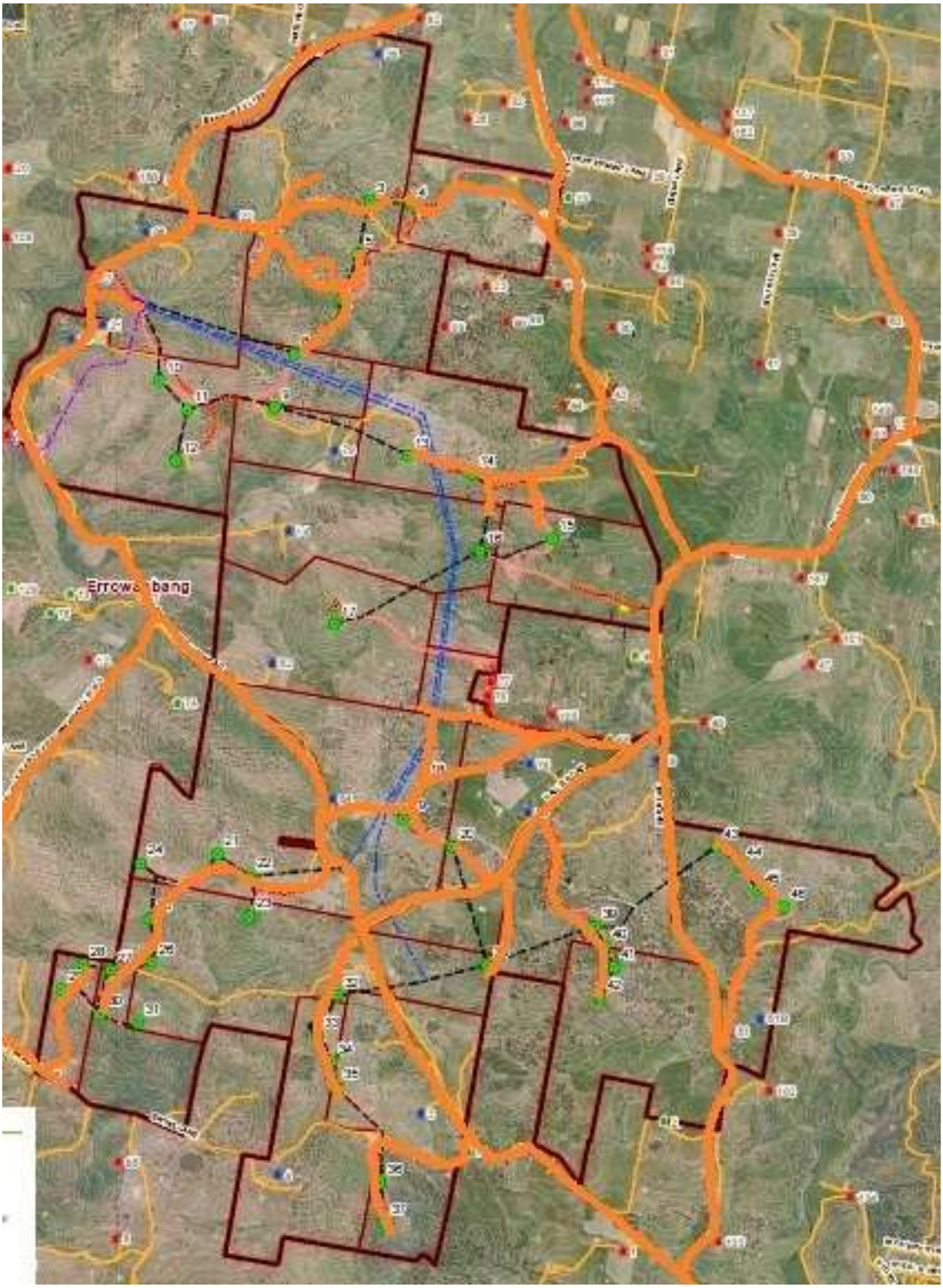

Figure 1. The Survey Areas on the proposed Flyers Creek Wind Farm Site.
(Main survey transects in orange are shown for 2008, 2009, 2010, 2011.)

4.0 THE SUPERB PARROT

Distribution

The Superb Parrot *Polytelis swainsonii* occurs throughout the western slopes of NSW, onto the edges of the tablelands of NSW, and into central Victoria. The breeding areas are in the central to southern part of its range, the core area in central NSW is between about Cowra, Cootamundra and Yass (Webster & Ahern 1992). Birds disperse widely from the breeding areas outside the breeding season, which if from September and January. Hollows in trees are essential for nesting.

The OEH online species profile states "on the south-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. It is estimated that there are less than 5000 breeding pairs left in the wild.

Habitat

This parrot is primarily a ground feeder, eating grass seeds and other herbaceous plants. Also eaten are fruit, nectar and insects; flowering or fruiting trees are also visited for foraging. The Orange region is at the north-eastern edge of the core breeding area outlined above (Webster & Ahern 1992). The key habitat component is the availability of tree hollows; these are essential for breeding. Dead and live trees are used for nesting.

Other Information

The following additional information is provided online by the OEH (extracted 14 October 2011):

- "Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.
- In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box.
- Nest in small colonies, often with more than one nest in a single tree.
- Breed between September and January.
- May forage up to 10 km from nesting sites, primarily in grassy box woodland.
- Feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants. Also eaten are fruits, berries, nectar, buds, flowers, insects and grain."

Threats

The following threats are listed for this parrot on the species profile available online from the OEH (date extracted: 14 October 201).

- "Removal of hollow bearing trees.
- Clearing of woodland remnants.
- Poor regeneration of nesting trees and food resources.
- Feeding on grain spills and subsequently being struck by vehicles.
- Loss of hollows to feral bees and native and exotic hollow-nesting birds.

- Illegal trapping which can also result in the destruction of hollows."

Conservation Status
The Superb Parrot is listed as vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act) and vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

5. SURVEY RESULTS

The Superb Parrot occurs in the Flyers Creek study area and is known to breed in that district. It is reported by land owners to be a year-round resident. The species was observed during earlier surveys in the area of the proposed wind farm, from 2008 to 2010. These earlier results and those in 2011 are summarised below; see **Table 1 and 2.** The distribution of all Superb Parrot records made during the consultant's surveys is shown on **Figure 2**.

2008 - 2010 Results
The Superb Parrot was observed several times in previous surveys of the study area during the breeding season in 2008, 2009 and 2010; these observations are set out below, in **Table 1**.

Table 1
Observations of Superb Parrots 2008 - 2010

Location (WGS 84)	Observations	Date
55 0692566 6290092	4 birds	10 Nov. 2008
55 0691486 6290704	3 birds seen several times	10 Nov. 2008
55 0689207 6289194	3 birds	10 Nov. 2008
55 0693630 6284395	1 bird	10 Nov. 2008
55 0692688 6283073	6 birds	10 Nov. 2008
55 0694093 6285294	1 bird	10 Nov. 2008
55 0695678 6285166	5 birds	23 Feb. 2009
55 0690454 6290526	3 birds	07 Oct. 2010
55 0689711 6289588	7 birds	07 Oct. 2010

2011 Results
The observations made in the surveys in October and November 2011 are set out below, in **Table 2**.

Table 2
Observations of Superb Parrots 2011

Site/Location (WGS 84)	Observations[1]	Date
1. 55 0689689 6289701	2 birds	17 Oct. 2011
2. 55 0690819 6286010	5 birds	17 Oct. 2011
1. 55 0689699 6289510	2 birds	18 Oct. 2011
2. 55 0690819 6286010	1 F and 2 M	18 Oct. 2011
3. 55 0692372 6283823	3 M	18 Oct. 2011

Table 2 cont... ***Observations of Superb Parrots 2011***		
Site/Location (WGS 84)	**Observations[1]**	**Date**
4. 55 0692672 6283069	2 birds (pair?)	18 Oct. 2011
5. 55 0690677 6286119	2 M birds	18 Oct. 2011
2. 55 0690819 6286010	c. 5 birds	18 Oct. 2011
1. 55 0689706 6289519	Pair birds plus 1M	19 Oct. 2011
2. 55 0690819 6286010	Pair birds	19 Oct. 2011
4. 55 0692663 6283070	1 bird	22 Nov. 2011
2. 550690818 6286004	1 bird	22 Nov. 2011
2. 550690818 6286004	1 bird (same bird as above?)	22 Nov. 2011
7. 55 0692179 6284813	1 bird	22 Nov. 2011
1. 55 0689695 6289693	1 F	23 Nov. 2011
8. 55 0692346 6290025	1 M + 1 F	23 Nov. 2011
8. 55 0692280 6290190	Pair birds	23 Nov. 2011
8. 55 0692396 6290182	Pair, 2 Y	23 Nov. 2011
8. 55 0692317 6290232	Pair + 4 Y; pair + 1 Y, +1 Y(?)	23 Nov. 2011
8. 55 0692021 6290376	3 birds	23 Nov. 2011
2. 55 0690923 6286000	2 M + 1 F	23 Nov. 2011
9. 55 0696583 6281209	2 birds	23 Nov. 2011
10. 55 0695596 6279796	1 M	23 Nov. 2011
11. 55 0693852 6280845	1 M	23 Nov. 2011
2. 55 0690560 6286234	1 M	23 Nov. 2011
4. 55 0692691 6283078	1 M	24 Nov. 2011
8. 55 0692436 6290117	6 birds	24 Nov. 2011
11. 55 0695553 6279855	2M, 2F + 1Y (?)	24 Nov. 2011

1. Detailed notes are provided at Appendix 1.

As Figure 2 illustrates, parrot observations were concentrated in four key areas. A summary of the observations at these four key sites is set out below, in **Table 3**. Most records and most birds were observed at these locations. Although no nest trees were located, nesting is considered most likely to be within or close to these four areas. The parrot is reported to nest in close proximity to other Superb Parrot nests, so that several nests may be in the areas identified above. The observation of at least six young birds and several pairs at site 8 on the property *Wallaby* support this view.

Only one area, on the properly *Wallaby* (site 8), is within the envelope containing the wind farm infrastructure.

Table 3
Observations of Superb Parrots at Key Sites

Site	Location name	Number of observations	Total no. of birds observed	Max. no of birds in 1 observation
1	Mackensie property	5	15	7
2	Errowanbang Road, Burnt Yards turnoff	8	21	5
4	Junction Halls and Errowanbang Roads	4	10	6
8	Property *Wallaby*	2 (visits)	27	17

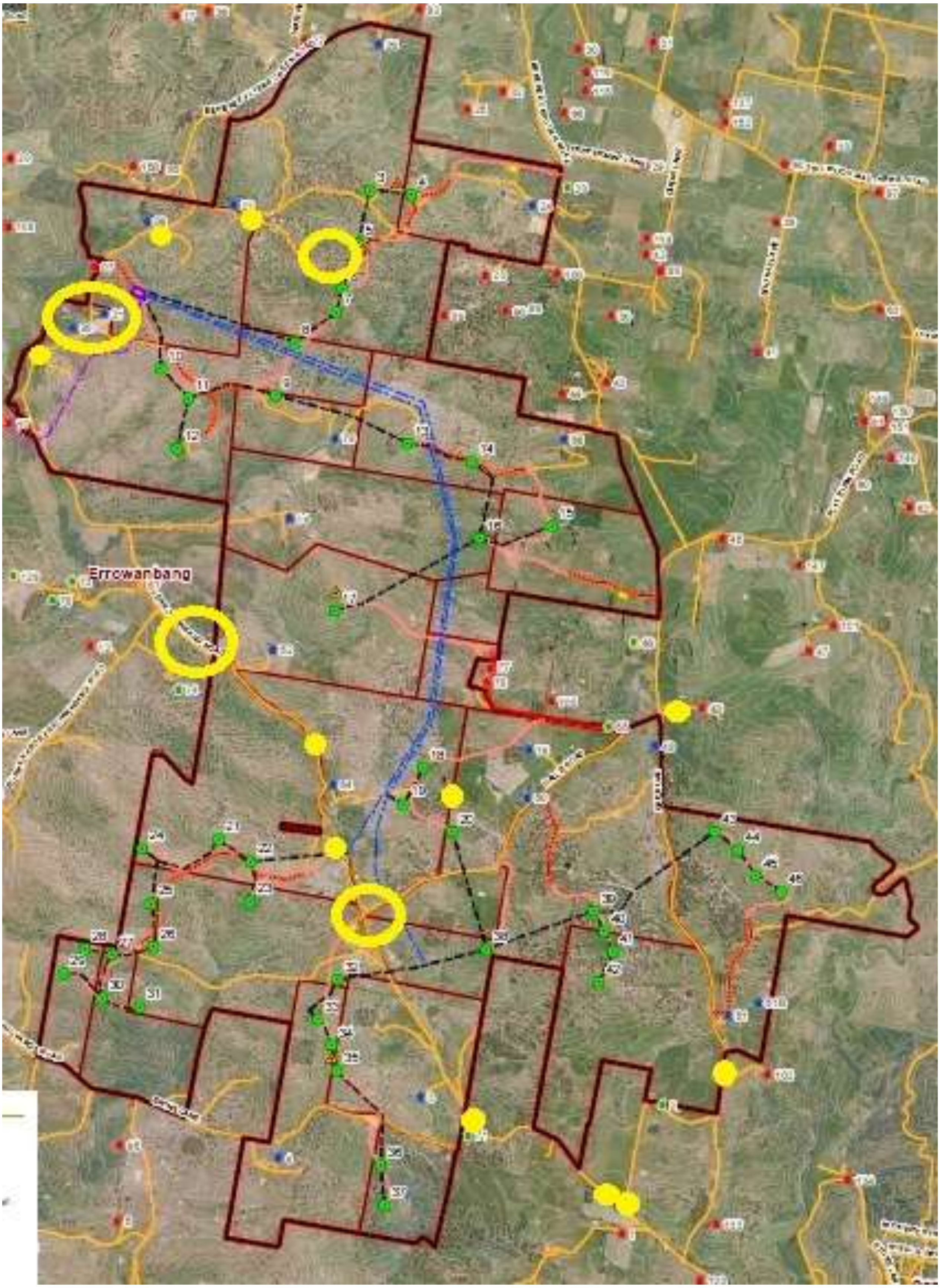

Figure 2. Location of Superb Parrot observations in the Study Area.
(Yellow dots indicate observations, circles indicate multiple observations.)

Bird of Prey Surveys

The opportunity was taken to survey for birds of prey, often cited as susceptible to blade strike, during the study period as many observations were being made. The results in **Table 4** were obtained in October – November 2011; none of these birds are threatened species. Once again, it is shown that almost all birds of prey operate below 50 metres above the ground.

Table 4
Observations of Birds of Prey, Spring 2011

Species	***Ground to fence height***	***Below tree height (20m)***	***20m to 50m***	***Over 50m***
Australian Hobby		1		
Australian Kestrel	4	17	2	
Black Kite				1
Black-shouldered Kite	2	20	4	
Brown Falcon	2	9	1	
Brown Goshawk		3		
Wedge-tailed Eagle				4

Other Threatened Species

All observations of threatened species other than the Superb Parrot are summarised at **Appendix 3**. Four other threatened bird species have now been recorded in the area; as assessed previously, none of these are likely to be impacted by the wind farm.

Updated Fauna List

During the current surveys, records were kept of incidental observations of vertebrate animal species within the study area. The list of animals prepared previously was updated as a result of these observations. The updated list is provided in **Appendix 2**.

6.0 DISCUSSION

Observations of the Superb Parrot in the study area at Flyers Creek have been made over four consecutive breeding seasons; i.e. from 2008 to 2011. The intensive field survey in spring 2011 added substantially to the understanding of the parrot in the district. The following is a summary of the main findings.

Virtually all observations of the Superb Parrot over the four year period are contained within an envelope of country centred on Errowanbang Road. This area is on the far western edge of the properties involved in the wind farm. Only a few observations were made outside this area. No observations over the four years were made on the highest ridges where the wind turbines are to be located.

The parrot is apparently a year-round resident of the area, and over the four years most observations were in the same four sites, indicating a high fidelity with particular sites. Young birds were observed in November 2011. The Blayney district is within the north-

eastern corner of the core breeding area of the species in the central-west of NSW identified by (Webster & Ahern 1992).
Three land owners independently commented that the parrot is more common now than it was 8-10 years ago, and in one case was less common than when they were young, say 40 years ago.

The habitat where birds were almost always observed is fairly consistent; i.e. amongst stands of old Yellow Box and Blakelys Red Gum trees on lower to upper slopes on the valley sides.

At the time of the surveys in spring 2011, birds were almost exclusively seen in or near heavily flowering Yellow Box and/or Blakelys Red Gum trees. Birds were often seen feeding on these flowers. Birds were not seen feeding on the ground, as they had been in the previous years; this is probably due to the good flowering of the eucalypts this year following several previous years of drought and poor flowering, so that birds were concentrating on that food source at this time.

In mid-October 2011, male and female birds were often seen, usually in pairs. Male birds in twos and threes were also seen flying together. This seems to indicate that breeding has started but that not all females have laid eggs yet. It is reported that females are not seen when sitting on eggs and males form flocks at that time. In November 2011, young birds and mixed post-nesting flocks were seen, probably indicating that most young had left the nest.

Observations outside the study area but in the region are documented in **Appendix 1**. These records, although scant, seem to show a similar pattern to that found at Flyers Creek. These are that birds are faithful to particular areas and observations of flocks and young are similar.

The following statements can be made about the results:

- Within the study area, the Superb Parrot is primarily found in four distinct areas.
- One of these areas, on *Wallaby*, is close to wind farm infrastructure.
- The parrot is absent from the higher ridges, and indeed the majority of the wind farm area, except for wandering birds.
- The Superb Parrot breeds somewhere in or near the above four areas.
- The parrot seldom occurs on the ridge where the turbines will be located; nest trees almost certainly do not occur on the higher ridges. It is reported that this parrot breeds in tree hollows, often near rivers.

7.0 CONCLUSION

The Superb Parrot is a resident of the Flyers Creek area and has been observed in and adjacent to the Flyers Creek Wind Farm properties during surveys between 2008 and 2011. Casual observations were made in the first three years, while a targeted survey was carried out in spring 2011. Opportunistic observations of the species elsewhere in the region during the visits to the area are also documented.

The majority of observations of the parrot were concentrated in four locations; these locations were consistent over the four year period. This indicates that these four sites are likely to be habitual areas of occurrence and breeding areas. The common characteristics of these areas are that they are located on lower to upper slopes and support a good cover of mature eucalypts, namely *Eucalyptus melliodora* and *Eucalyptus blakelyi*. Although no nest trees were found, several young birds seen at site 8 on 23 November 2011 indicate that nests were likely to be nearby, probably in the gully at the bottom of the site.

Of the four identified sites, one is adjacent to proposed wind farm infrastructure. A turbine and an access road are proposed on the ridge above and to the east of the identified habitat area. With the current location of the turbines and appropriate routing of the access road, there should be no need to remove trees within or adjacent to the identified area.

The results of the targeted Superb Parrot surveys have not changed the recommendations or conclusions from our previous report (KMA 2011). Recommendations (i) and (ii) to have an ecologist present to provide advice with regards to native tree removal and to minimise the removal of hollow-bearing trees are still valid. In addition, the conclusion that the project is unlikely to have a significant impact on matters of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* remains unchanged.

8.0 REFERENCES

Commonwealth of Australia (1999). *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth Government, Canberra.

Forshaw, J. M. (1981). *Australian Parrots.* Lansdowne Editions, Melbourne, 312p. Second edition.

Kevin Mills & Associates (KMA) (2011). Flora and Fauna Assessment, Flyers Creek Wind Farm, Shire of Blayney, Central Tablelands, New South Wales. Prepared for Aurecon Australia Pty Limited, Sydney, May.

New South Wales (1995). *Threatened Species Conservation Act 1995*. NSW Government, Sydney.

NSW Department of Environment and Climate Change (DECC). NSW Wildlife Atlas. Computer database of species records, various contributors, periodically updated.

Webster, R. & Ahern, L. (1992). Management for Conservation of the Superb Parrot (*Polytelis swainsonii*) in New South Wales and Victoria, November.

Appendix 1
Details of Superb Parrot sightings in October-November 2011

Location	Observations/Date
October 2011	
Errowanbang Road 55 0689689 6289701	17 Oct. 2011. Two birds (pair?) flying towards the northeast near McKenzie homestead. 3.35 pm.
Errowanbang Road (near Burnt Yards turnoff) 55 0690819 6286010	17 Oct. 2011. Five birds observed in flowering *E. melliodora*. One male in low branches of *E. melliodora* tree, female nearby in another tree feeding. Other birds flying amongst trees to south. 4.40 pm to 4.50 pm. Same birds seen later at 6.10 pm in same trees.
Errowanbang Road 55 0689699 6289510	18 Oct. 2011. Two birds flying in trees near near McKenzie homestead.
Errowanbang Road (near Burnt Yards turnoff) 55 0690819 6286010	18 Oct. 2011. One female and two males observed in flowering *E. melliodora*. Same site as 17.10.11
Errowanbang Road (North of Halls Rd) 55 0692372 6283823	18 Oct. 2011. Three males flying north over road, lost over ridge to north.
Halls Road, west end 55 0692672 6283069	18.10.11. Two birds (pair?) flying north through trees. 3.50pm
Errowanbang Road (near Burnt Yards turnoff) 550 0690677 6286119	18.10.11. Two male birds flying south though scattered trees. 4.30pm
Errowanbang Road (near Burnt Yards turnoff) 55 0690819 6286010	18 Oct. 2011. Male bird in same branch of flowering *E. melliodora* as 17.10.11. Pair in tree 30m to east, and another male in tree nearby. At least one more bird calling to south of road. c. 5.30pm
Errowanbang Road 55 0689706 6289519	19 Oct. 2011. Pair flying around stand of Yellow Box trees. One male flying though area to northeast. 8.50 am
Errowanbang Road (near Burnt Yards turnoff) 55 0690819 6286010	19 Oct. 2011. Pair flying into Yellow Box tree, north side of road. 9.20 am
November 2011	
Errowanbang Road Near Halls Road 55 0692663 6283070	22 Nov. 2011. One bird flying overhead, heading south. Site of several observations previously.
Errowanbang Road (near Burnt Yards turnoff) 550690818 6286004	One bird overhead, heading north. 22 Nov. 2011
Errowanbang Road (near Burnt Yards turnoff) 550690818 6286004	One bird overhead, heading south. (May be same bird as above.) 22 Nov. 2011
Errowanbang Road 55 0692179 6284813	One bird flying overhead, heading east. 22 Nov. 2011
Errowanbang Road 55 0689695 6289693	F flew off to the northeast, 9.25 am 23 Nov. 2011

Location	Observations	Date
"Wallaby" property 55 0692346 6290025	M and F sitting in dead tree, 10.45 am	23 Nov. 2011
"Wallaby" property 55 0692280 6290190	Pair in live tree. 10.50 am	23 Nov. 2011
"Wallaby" property 55 0692396 6290182	Pair in dead tree, flew off and returned to tree with two young birds. 10.55 am	23 Nov. 2011
"Wallaby" property 55 0692317 6290232	Pair in live tree + 4 young; pair + 1 young in nearby tree +1 young(?) in same tree; minimum parrots in area 17. 11.00 am	23 Nov. 2011
"Wallaby" property 55 0692021 6290376	3 birds flying to east towards above area.	23 Nov. 2011
Errowanbang Road (near Burnt Yards turnoff) 55 0690923 6286000	2M and 1F in tree; 10.40 am, flew off to south	23 Nov. 2011
9. 55 0696583 6281209	2 birds overhead, heading west, sex undetermined	23 Nov. 2011
10. 55 0695596 6279796	M overhead in trees; 3.55 pm	23 Nov. 2011
11. 550693852 6280845	M drinking in puddle in road; 3.40 pm	23 Nov. 2011
Errowanbang Road (near Burnt Yards turnoff) 55 0690560 6286234	M overhead; 3.55 pm	23 Nov. 2011
Errowanbang Road, near Halls Road 55 0692691 6283078	M flying overhead to north. 8.30 am	24 Nov. 2011
"Wallaby" property 55 0692436 6290117	6 birds in area, windy conditions 9.45 am onwards	24 Nov. 2011
Errowanbang Road, North of Gap Road 55 0695553 6279855	2M, 2F and 1Y (?), feeding in flowering *Eucalyptus melliodora*	24 Nov. 2011

Outside Study Area		
October 2011		
Carcoar showground 55 0698657 6278331	Three males flying amongst tall trees.	19 Oct. 2011
9 km south of Blayney 55 0701621 6280595	Two birds flying westwards over highway.	19 Oct. 2011
November 2011		
6 km south of highway, Neville Road 55 0696314 6271185	2F, 1M sitting in dead tree	22 Nov. 2011
5.5 km south of highway, Neville Road 55 069	12 birds, mixed flock, probably young (sex ratio undetermined)	22 Nov. 2011
2.5 km S of Mundurama, Neville Road, 55 0693366 6272502	4 birds overhead (sexes undetermined)	22 Nov. 2011

3 km north of Mundurama 55 065318 6276083	3 birds overhead (sexes undetermined)	22 Nov. 2011
Mundurama township 55 0692287 6274683	c.15 birds flying through town	24 Nov. 2011
300m south of Mundurama 55 0692755 6274533	6 birds flying between trees	24 Nov. 2011
Neville Road south of Mundurama 55 0695978 6271239	2 birds in dead tree	24 Nov. 2011

Appendix 2
Updated Animal Species List for the Flyers Creek Study Area

a. Source of record.
   1. Recorded in the NSW Wildlife Atlas within 5 km of the project area.
   2. Recorded previously in the near vicinity in the study by Cenwest (2005).
   3. Recorded in the project area in 2008/09/10.
   4. Recorded in the project area in spring 2011.
b. Introduced bird species are indicated by an asterisk (*).
c. Cadia mine site and nearby (Western Research Institute & Resource Strategies 2009).
d. Reported by land owners in the area.

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	11
MAMMALS					
ORNITHORHYNCHIDAE					
Platypus	*Ornithorhynchus anatinus*	1	2		
TACHYGLOSSIDAE					
Short-beaked Echidna	*Tachyglossus aculeatus*	1	2		
DASYURIDAE					
Brown Antechinus	*Antechinus stuartii*		2		
Yellow-footed Antechinus	*Antechinus flavipes*		2		
Common Dunnart	*Sminthopsis murina*		2		
VOMBATIDAE					
Common Wombat	*Vombatus ursinus*	1	2		
PETAURIDAE					
Sugar Glider	*Petaurus breviceps*		2		
Squirrel Glider	*Petaurus norfolcensis*		2		
PSEUDOCHEIRIDAE					
Common Ringtail Possum	*Pseudocheirus peregrinus*		2		
PHALANGERIDAE					
Common Brushtail Possum	*Trichosurus vulpecula*	1	2		
MACROPODIDAE					
Eastern Grey Kangaroo	*Macropus giganteus*	1	2	3	4
Common Wallaroo	*Macropus robustus*		2	3	
Swamp Wallaby	*Wallabia bicolor*	1	2	3	
EMBALLONURIDAE					
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		2		
MOLOSSIDAE					
Southern Freetail Bat	*Mormopterus planiceps*		2		
Inland Freetail Bat	*Mormopterus* species		2		
White-striped Freetail Bat	*Nyctinomus australis*		2		
VESPERTILIONIDAE					
Large Bentwing Bat	*Miniopterus schreibersii*		2		

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	11
Lesser Longeared Bat	*Nyctophilus geoffroyi*		2		
Gould's Longeared Bat	*Nyctophilus gouldi*		2		
Gould's Wattled Bat	*Chalinolobus gouldii*		2		
Chocolate Wattled Bat	*Chalinolobus morio*		2		
Eastern Cave Eptesicus	*Eptesicus pumilius*		2		
Little Broadnosed Bat	*Scotorepens greyii*		2		
Eastern Broadnosed Bat	*Scotorepens orion*		2		
Large Forest Bat	*Vespadelus darlingtoni*		2		
Southern Forest Bat	*Vespadelus regulus*		2		
Little Forest Bat	*Vespadelus vulturnus*		2		
MURIDAE					
Water-rat	*Hydromys chrysogaster*	1	2		
House Mouse*	*Mus musculus*		2		
Black Rat*	*Ratus rattus*		2		
CANIDAE					
Fox*	*Vulpes vulpes*	1	2	3	
FELIDAE					
Feral Cat*	*Felis catus*		2	3	
LEPORIDAE					
Rabbit*	*Oryctolagus cuniculus*	1	2	3	4
Brown Hare*	*Lepus capensis*		2	3	4
BOVIDAE					
Domestic Cattle*	*Bos taurus*		2	3	4
Domestic Sheep*	*Ovis aries*			3	4
Feral Goat*	*Capra hircus*	1			
CERVIDAE					
Unidentified Deer*	*Cervus* sp.	1			
BIRDS					
PHASIANIDAE					
Stubble Quail	*Coturnix pectoralis*			3	
Brown Quail	*Coturnix ypsilophora*		2		
ANATIDAE					
Black Swan	*Cygnus atratus*		2	3	4
Australian Wood Duck	*Chenonetta jubata*	1	2	3	4
Pacific Black Duck	*Anas superciliosa*		2	3	4
Grey Teal	*Anas gracilis*		2	3	4
Musk Duck	*Biziura lobata*		2		
Hardhead	*Aythya australis*			3	4
Pink-eared Duck	*Malacorhynchus membranaceus*		2	3	
Australian Shoveler	*Anas rhynchotis*		2	3	
Mallard*	*Anas platyrhynchos*		2		

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	 11
PODICIPEDIDAE					
Australasian Grebe	*Tachybaptus novaehollandiae*		2	3	4
Hoary-headed Grebe	*Poliocephalus poliocdephalus*		2	3	
PHALACROCORACIDAE					
Little Pied Cormorant	*Microcarbo melanoleucos*		2	3	4
Great Cormorant	*Phalacrocorax carbo*		2	3	4
ARDEIDAE					
White-faced Heron	*Egretta novaehollandiae*	1	2	3	4
White-necked Heron	*Ardea pacifica*			3	4
THRESKIORNITHIDAE					
Australian White Ibis	*Threskiornis molucca*			3	4
Straw-necked Ibis	*Threskiornis spinicollis*			3	4
ACCIPITRIDAE					
Black-shouldered Kite	*Elanus axillaris*		2	3	4
Black Kite	*Milvus migrans*			3	4
Brown Goshawk	*Accipiter fasciatus*		2	3	4
Wedge-tailed Eagle	*Aquila audax*		2	3	4
Little Eagle	*Hieraaetus morphnoides*		2	3	
FALCONIDAE					
Brown Falcon	*Falco berigora*		2	3	4
Australian Hobby	*Falco longipennis*		2		4
Peregrine Falcon	*Falco peregrinus*	1	2		
Nankeen Kestrel	*Falco cenchroides*		2	3	4
RALLIDAE					
Purple Swamphen	*Porphyrio porphyrio*				4
Dusky Moorhen	*Gallinula tenebrosa*		2	3	4
Eurasian Coot	*Fulica atra*		2	3	4
CHARADRIIDAE					
Double-banded Plover	*Charadrius bicinctus*		2		
Black-fronted Dotterel	*Elseyornis melanops*		2		
Masked Lapwing	*Vanellus miles*		2	3	4
LARIDAE					
Silver Gull	*Larus novaehollandiae*		2	3	
COLUMBIDAE					
Common Bronzewing	*Phaps chalcoptera*		2		
Crested Pigeon	*Ocyphaps lophotes*		2	3	4
Peaceful Dove	*Geopelia striata*		2		
Bar-shouldered Dove	*Geopelia humeralis*		2		
CACATUIDAE					
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*		2		
Galah	*Eolophus roseicapillus*	1	2	3	4

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	 11
Long-billed Corella*	*Cacatua tenuirostris*			3	
Little Corella	*Cacatua sanguinea*		2		
Sulphur-crested Cockatoo	*Cacatua galerita*	1	2	3	4
PSITTACIDAE					
Cockatiel	*Nymphicus hollandicus*		2		
Little Lorikeet	*Glossopsitta pusilla*		2		
Crimson Rosella	*Platycercus elegans*	1	2	3	4
Eastern Rosella	*Platycercus eximius*	1	2	3	4
Red-rumped Parrot	*Psephotus haematonotus*		2	3	4
Superb Parrot	*Polytelis swainsonii*		2	3	4
CUCULIDAE					
Pallid Cuckoo	*Cacomantis pallidus*		2	3	4
Brush Cuckoo	*Cacomantis variolosus*		2		
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		2		
Black-eared Cuckaoo	*Chalcites osculans*		2		
Horsfield's Bronze-Cuckoo	*Chalcites basalis*		2		
Shining Bronze-Cuckoo	*Chalcites lucidus*		2		
STRIGIDAE					
Southern Boobook	*Ninox novaeseelandiae*		2		4
TYTONIDAE					
Barn Owl	*Tyto alba*		2		
PODARGIDAE					
Tawny Frogmouth	*Podargus strigoides*		2		
AEGOTHELIDAE					
Australian Owlet-nightjar	*Aegotheles cristatus*		2		
APODIDAE					
White-throated Needletail	*Hirundapus caudacutus*		2		
HALCYONIDAE					
Laughing Kookaburra	*Dacelo novaeguineae*	1	2	3	4
Sacred Kingfisher	*Todiramphus sanctus*		2	3	4
MEROPIDAE					
Rainbow Bee-eater	*Merops ornatus*		2	3	
CORACIIDAE					
Dollarbird	*Eurystomus orientalis*		2	3	4
CLIMACTERIDAE					
White-throated Treecreeper	*Cormobates leucophaea*		2	3	4
Red-browed Treecreeper	*Climacteris erythrops*		2		
Brown Treecreeper	*Climacteris picumnus*		2		

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	 11
MALURIDAE					
Superb Fairy-wren	*Malurus cyaneus*	1	2	3	4
Variegated Fairy-wren	*Malurus lamberti*		2		
PARDALOTIDAE					
Spotted Pardalote	*Pardalotus punctatus*		2	3	
Striated Pardalote	*Pardalotus striatus*	1	2	3	4
Speckled Warbler	*Chthonicola sagittata*		2		
White-browed Scrubwren	*Sericornis frontalis*	1	2	3	
Weebill	*Smicrornis brevirostris*		2		
White-throated Gerygone	*Gerygone olivacea*		2	3	
Western Gerygone	*Gerygone fusca*		2		
Brown Thornbill	*Acanthiza pusilla*		2		
Buff-rumped Thornbill	*Acanthiza reguloides*		2	3	4
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	1	2	3	4
Yellow Thornbill	*Acanthiza nana*		2	3	
Striated Thornbill	*Acanthiza lineata*	1	2	3	
Southern Whiteface	*Aphelocephala leucopsis*		2		
MELIPHAGIDAE					
Red Wattlebird	*Anthochaera carunculata*		2	3	4
Noisy Friarbird	*Philemon corniculatus*	1	2	3	4
Little Friarbird	*Philemon citreogularis*		2		
Singing Honeyeater	*Lichenostomus virescens*		2		
Noisy Miner	*Manorina melanocephala*		2	3	4
Yellow-faced Honeyeater	*Lichenostomus chrysops*		2	3	4
White-eared Honeyeater	*Lichenostomus leucotis*		2		
White-plumed Honeyeater	*Lichenostomus penicillatus*	1	2	3	4
Brown-headed Honeyeater	*Melithreptus brevirostris*		2	3	
White-throated Honeyeater	*Melithreptus albogularis*		2	3	
White-naped Honeyeater	*Melithreptus lunatus*		2		
Eastern Spinebill	*Acanthorhynchus tenuirostris*		2		
Scarlet Honeyeater	*Myzomela sanguinolenta*		2		
White-fronted Chat	*Epthianura albifrons*		2		
PETROICIDAE					
Jacky Winter	*Microeca fascinans*		2	3	
Scarlet Robin	*Petroica boodang*		2		
Red-capped Robin	*Petroica goodenovii*		2		
Flame Robin	*Petroica phoenicea*		2		
Eastern Yellow Robin	*Eopsaltria australis*		2		
NEOSITTIDAE					
Varied Sittella	*Daphoenositta chrysoptera*		2	3	
PACHYCEPHALIDAE					
Crested Shrike-tit	*Falcunculus frontatus*		2		
Golden Whistler	*Pachycephala pectoralis*		2		
Rufous Whistler	*Pachycephala rufiventris*		2	3	4
Grey Shrike-thrush	*Colluricincla harmonica*		2		4

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	 11
DICRURIDAE					
Leaden Flycatcher	*Myiagra rubecula*		2		
Satin Flycatcher	*Myiagra cyanoleuca*		2	3	
Restless Flycatcher	*Myiagra inquieta*		2		
Magpie-lark	*Grallina cyanoleuca*	1	2	3	4
Grey Fantail	*Rhipidura albiscapa*		2	3	4
Willie Wagtail	*Rhipidura leucophrys*	1	2	3	4
CAMPEPHAGIDAE					
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		2	3	4
White-winged Triller	*Lalage sueurii*		2	3	4
ORIOLIDAE					
Olive-backed Oriole	*Oriolus sagittatus*		2		4
ARTAMIDAE					
Dusky Woodswallow	*Artamus cyanopterus*		2	3	4
White-browed Woodswallow	*Artamus superciliosus*			3	4
Masked Woodswallow	*Artamus personatus*				4
Grey Butcherbird	*Cracticus torquatus*			3	
Pied Butcherbird	*Cracticus nigrogularis*		2	3	4
Australian Magpie	*Cracticus tibicen*	1	2	3	4
Pied Currawong	*Strepera graculina*	1	2	3	4
Grey Currawong	*Strepera versicolor*		2		
CORVIDAE					
Australian Raven	*Corvus coronoides*	1	2	3	4
Little Raven	*Corvus mellori*		2		
CORCORACIDAE					
White-winged Chough	*Corcorax melanorhamphos*		2	3	4
MOTACILLIDAE					
Australasian Pipit	*Anthus novaeseelandiae*		2	3	4
PASSERIDAE					
House Sparrow*	*Passer domesticus*		2	3	4
Red-browed Finch	*Neochmia temporalis*	1	2	3	4
Diamond Firetail	*Stagonopleura guttata*	1	2	3	
FRINGILLIDAE					
European Greenfinch*	*Carduelis chloris*		2		
European Goldfinch*	*Carduelis carduelis*		2	3	4
DICAEIDAE					
Mistletoebird	*Dicaeum hirundinaceum*		2	3	
HIRUNDINIDAE					
White-backed Swallow	*Cheramoeca leucosternus*		2		
Welcome Swallow	*Hirundo neoxena*	1	2	3	4
Tree Martin	*Petrochelidon nigricans*		2	3	4

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	11
Fairy Martin	*Petrochelidon ariel*		2	3	4
SYLVIIDAE					
Clamorous Reed-Warbler	*Acrocephalus stentoreus*		2	3	4
Rufous Songlark	*Cincloramphus mathewsi*		2		
ZOSTEROPIDAE					
Silvereye	*Zosterops lateralis*		2		
MUSCICAPIDAE					
Common Blackbird*	*Turdus merula*	1	2	3	4
STURNIDAE					
Common Starling*	*Sturnus vulgaris*	1	2	3	4
Common Myna*	*Acridotheres tristis*		2		
FROGS					
MYOBATRACHIDAE					
Common Eastern Froglet	*Crinia signifera*		2	3	4
Eastern Sign-bearing Froglet	*Crinia parinsignifera*		2		
Eastern Banjo Frog	*Limnodynastes dumerilii*	1	2	3	
Brown-striped Frog	*Limnodynastes peronii*		2		
Spotted Grass Frog	*Limnodynastes tasmaniensis*		2	3	4
Smooth Toadlet	*Uperoleia laevigata*		2	3	
Brown Toadlet	*Pseudophryne bibronii*		2		
Smooth Toadlet	*Uperoleia laevigata*		2		4?
Wrinkled Toadlet	*Uperoleia rugosa*		2		
HYLIDAE					
Brown Tree Frog	*Litoria ewingii*		2		
Broad-palmed Frog	*Litoria latopalmata*		2		
Freycinet's Frog	*Litoria freycineti*		2		
Jervis Bay Tree Frog	*Litoria jervisiensis*		2		
Lesueur's Frog	*Litoria lesueuri*		2		
Peron's Tree Frog	*Litoria peronii*		2		
Verreaux's Tree Frog	*Litoria verreauxii*		2		

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	11
REPTILES					
CHELIDAE					
Long-necked Tortoise	*Chelodina longicollis*		2	3	
GEKKONIDAE					
Marbled Gecko	*Christinus marmoratus*	1	2		
Thick-tailed Gecko	*Underwoodisaurus milii*	1			
AGAMIDAE					
Jacky Lizard	*Amphibolurus muricatus*		2		
Eastern Water Dragon	*Physignathus lesueurii*		2		

FAMILY Species		Wildlife Atlas	Cadia area[c]	This Study 08-10	11
Bearded Dragon	*Pogona barbata*		2		4
PYGOPODIDAE					
Plain Snake-lizard	*Delma inorata*		2		
VARANIDAE					
Lace Monitor	*Varanus varius*		2		
SCINCIDAE					
Red-throated Skink	*Pseudemoia platynota*		2		
Southern Rainbow-Skink	*Carlia tetradactyla*		2		
Speckled Tree Skink	*Cryptolepharus xanabyi*		2		
Striped Skink	*Ctenotus robustus*		2		
Copper-tailed Skink	*Ctenotus taeniolatus*		2		
Cunningham's Skink	*Egernia cunninghami*		2	3	4
Tree Skink	*Egernia striolata*		2		
Eastern Water Skink	*Eulamprus quoyii*		2		
Three-toed Skink	*Hemiergis decresiensis*		2		
Delicate Skink	*Lampropholis delicata*		2		
Grass Skink	*Lampropholis guichenoti*		2		
South-eastern Slider	*Lerista bougainvillii*		2		
South-eastern Morethia Skink	*Morethia boulengeri*		2		
Weasel Skink	*Saproscincus mustelinus*		2		
Eastern Blue-tongued Lizard	*Tiliqua scincoides*		2	3	
Blotched Blue-tongued Lizard	*Tiliqua nigrolutea*		2		
Shingle-back	*Trachydosaurus rugosus*		2		
ELAPIDAE					
Eastern Blind Snake	*Ramphotyphops nigescens*		2		
Lowland Copperhead	*Austrelaps superbus*		2		
Common Death Adder	*Acanthophis antarcticus*		2		
Copperhead	*Austrelaps superbus*		2	3[d]	4
Red-bellied Black Snake	*Pseudechis porphyriacus*		2	3[d]	
Eastern Brown Snake	*Pseudonaja textilis*		2	3[d]	4
Bandy-Bandy	*Vermicella annulata*		2		
Dwyer’s Black-headed Snake	*Suta dwyeri*		2		

Appendix 3
Records of threatened species, other than the Superb Parrot

Species **Location**(WGS 84)	**Observation**	**Date**
Diamond Firetail		
55 0693986 6283555	10 birds	24 Feb. 2009
55 0691768 6290514	2 birds	25 Feb. 2009
55 0694250 6280656	1 bird	24 Nov. 2011

Little Eagle
This bird of prey was observed flying over the study area in February 2009. The species has also been recorded on the Cadia Mine site.

White-browed Woodswallow		
55 0691991 6290901	Large flock (c.100) with Masked Woodswallows	23 November 2011
Varied Sittella		
55 0694819 6288143	2 birds	23 Feb. 2009
55 0692230 6290043	3 birds	24 Feb. 2009

Appendix Q

Acoustics Australia

Airfoil tonal noise

Pile driving noise

Vibrations of bubbles and balloons

Music, order and complexity

Helmholtz attenuators for pipes

Vibration of a double-leaf plate

Electric vehicles: too quiet?

Future generation road vehicles

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LETTERS

PAPERS

TECHNICAL NOTES

REGULAR ITEMS

Cover design: Helena Brusic

LETTER TO THE EDITOR

Kym Burgemeister, Arup, Melbourne, VIC 3000
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Response to article by S. Cooper, "Wind farm noise - an ethical dilemma for the Australian Acoustical Society?", *Acoustics Australia* **40**(2), 139-142 (2012)

I was disappointed to read Stephen Cooper's technical note asking if the acoustical engineers and consultants preparing wind farm noise assessments in Australia are acting in accordance with the Australian Acoustical Society's Code of Ethics. It is apparent that Mr Cooper believes that many of the acoustical engineers and consultants who undertake these assessments are acting unethically on the basis that they *are* relying on ill-informed standards and guidelines and not challenging those guidelines or looking beyond them.

I have been fortunate enough to have recently been engaged by several government agencies to undertake an independent review of the standards and guidelines relating to the assessment of wind farm noise. Since I have never previously consulted to either the wind farm developers or the wind farm opponent groups I was able to approach this work from a 'neutral' position. The study has allowed me to develop an over-arching and contemporary view of the practice of wind farm noise assessment in Australia – a view which leads me to largely reject Mr Cooper's accusations.

I agree that there is genuine community concern regarding the potential for adverse effects associated with noise from wind farm developments, and a great deal of publicity regarding wind farm noise, particularly in the popular media. Nevertheless, much of the publicity is inaccurate and ill-informed, and articles such as Mr Cooper's technical note will, at best, only serve to reinforce the public perception that there is still significant disagreement amongst 'acoustic experts' regarding the best ways to measure, predict and assess wind farm noise - there is not. At worst, it will be adopted as a 'key reference' by wind farm development opponents.

In his note, Mr Cooper contrasts the lack of informed consideration of the 'acoustic impact of wind farms' against the apparently more robust acoustic and socio-acoustic studies which informed the 'aircraft noise debate' following the opening of the third runway at Kingsford Smith Airport in Sydney. He then provides an account of his own contribution to the prediction of aircraft noise, in particular, the identification of several 'errors' in the common prediction methodology. The implication is that consultants are making similar errors in their prediction and assessment of wind farm noise, particularly by simply adopting international standards, with no 'localisation' to Australian conditions.

It is fair to say that the assessment methodology and choice of assessment criteria for wind farms is not perfect. But, as discussed in Isaac Asimov's enlightening and entertaining essay *The Relativity of Wrong* [1], it is important <u>not</u> to assume that 'that which isn't perfectly and completely right, is totally and equally wrong'. In practice, most of us are able to accept that there are no criteria, or guidelines, or assessment techniques that are ever perfect. They are always the result of compromise and an attempt to *balance* the impact of noise on the amenity of the community against the wider benefits that the noise source provides. It therefore must be accepted that noise criteria, whether they are for industrial noise, noise from pubs, or barking dogs, or even wind farms, could always result in some adverse impact, particularly on people who have heightened sensitivity to noise.

My view is that consultants in Australia are doing their best to provide a reasonable and fair assessment of noise from wind farms. Much of this is based on reliable research and technical work that has been, and continues to be undertaken overseas by Geoff Leventhall, Andrew Bullmore, Dick Bowdler and other prominent acoustic engineers [2-7], research that appears to have been overlooked by Mr Cooper.

There are also many consultants and engineers in Australia and New Zealand who are undertaking excellent research, people like Tom Evans, Jon Cooper, Christophe Delaire and Colin Tickell amongst others in Australia, and Michael Smith and Stephen Chiles in New Zealand. These engineers are exploring new techniques to measure and assess noise from wind farms in a fair and equitable way [8-10], for example, by exploring 'bin analysis' of measured background and wind farm noise level [11] rather than the cumbersome 'regression' analysis which is usually adopted.

Furthermore, the continuing research into the potential health effects of wind farm noise is not being ignored; rather, the New Zealand Standard is based on a *reasonable* interpretation of the current research, and the New Zealand standards technical committee and other experts continue to review work such as that by Møller and Pedersen [12] and from DELTA [13, 14].

Mr Cooper has also published a peer review of the acoustic assessment undertaken for the Flyers Creek Wind Farm [15] which demonstrates several fundamental misunderstandings and inaccuracies which are also worthwhile examining.

With regard to low-frequency noise, Mr Cooper notes that a significant number of papers report low-frequency noise impacting on residents where the wind farm '*give[s] rise to frequencies below that of the human ear*' (sic).

His measurements of wind farm indoor and outdoor noise levels at residences near the Capital wind farm are claimed to show an impact from low-frequency noise from the wind turbines. However, only noise levels measured both with the wind farm operating in windy conditions and without the wind turbines operating, in calm conditions, are presented. The necessary case of the wind farm *not* operating in windy conditions is not shown, and would be likely to show low frequency noise due to increased environmental noise generation. It is accepted that this type of measurement is difficult, or impossible to do without the participation of the wind farm operator – nevertheless, such a significant omission makes the subsequent analysis meaningless.

For example, it seems irrational to suggest that '*typically when the wind farm was generating an electrical output [that] the background level increased, and when the wind farm reduced generating electrical output the background reduced*' infers that the wind farm is solely responsible for the background noise, while ignoring the fact that high ambient wind conditions, which is a necessary condition for the wind turbine to operate, also generates significant noise.

With regards to the internal noise level measurements undertaken inside nearby properties, Cooper's report states that '*no noise associated with the turbines could be detected inside the dwelling because the sound pressure levels recorded in those bands are below the nominal threshold of hearing*'.

There are further anomalies; data in Appendix G of the Flyer's Creek review showing a so-called 'Pulse Time Analysis' analyses the measured wind farm sound level using *fast response exponential averaging at 50ms*. Yet 125 ms is commonly accepted as a time constant representing that of human hearing, and the measurements shown in Appendix G does not appear to be exponentially averaged. While the figure title suggests a 24.4 Hz high-pass filter was applied, the measured levels only roll-off below around 5 Hz. Similarly, the results shown in Appendix H do not appear to have been high-pass filtered as suggested in the text.

Finally, he concludes that the measured Capital wind farm sound levels exceed various low frequency noise criteria. This includes the suggestion that Norm Broner has proposed a low-frequency noise limit of the dB(A) level + 30 dB '*where the C-weighted value is above 30 dB(A)*' (sic). Actually, Dr Broner recommends a 'desirable' outdoor L_{eq} limit of 60 dBC, with a maximum limit of 65 dB(C) for night-time operation [16]. In any case, the wind farm sound levels Mr. Cooper measured near the Capital wind farm are below the internationally recognised guidance limits of 85 dB(G) and 65 dB(C) [14, 17].

In order to constructively contribute to the wind farm noise discussion, it is helpful to examine some of those key aspects of wind farm noise measurement and assessment that would benefit most from additional research in order to *improve* the way that wind farms are measured and assessed.

Firstly, I agree with Mr Cooper that there is value in undertaking psycho-acoustic studies of the impact and annoyance of noise from operating wind farms – this was recommended by the Senate Enquiry into the Social and Economic Impact of Rural Wind Farms [18]. This would help to inform the science. This should particularly look at understanding the influence of amplitude modulation on the audibility and subjective response of wind turbine noise. The measurement of background and wind farm noise also requires improvement; the current regression techniques are quite cumbersome and not particularly transparent. While filtering by day, night, season, wind direction or atmospheric stability (or some combination of these) usually helps, perhaps alternative 'bin' type analysis (proposed to be adopted in the 3rd revision of IEC 61400-11) might prove more appropriate. The proposed *Good practice guide to wind turbine noise assessment* currently being developed by the UK IoA is likely help to inform the procedure.

The application of penalties for so-called 'Special Audible Characteristics' (or SACs) to measured noise levels requires further refinement – should penalties be applied to individual 10 minute measurements (and included in the regression, as implied in NZS 6808), or applied in bulk to the regression curve should a particular threshold of occurrence be exceeded?

We require better definition about when it might be appropriate to suggest or apply a more conservative limit (such as the High Amenity limit in NZS 6808-2010), and when the base limit is reasonable.

We should consider some standardisation of the structure of assessment studies and compliance reports, so that the community can be assured of some minimum level of information.

So, taking guidance from Dr. Asimov who concludes that 'theories are not so much wrong, as incomplete', until the outcomes of the research are available, I see no 'unethical behaviour' in using existing theory and the tools that are currently available to assess noise from wind farms.

Yours sincerely,

Dr Kym Burgemeister

REFERENCES

[1] I. Asimov, *The Relativity of Wrong*, 1988. Full text available at http://hermiene.net/essays-trans/relativity_of_wrong.html

[2] G. Leventhall, A. Bullmore, M. Jiggins, M. Hayes, A. McKenzie, R. Bowdler and R. Davis, "Prediction and assessment of wind turbine noise, Agreement about the relevant factors for noise assessment from wind energy projects", *Acoustics Bulletin* **34**(2), 35-37, March/April (2009)

[3] Hayes McKenzie Partnership Ltd, *Analysis of how noise impacts are considered in the determination of wind farm planning applications*. Report 2293/R1, Research Contract 01.08.09.01/492A (Analysis), UK Department of Energy and Climate Change, April 2011

[4] UK Institute of Acoustics, *Good practice guide to wind turbine noise assessment, Working Group terms of reference* http://www.ioa.org.uk/pdf/ioa-good-practice-guide-terms-of-reference-v-09-12-11-version-5.pdf (last accessed November 2012)

[5] A. Bullmore, J. Adcock, M. Jiggins and M. Cand, "Wind farm noise predictions and comparison with measurements", *Proceedings of the 3rd International Meeting on Wind Turbine Noise*, Aalborg, Denmark, 17-19 June 2009

[6] A. Bullmore, M. Jiggins, M. Cand, M. Smith and S. Von-Hunerbein, "Wind turbine amplitude modulation: Research to improve understanding as to its cause & effect", *Proceedings of the 4th International Meeting on Wind Turbine Noise*, Rome, Italy, 11-14 April 2011

[7] D. Bowdler, "Amplitude modulation of wind turbine noise, A review of the evidence", *Acoustics Bulletin* **33**(4), July/August 2008, pp. 31-35

[8] C.E. Tickell, J.T. Ellis and M. Bastasch, "Wind turbine generator noise prediction – Comparison of computer models", *Proceedings of Acoustics 2004*, Gold Coast, Australia, 3-5 November 2004, pp. 45-50
[9] T. Evans and J. Cooper, "Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms", *Proceedings of Acoustics 2011*, Gold Coast, Australia, 2-4 November 2011
[10] J. Cooper, D. Leclercq and M. Stead, "Wind induced aerodynamic noise on microphones from atmospheric measurements", *Proceedings of the 20th International Congress on Acoustics*, Sydney, Australia, 23-27 August 2010
[11] M. Smith and S. Chiles, "Analysis techniques for wind farm sound level measurements", *Acoustics Australia* **40**(1), 51-56 (2012)
[12] H. Møller and C.S. Pedersen, "Low-frequency noise from large wind turbines", *Journal of the Acoustical Society of America*, **129**(6), 3727-3744 (2011)
[13] B. Søndergaard and K.D. Madsen, *Low frequency noise from large wind turbines: Results from sound power measurements*, DELTA Acoustics & Electronics, AV136/08, 2008
[14] T.H. Pedersen, *Low frequency noise from large wind turbines: A procedure for evaluation of the audibility for low frequency sound and a literature study*, DELTA Acoustics & Electronics, AV1098/08, 2008
[15] S. Cooper, *Peer review of acoustic assessment*, Flyers Creek wind farm, The Acoustic Group Pty Ltd. Report 41.4963. R1A:ZSC, 15 December 2011
[16] N. Broner, "A simple outdoor criterion for assessment of low frequency noise emission", *Acoustics Australia* **39**(1), 7-14 (2011)
[17] D.M. Hessler and G.F. Hessler, "Recommended noise level design goals and limits at residential receptors for wind turbine developments in the United States", *Noise Control Engineering Journal* **59**(1), 94-104 (2011)
[18] The Senate Community Affairs References Committee, *The social and economic impact of rural wind farms*, Australian Senate June 2011 http://apo.org.au/node/25321

LETTER TO THE EDITOR

Marion Burgess
School of Engineering and Information Technology, The University of New South Wales, Canberra, ACT 2600

Australian Standards

At the recent AAS conference in Perth we held a discussion session on Australian Standards to elicit the view from the participants on the direction for the AAS in future dealings with Standards Australia. To explain just a little of the background – the operating model for Standards Australia has changed greatly over the last decade putting more responsibility onto the stakeholder bodies to fully canvas all those who may have any interest in the standard and put forward a submission to Standards Australia for a project. It is then only if that submission is accepted as a project that any work can be done by the Standards Australia committee to update/correct an existing Australian Standard, to replace an outdated Australian Standard with a current ISO or similar as a direct text adoption with or without any additional comment to relate that document to Australian conditions.

A submission prepared by a member under the auspices of the AAS has a reasonable chance of being accepted. There is however considerable effort to get the documentation together so there is a need to prioritise and select those Australian Standards that are desperately in need of amendment, updating or replacement. The discussion at the conference brought forward some proposals of those desperately needing some work – for example AS 2107 and AS 1055 were needing updating or replacement. If any member would like to suggest an Australian Standard that they consider is in desperate need of updating or replacing or removing and could be on the priority listing for an AAS action then please send me an email: m.burgess@adfa.edu.au

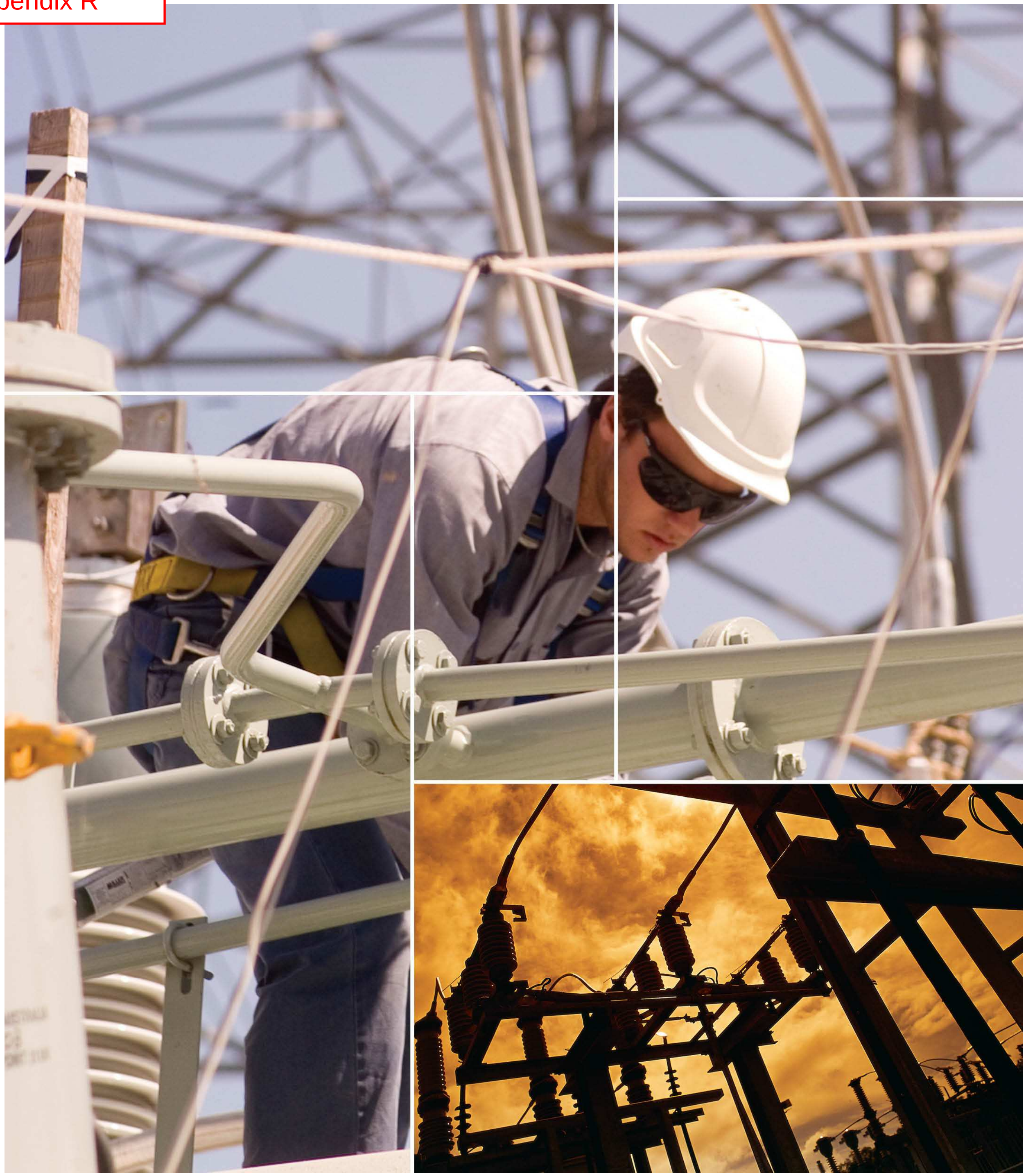
Marion Burgess

MESSAGE FROM THE EDITOR

This is just a short note to say thank you to all the lovely people who have been involved with the journal this year, in particular the authors and reviewers (we would not exist without you!), contributors to the various news articles and our advertisers. I believe the journal is gaining momentum in its recognition. In the last twelve months, there were 287,700 requests for the journal – that's a lot of requests! The next issue (April 2013) will be a special issue on Underwater Acoustics. If you would like to contribute an article to this special issue, please email myself (n.kessissoglou@unsw.edu.au) or Alec Duncan (A.J.Duncan@curtin.edu.au) your submission by the end of January at the very latest. I take this opportunity to wish everyone an enjoyable and relaxing break and a happy new year. Let's hope that 2013 continues to bring much attention to our Acoustics Australia journal.

Nicole Kessissoglou

Appendix R



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EMF Assessment

Prepared for: Infigen Energy

Project: 231276

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Name	Paul Flanagan	Name	Steve Redhead
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Contents

1. Introduction

1.1 Background and scope

Infigen Energy proposes to develop the Flyers Creek Wind Farm near Carcoar in NSW and has engaged Aurecon to assess the electric and magnetic fields (EMF), likely to be associated with it, against relevant health guidelines.

In more detail, the scope of the assignment involves the following:

- Identify the key potential sources of EMF
- Estimate the EMF contribution of the identified sources to the EMF environment beyond the wind farm, with particular reference to the nearest residences.
- Assess the estimated fields against relevant limits/criteria.

Owing to the preliminary stage of the project's development, it is not possible to undertake precise EMF calculations. Accordingly, it is necessary to base the assessment on generic calculations for typical facilities carrying loads similar to those proposed. This approach is considered appropriate, provided that the predicted EMF levels do not approach the relevant health guideline limits. In the event that health guideline limits are approached, it would be necessary to undertake a precise assessment once final design details become available.

1.2 Structure of Report

Section 2 provides background information on the EMF and human health issue and Section 3 documents the relevant information sourced from Infigen Energy. Section 4 documents our estimates of the facilities' likely future contribution to the EMF environment within and surrounding the site and Section 5 discusses our findings against relevant EMF standards. Conclusions are presented in Section 6 and a list of reference documents is contained in Section 7.

2. Overview of Electric and Magnetic Fields

2.1 General Description

The electric and magnetic fields associated with electrical equipment are essentially independent of one another. The electric field is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires.

An **electric field** is a region where electric charges experience an invisible force. The strength of this force is related to the voltage, or pressure, which forces electricity along wires. Electric fields are strongest close to their source, and their strength diminishes rapidly with distance from the source, in much the same way as the warmth of a fire decreases with distance. Many common materials – such as brickwork or metal – block electric fields, so they are readily shielded and, for all practical purposes, do not penetrate buildings. They are also shielded by human skin, such that the electric field inside a human body will be at least 100,000 times less than the external field (Ref 1).

Being related to voltage, the electric fields associated with transmission lines and electrical equipment remain relatively constant over time, except where the operating voltage changes.

A **magnetic field** is a region where magnetic materials experience an invisible force produced by the flow of electricity (known as the electric current and measured in Amps). As magnetic fields are related to the current rather than the voltage, high voltage equipment is not the only source of magnetic fields encountered in everyday life. Modern life involves frequent contact with magnetic fields from a variety of sources such as electrical wiring, appliances in the home and workplace and electrical machinery.

The strength of a magnetic field depends on the size of the current (measured in amps), and decreases with distance from the source. While electric fields are blocked by many common materials, this is not the case with magnetic fields. This is why locating equipment in enclosures or underground will eliminate any external electric field but not the magnetic fields.

The magnetic field strength resulting from an electrical installation varies continually with time and is affected by a number of factors including:

- The total electric load;
- The size and nature of the equipment;
- The design of the equipment; and
- The layout and electrical configuration of the equipment and its interaction with other equipment.

2.2 Overview of EMF and Human Health

The possibility of adverse health effects due to the EMFs associated with electrical equipment has been the subject of extensive research throughout the world. To date, while adverse health effects have not been established for fields at the levels commonly encountered in the modern world, the possibility that they may exist cannot be ruled out.

While EMFs involve both electric and magnetic components, electric fields are relatively constant over time, are readily shielded and, in the health context, are generally no longer associated with the same level of interest as magnetic fields. Nevertheless, in some situations[1], electric field strengths can approach the level at which "nuisance shocks" can occur and this phenomenon needs to be managed. (This is normally achieved by simple earthing.) Magnetic fields are not readily shielded, are more ubiquitous and remain the subject of some debate. Accordingly, much of the remainder of this report is directed towards magnetic fields.

Research into EMFs and health is a complex area involving many scientific disciplines – from biology, physics and chemistry to medicine, biophysics and epidemiology. Many of the health issues of interest to researchers are quite rare. In this context, it is well accepted by scientists that no study considered in isolation will provide a meaningful answer to the question of whether or not EMFs can contribute to adverse health effects. In order to make an informed conclusion from all of the research, it is necessary to consider the science in its totality. Over the years, governments and regulatory agencies around the world have commissioned independent scientific review panels to provide such overall assessments.

The most recent scientific reviews by authoritative bodies are reassuring for most potential health issues. However, statistical associations[2] between prolonged exposure to elevated magnetic fields and childhood leukaemia have persisted. This led the International Agency for Research on Cancer (IARC) (Ref 2) in 2001 to classify magnetic fields as a "possible carcinogen".[3]

The fact that, despite over 20 years' laboratory research, no mechanism for an effect has been established, lends weight to the possibility that the observed statistical associations reflect some factor other than a causal relationship. This point is made in the 2001 report of the UK National Radiological Protection Board's (NRPB) Advisory Group, chaired by eminent epidemiologist, the late Sir Richard Doll (Ref 3)

> *"in the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children"* (page 164).

2.3 Health Standards

Until a few years ago, the relevant Australian health standard was the document called 'Interim Guidelines on Exposure to 50/60 Hz Electric and Magnetic Fields' (1989) (Ref 4), issued by the National Health and Medical Research Council (NHMRC) and based on international guidelines[4]. As the NHMRC has not updated these guidelines since their original issue, they have rescinded them.

---

[1] *Generally restricted to localised areas within electrical substations or directly under extra high voltage lines operating at 300kV and above.*

[2] *It should be noted that that a statistical association does not necessarily reflect a cause and effect relationship.*

[3] *IARC publishes authoritative independent assessment by international experts of the carcinogenic risks posed to humans by a variety of agents, mixtures and exposures. These agents, mixtures and exposures are categorised into 5 groups, namely:*

- *Group 1 -the agent is carcinogenic to humans - 108 agents are included in the group, including asbestos, tobacco and ultra violet radiation;*
- *Group 2A - the agent is probably carcinogenic - 64 agents have been included in this group, including diesel engine exhaust, creosotes and PCBs;*
- *Group 2B - the agent is possibly carcinogenic to humans - 271 agents have been included in this group, including coffee, gasoline, lead, nickel, petrol engine exhaust and extremely low frequency magnetic fields;*
- *Group 3 - the agent is not classifiable as to carcinogenicity - 508 agents have been included in this group, including caffeine, coal dust and extremely low frequency electric fields;*
- *Group 4 - the agent is probably not carcinogenic to humans - only 1 agent (caprolactam) has been included in this group.*

[4] *The relevant international guidelines are those issued by the International Commission on Non-ionising radiation Protection (ICNIRP). These were first issued in 1988, have been regularly updated since, and were most recently re-issued in 2010.*

The relevant Australian regulator (now ARPANSA) has been developing a new standard for several years. In December, 2006, ARPANSA issued a Draft Standard on “Exposure Limits for Electric and Magnetic Fields (0 Hz to 3 kHz)” for public comment (Ref 5). The Draft Standard proposed a magnetic field exposure limit (Reference Level) for the general public of 1000 milligauss (mG), which is numerically identical[5] to the previous (Australian) NHMRC Guidelines but only 50 % of the current (2010) version of the international (ICNIRP) guidelines (Ref 6), upon which they were based. It is understood that, as a result of submissions received in response to the 2006 Draft, the Australian Government Radiation Health Committee, at its meeting of 18th July, 2007 (Ref 7), resolved, inter alia, to revise the magnetic field limit for the general public upwards to 3000 mG. It is also understood that, more recently (9th November, 2011), following the release of the 2010 ICNIRP Guidelines, the Committee agreed that the Draft Australian Guidelines be reviewed to adopt as much of the ICNIRP 2010 Guidelines as possible (Ref 8).

In the absence of a current Australian standard, while noting the possible adoption of a magnetic field limit of 3000 mG in the new ARPANSA Standard, we have favoured the current international (ICNIRP) guideline level of 2000 mG for this assessment.

In applying the ICNIRP Guideline, it is important to recognise that the numerical limits, e.g. 2000 mG, are based on established health effects. In ICNIRP’s fact sheet on the guidelines (Ref 9), it notes that:

“It is the view of ICNIRP that the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukaemia is too weak to form the basis for exposure guidelines. Thus, the perception of surface electric charge, the direct stimulation of nerve and muscle tissue and the induction of retinal phosphenes are the only well established adverse effects and serve as the basis for guidance.”

The limits for both electric and magnetic fields contained in the various health guidelines are summarised in Table 2.1.

Table 2.1 – Health Guidelines

Parameter	**NHMRC (1989)**	**ARPANSA 2006 Draft**	**ARPANSA 2009**	**ICNIRP 2010**
Electric Fields - General Public	5 kV/m	5 kV/m	5 kV/m	5 kV/m
Electric Fields - Occupational	10 kV/m	10 kV/m	10 kV/m	10 kV/m
Magnetic Fields - General Public	1000 mG	1000 mG	3000 mG	2000 mG
Magnetic Fields - Occupational	5000 mG	5000 mG	5000 mG	5000 mG

Being based on established biological effects (which occur at field levels much higher than those normally encountered in the vicinity of electrical equipment), the (numerical) exposure limits in the guidelines and standards cannot be said to define safe limits for possible health effects, should these exist, from magnetic fields at levels normally encountered in the vicinity of electrical equipment. Nevertheless, in the Foreword to the ARPANSA Draft Standard, the CEO of ARPANSA, Dr John Loy notes that

[5] *In line with the international guidelines, this limit is now independent of duration of exposure. Previous relaxations for shorter term exposures no longer apply.*

“the incorporation of arbitrary additional safety factors beyond the limits of the Standard is not supported”.

Internationally, the World Health Organisation has also addressed the adequacy of the health standards in its 2007 publication Extremely low frequency fields. Environmental Health Criteria, Vol. 238 (Ref 1), which states:

“…..the use of precautionary approaches is warranted. However, it is not recommended that the limit values in exposure guidelines be reduced to some arbitrary level in the name of precaution. Such practice undermines the scientific foundation on which the limits are based and is likely to be an expensive and not necessarily effective way of providing protection.”

3. Input Information

Most of the information for this assessment has been sourced from the Flyers Creek Wind Farm Environmental Assessment.

In particular:

- The output from the turbines is to be collected via 33kV underground cables throughout the wind farm.
- With the exception of the southern turbine groups, the 33kV underground cable will feed directly into the 33/132kV substation, which is to be sited on the north western side of the wind farm.
- The substation will comprise two outdoor transformers and two outdoor 132kV feeder bays. The 33kV switchgear will be of the indoor variety.
- The southern turbine groups will be connected to the substation via an overhead 33kV line some 11 km in length.
- The two circuits of the 33kV overhead line will carry the output of 11 and 16 turbines respectively.
- The substation is to be connected to the electricity grid via a 132kV overhead transmission line.
- The 132kV line is expected to be of single circuit, single pole construction, similar to Essential Energy's standard construction.
- The distance from the substation to the nearest residence will be some 400 metres.
- The distance from the 132kV line to the nearest residence will be some 180 metres.
- The distance from the 33kV overhead line to the nearest residence will be some 500 metres

Infigen Energy has instructed us to assume a total load of 130 MW for the assessment:

4. Estimation of Field Levels

4.1 Identification of key EMF sources

The key potential sources of EMF identified for assessment are the 33kV overhead and underground reticulation within the site, the 33/132kV substation and the 132kV transmission line connecting the wind farm to the electricity grid.

4.2 Loadings used for modelling/estimation

The magnetic fields from electrical equipment depend on the loadings at that particular time. Accordingly, in characterising the magnetic fields from an item of electricity infrastructure, it is necessary to make practical assumptions regarding the loadings on it. For the purposes of this assessment, we have been instructed to assume an output of 130 MW. It is understood that the output will be less than this figure for 90% of the time. This is a more stringent requirement than that required under the relevant industry guideline (Ref 10) which stipulates that the 85th percentile level (i.e. that level which is exceeded for only 15% of the year) be used for the purposes of EMF assessment. It should be noted that, in practice, the magnetic fields would be dependent on the actual output at the time, rather than those used for calculation purposes.

The load currents assumed for the assessment, based on a total output of 130 MW, are set out in Table 4.1.

Element	Load MW	Current (Amps) @ 0.9 p.f.
132kV transmission line	130	630
33kV double circuit overhead line	33 + 47	640 + 915
33kV underground cable	30	575
33/132kV substation	130	N/A

Table 4.1 Loadings used for modelling/estimation

4.3 Magnetic Fields

The magnetic fields were calculated for typical 33kV and 132kV installations carrying the loads set out in Table 4.1. The fields were calculated at a height of 1 m above ground in accordance with international practice.

4.3.1 132kV transmission line

The magnetic field profile beneath at the low point in the span of a typical 132kV transmission line carrying a load current of 630 Amps is shown in Figure 4.1. The profile extends for a distance of 100 metres on each side of the line.

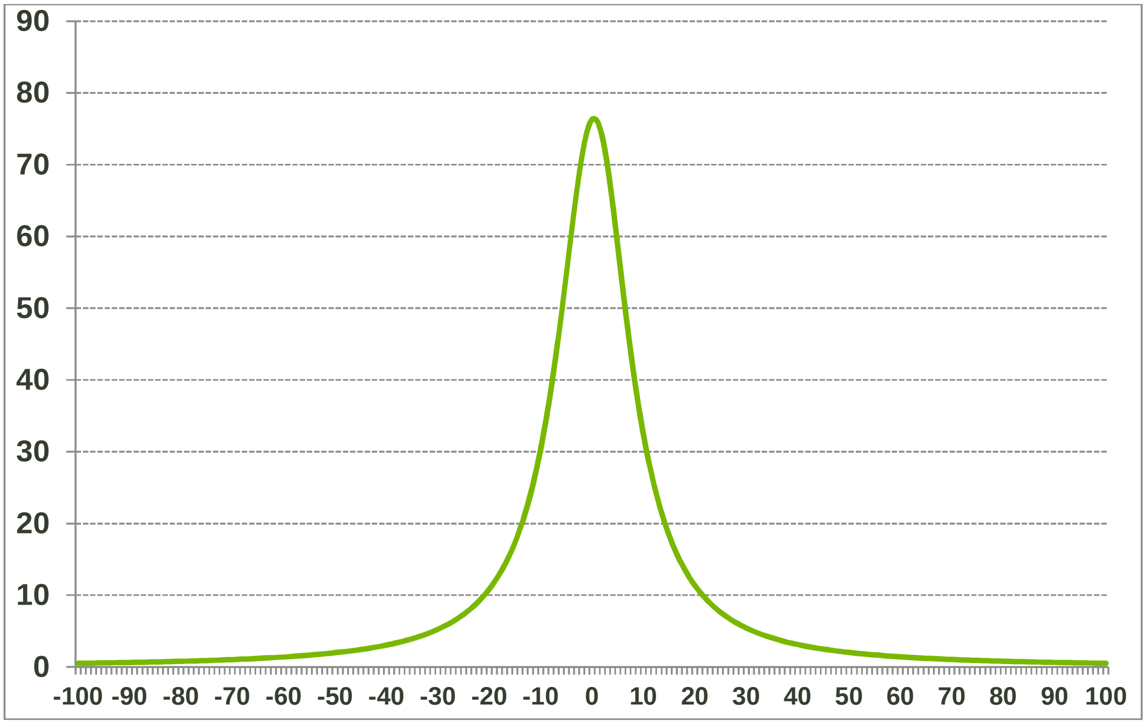

Figure 4.1 Magnetic field profile (mG) – 132kV line carrying 630 Amps

It can be seen from Figure 4.1 that the magnetic field directly under the line is 76 mG, which is less than 4% of the relevant health guideline for the general public. This drops off quickly as one moves away from the line, being 11mG at 20 metres, 5mG at 30 metres, 2mG at 50 metres and 0.5 mG at 100 metres. The line's contribution to the magnetic field at the nearest residence would be virtually nil.

4.3.2 33kV overhead line

The magnetic field profile beneath at the low point in the span of a typical (heavy) double circuit 33kV transmission line carrying load currents of 640 and 915 Amps in the respective circuits is shown in Figure 4.2. The profile extends for a distance of 100 metres on each side of the line.

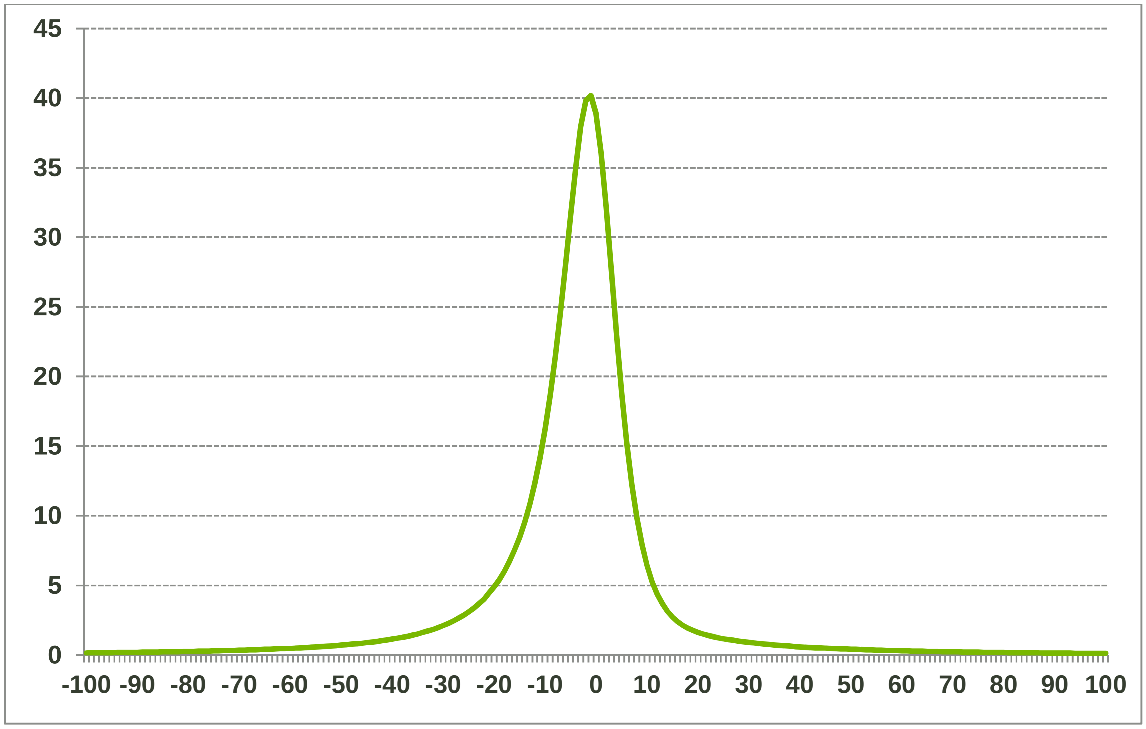

Figure 4.2 Magnetic field profile (mG) – double circuit 33kV line carrying 640 + 915 Amps

It can be seen from Figure 4.2 that the magnetic field directly under the line is 40 mG, which is less than 2% of the relevant health guideline for the general public. As with the 132kV line, this drops off quickly as one moves away from the line, being 5mG at 20 metres, 2mG at 30 metres and 0.7 mG at 50 metres. It will also be noted that the rate of decrease is greater than for the 132kV line. This is due to the mutual cancellation between the two circuits. The line's contribution to the magnetic field at the nearest residence would be virtually nil.

4.3.3 33kV underground cable

The most heavily loaded 33kV underground cable circuit is that connecting the 10 turbines of the Northern Group to the substation. The magnetic field above this cable has been estimated and is shown as a profile in Figure 4.3. The profile extends for a distance of 50 metres on each side of the cable.

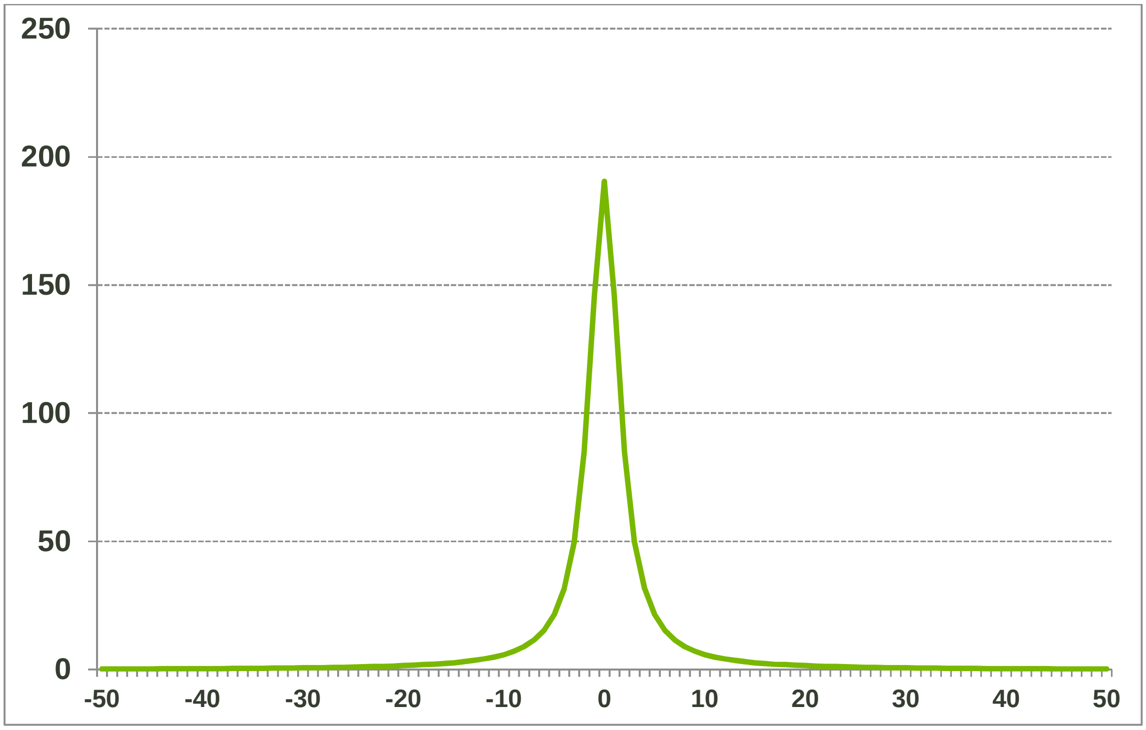

Figure 4.3 Magnetic field profile (mG) – 33kV underground cable carrying 575 Amps

It can be seen from Figure 4.3 that the magnetic field directly above the cable is 190 mG, which is less than 10% of the relevant health guideline for the general public. This drops off quickly as one moves away from the cable, being 6mG at 10 metres and less than 1mG at 25 metres. It will also be noted that the rate of decrease is much greater than for the overhead lines. This is due to the phases of the underground cable circuit being much closer together than for the overhead lines. The cable's contribution to the magnetic field at the nearest residence would be nil.

4.3.4 33/132kV substation

The magnetic fields in the vicinity of a substation are influenced by the substation itself and by the incoming and outgoing overhead lines and underground cables. The contributions of the lines and cables have been addressed in Sections 4.3.1 to 4.3.3 and this section addresses the substation itself. Owing to the preliminary nature of the substation design, it is not considered beneficial to purport to model it. Accordingly, we have taken a two transformer substation previously modelled and adjusted the results to reflect the anticipated wind farm loading. Based on this approach, and consistent with our experience on substations elsewhere, it is estimated that the substation's contribution to the magnetic field environment will be of the order of 30 mG at the switchyard fence and 2 mG at a distance of 50 metres outside the fence. At the points where lines and cables enter and leave the substation, the localised fields will be similar to those described in Sections 4.3.1 to 4.3.3. The substation's contribution to the magnetic field at the nearest residence would be nil.

4.4 Electric Fields

Electric fields are broadly reflective of the operating voltage of the equipment.

The electric fields were calculated for the same “typical” 33kV and 132kV installations as those used for the magnetic field calculations reported in Section 4.3. The fields were calculated at a height of 1 m above ground in accordance with international practice.

4.4.1 132kV transmission line

The electric field profile beneath at the low point in the span of a typical 132kV transmission line is shown in Figure 4.4. The profile extends for a distance of 100 metres on each side of the line.

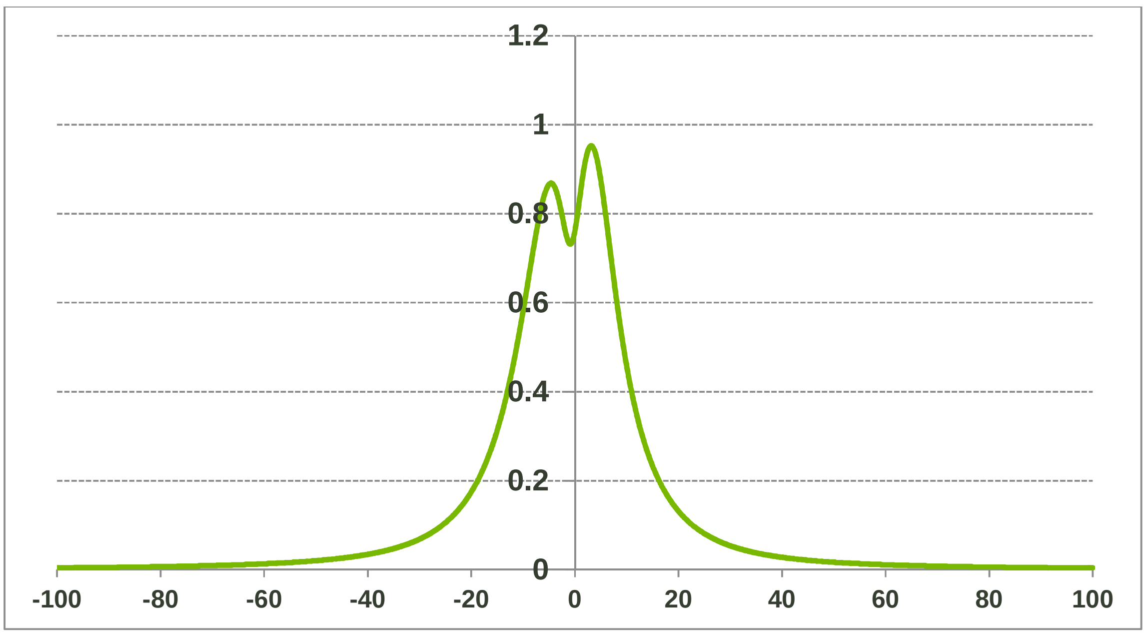

Figure 4.4 Electric field profile kV/metre – 132kV line

It can be seen from Figure 4.4 that the electric field directly under the line is 0.95kV/metre, which is less than 20% of the relevant health guideline for the general public. This drops off quickly as one moves away from the line, being 0.13kV/metre at 20 metres and 0.02kV/metre at 50 metres. The line’s contribution to the electric field at the nearest residence would be nil.

4.4.2 33kV overhead line

The electric field profile beneath at the low point in the span of a typical (heavy) double circuit 33kV transmission line is shown in Figure 4.5. The profile extends for a distance of 100 metres on each side of the line.

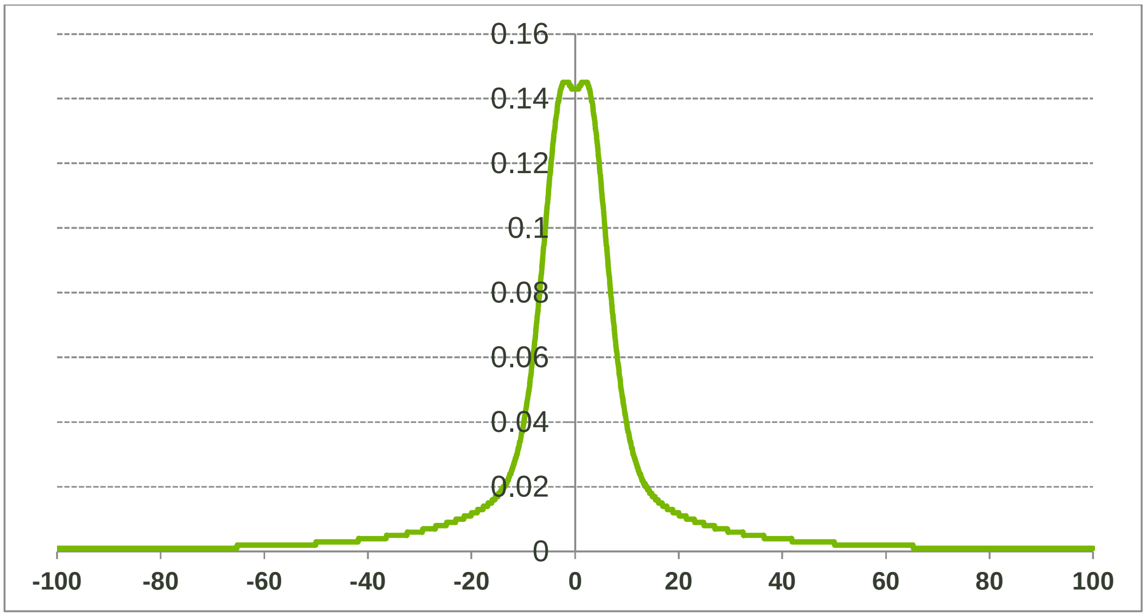

Figure 4.5 Electric field profile (mG) – double circuit 33kV line

It can be seen from Figure 4.5 that the electric field directly under the line is 0.15kV/metre, which is less than 3% of the relevant health guideline for the general public. As with the 132kV line, this drops off quickly as one moves away from the line, being 0.01kV/metre at 20 metres. The line's contribution to the electric field at the nearest residence would be nil.

4.4.3 33/132kV substation

The electric fields outside the switchyard fence are expected to be less than 0.1kV/metre and will decrease rapidly with distance. The switchyard's contribution to the electric fields at the nearest residences will be nil.

5. Discussion of Estimated Fields

While the magnetic field levels estimated in Section 4 are approximations only, it should be noted that the assumptions on which they are based are conservative. Accordingly, the field levels are more likely to have been over-estimated than under-estimated.

In order to place the magnetic field estimates in Section 4 into some perspective, it is instructive to compare them with typical fields experienced in the modern environment and with relevant health guidelines. In this regard, it is also relevant to note that modern life involves frequent contact with magnetic fields from a variety of sources such as appliances and electrical machinery. Some relevant material is set out in Tables 5.1 and 5.2 below.

The (Australian) Energy Networks Association (Ref 11) has published a series of typical magnetic field levels associated with particular appliances etc **at normal user distance**. These are set out in Table 5.1.

MAGNETIC FIELD SOURCE	TYPICAL MEASUREMENT (MILLIGAUSS)	RANGE OF MEASUREMENTS (MILLIGAUSS)
Electric Stove	6	2-30
Computer Screen	5	2-20
Television Screen	1	0.2-2
Electric Blanket	20	5-30
Hairdryer	25	10-70
Refrigerator	2	2-5
Electric Toaster	3	2-10
Electric Kettle	3	2-10
Electric Fan	1	0.2-2
Street Distribution Line (directly under line)	10	2-20
High Voltage Transmission Line directly under line at edge of easement	 20 10	 10-200 2-50

Table 5.1: Magnetic Field Levels Associated with Appliances etc

The relevant health guidelines are shown in Table 5.2, along with the range of background magnetic fields measured in typical homes away from power lines.

Parameter	Magnetic Field (mG)	Notes
Relevant (ICNIRP) health guideline for the general public	2,000 mG	Based on established health effects
Range of fields measured in typical homes remote from powerlines	0.1 – 2.5 mG	Sourced from ARPANSA

Table 5.2: Health guidelines and typical magnetic field levels in homes

From Tables 5.1 and 5.2, it can be seen that the estimated magnetic fields within the wind farm, beyond a few metres from the overhead lines and underground cables, are within the range normally encountered in everyday life. The fields directly under the overhead lines and above the underground cables are in the range normally encountered in such situations and are less than 10% of the relevant health guidelines. The estimated fields at the substation fence are well within the range normally encountered in everyday life.

The contribution of the wind farm to the magnetic field levels at the nearest residences will be virtually nil.

Detailed information regarding magnetic fields and human health is available on the ARPANSA website (www.arpansa.gov.au).

6. Conclusions

The contribution of the wind farm to the electric and magnetic field levels at the nearest residences will be virtually nil. Our conclusions are detailed further in the following paragraphs.

6.1 Magnetic Fields

The estimated magnetic field directly under the proposed 132kV line is 76 mG, which is less than 4% of the relevant health guideline for the general public. This drops off quickly as one moves away from the line, being 11mG at 20 metres, 5mG at 30 metres, 2mG at 50 metres and 0.5 mG at 100 metres. The line's contribution to the magnetic field at the nearest residence would be virtually nil.

The estimated magnetic field directly under the proposed 33kVline is 40 mG, which is less than 2% of the relevant health guideline for the general public. This drops off quickly as one moves away from the line, being 5mG at 20 metres, 2mG at 30 metres and 0.7 mG at 50 metres. The line's contribution to the magnetic field at the nearest residence would be virtually nil.

The estimated magnetic field directly above the most heavily loaded 33kV cable is 190 mG, which is less than 10% of the relevant health guideline for the general public. This drops off quickly as one moves away from the cable, being 6mG at 10 metres and less than 1mG at 25 metresThe cable's contribution to the magnetic field at the nearest residence would be nil.

The estimated contribution of the substation to the magnetic field environment at the switchyard fence will be of the order of 30mG, which is less than 2% of the relevant health guideline for the general public. At a distance of 50 metres outside the fence, it will be less than 2 mG. The substation's contribution to the magnetic field at the nearest residence would be nil.

The substation's estimated magnetic fields beyond a few metres from the overhead lines and underground cables are within the range normally encountered in everyday life. The fields directly under the overhead lines and above the underground cables are in the range normally encountered in such situations and are less than 10% of the relevant health guidelines. The estimated fields at the substation fence are well within the range normally encountered in everyday life.

6.2 Electric Fields

The electric fields directly beneath the 132kV line are estimated to be less than 1kV/metre or 20% of the relevant health guideline. The electric fields directly beneath the 33kV line are estimated to be about 0.15 kV/ metre or 3% of the relevant health guideline. The electric fields outside the switchyard fence are expected to be less than 0.1kV/metre or 2% of the relevant health guideline. All of these fields will decrease rapidly with distance such that the wind farm's contribution to the electric fields at the nearest residences will be nil.

7. References

1. World Health Organisation: Environmental Health Criteria Vol. 238: Extremely low frequency fields. (2007).

2. World Health Organisation, International Agency for Research on Cancer, Lyon, France: IARC Monographs on the evaluation of carcinogenic risks to humans. Non-ionising Radiation, part 1: Static and extremely low frequency (ELF) electric and magnetic fields. (2001).

3. National Radiological Protection Board, (UK), ELF Electromagnetic Fields and the Risk of Cancer, Report of an Advisory Group on Non-ionising Radiation, Chairman, Sir Richard Doll, NRPB Vol 12 No.1, 179 pages, 2001.

4. National Health and Medical Research Council: Radiation Health Series No. 30: Interim Guidelines on Limits of Exposure to 50/60 Hz Electrical and Magnetic Fields (1989).

5. ARPANSA: Exposure Limits for Electric & Magnetic Fields – 0 Hz to 3 kHz. Public Consultation Draft. 7 December 2006.

6. International Commission on Non-Ionising Radiation Protection (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz): Health Physics, April 1999, Volume 74, Number 4; pp 4494-5528. Revised 2010.

7. Meeting Minutes - Australian Government Radiation Health Committee - 18 July 2007: Agenda Item 2.4.

8. Meeting Minutes - Australian Government Radiation Health Committee – 9 November 2011.

9. ICNIRP Fact Sheet on the guidelines for limiting exposure to time-varying electric, and magnetic fields (1Hz-100kHz) published in Health Physics 99(6): 818-836; 2010. www.icnirp.de/documents/factsheetLF.pdf

10. Standard Basis for Quoting Transmission Line Magnetic Fields. Energy Networks Association, 2006.

11. Electric and Magnetic Fields: What we know: Energy Networks Association, June 2006.

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Appendix S

Revised Table 9.3

Table 9.1 – Distribution of residences within five kilometres of Flyers Creek Wind Farm

Distance of residence from nearest turbine	Total number of residences	Wind farmer [(1)]	Neighbours (non-Windfarmer)
0 to 1 kilometres	6	6	0
1 to 2 kilometres	43	19	24 [(2)]
2 to 3 kilometres	47	1	46
3 to 4 kilometres	36	0	36
4 to 5 kilometres	26	0	26
Total	**158**	**26**	**132**

Note: [(1)] A wind-farmer residence is one where the owner has leased part or all of their land for the wind farm development. Some neighbouring residences are owned by wind farmers and are included here as wind farmer residences.

[(2)] Includes school – “Residence 57”

[(3)] Sheds or abandoned mines are not counted

Appendix T

Flyers Creek Wind Farm

Construction Traffic Volume Analysis

May 2013

Wendy Moloney
Construction Manager

Background

Chapter 13 of the Flyers Creek Wind Farm Environment Assessment (EA) discussed the expected construction traffic associated with the Flyers Creek wind farm project should it proceed to construction. A map of the proposed construction traffic routes is shown in Figure 13.2 of the EA. Total predicted one-way vehicle movements for the construction phase of the project are documented in Tables 13.3 and 13.4 of the EA.

In order to provide additional information with regards to expected construction traffic volumes, this report provides an estimate of the average daily traffic movements for construction traffic and compares these traffic volumes with existing traffic on the primary construction access routes. This brief report should be read in conjunction with Chapter 13 of the EA as it provides additional information and is not intended to replace or supersede the information provided in the EA.

Existing Traffic Volumes

Traffic counts for the roads in the vicinity of the proposed wind farm were requested from Blayney Shire Council's Engineering Services Department. Traffic counts existed for Gap Road (Road # 2) from 2010. Infigen Energy then commissioned Blayney Shire Council to perform traffic counts for the other three construction access routes. A summary of the results of their new and existing traffic counts provided by Blayney Shire are shown below in Table 1.

Table 1: Existing average daily vehicle one-way volumes

Road Name	Route No. in Figure 13.2	Average daily vehicle movements in one direction*
Gap Road	2	44
Halls Road	2A	9
Beneree Road	2B	24
Errowanbang Road	3B	15

**Source: Blayney Shire Council; 2010 and April 2013*

As one can see, the existing traffic volume for these roads is relatively light. Even the busiest road, Gap Road, averages only about four one-way trips per hour (assuming a 12 hour 'day'). The other roads have substantially less traffic. Halls Road has three farm gates which must be opened and closed which likely contribute to its very low traffic volumes.

Predicted Daily Construction Traffic Volumes

The total vehicle movements estimated by Aurecon in Table 13.3 and 13.4 of the EA were then utilised to arrive at both estimated average and maximum daily one-way vehicle movements for three categories of vehicles:

- Restricted Access Vehicles (RAVs) - Oversize vehicles and/or those exceeding axle and gross vehicle mass limits of a general access heavy vehicle
- Heavy Vehicles - General access heavy vehicles carrying gravel, water and other materials and equipment
- Light Vehicles – i.e. passenger cars, vans and utes.

It was assumed that an on-site concrete batching plant was utilised (see Table 13.4 of the EA).

Typical vehicle movements, as well as an estimated maximum number of vehicle movements were then estimated and are shown in Table 2 below.

Table 2: Predicted construction traffic volumes

Vehicle Type	Total Trips [1]	Approx. Duration (wks)	Est. Typical one-way trips/day	Est. Max one-way trips/day
RAVs	448	20	4	6
General Access Heavy Vehicles	4239	78	12	50
Light Vehicles	5000	84	30	60

NOTE 1: The EA was based on a 44 wind turbine generator layout and the derived numbers above are based on the 43 turbine layout.

As shown in Table 2, the daily volume of RAVs is relatively small and, of course, the scheduling of these trucks will be carefully considered as part of the project's Traffic Management Plan (TMP) to minimise inconvenience to existing road users. The heavy vehicle traffic would typically be rather moderate; however, there is the potential for some days to have higher truck traffic during certain periods of the construction process. Light vehicle traffic constitutes the highest traffic volumes. However, whilst the additional 30 vehicle movements per day will increase traffic volumes, they will have little impact on traffic conditions, in terms of capacity or delay and would not significantly change traffic conditions.

Comparison of Existing and Predicted Traffic Volumes

The existing traffic volumes were then compared to the typical predicted construction traffic volumes for each of the four primary construction routes. The predicted construction traffic volumes for each road depended primarily on how many of the proposed 43 turbines were being accessed using that route. As Gap Road will be utilised to access all 43 turbine locations, that road will see the highest volume of traffic whereas Beneree Road and Errowanbang Road (north of Halls Road) will experience less traffic as fewer turbines are accessed using these routes. The comparison of traffic volumes are shown in Table 3 below.

Table 3: Comparison of predicted and existing traffic volumes

Road	Est. typical RAV one-way trips/day	Est. typical heavy vehicle one-way trips/day	Est. typical light vehicle one-way trips/day	Current one-way trips/day
Gap Road (#2)	4	12	30	44
Halls Road (#2a)	2	7	17	9
Beneree Road (#2b)	1	3	9	24
Upper Errowanbang Road (#3b)	1	4	10	15

The RAV trips may result in some traffic delays due to the RAV speed and traffic control requirements at intersections. The predicted light vehicle utilisation is comparable to existing traffic volumes; however, light vehicle utilisation at these relatively low volumes will not materially affect, or delay, existing users of the roads. Similarly, the heavy vehicle movements will maintain similar speeds as existing road users and no additional traffic controls would be needed for heavy vehicles. As such, the impact of heavy vehicles to travel times of other users should be minimal.

Conclusion

The volume of existing traffic on the principal construction routes is relatively low. The additional traffic volumes predicted during the wind farm construction period are expected to have a minimal impact on traffic conditions. However, the traffic control requirements and speed of travel of the RAVs may well result in temporary delays to existing road users. Light and heavy vehicle traffic due to construction of the project will not have a significant impact on the normal flow of traffic on these roads.

As stated in Chapter 13 of the EA, should the Flyers Creek wind farm project proceed to construction, a detailed TMP will be developed in conjunction with the Roads and Maritime Services, the Blayney Shire Council and representatives of the local community. One of the primary objectives of the TMP is to minimise local traffic disruptions and delays during the construction phase of the project. This can be achieved through daily scheduling to avoid deliveries during local peak periods.