

**CROOKWELL 2 WIND FARM**

**SUPPLEMENTARY ECOLOGICAL IMPACT  
ASSESSMENT OF PROPOSED  
MODIFICATIONS (MOD-2)**

**Crookwell Development Pty Ltd**



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## 1. EXECUTIVE SUMMARY

Development consent was originally granted in 2004 for the Crookwell 2 Wind Farm – a wind farm located across a 2,088 hectare area centred 14 km south-east of Crookwell in the Southern Tablelands of New South Wales. In 2008, approval was sought to modify (Mod-1) the development consent by substituting larger turbines for those previously approved. This modification to the development consent was subsequently approved (DA 176-8-2004-i) in June 2009. Given subsequent further developments in wind turbine technology, Crookwell Development Pty Ltd now seek approval to modify the Mod-1 development consent by again increasing the size of proposed wind turbines. The revised proposal (Mod-2) also includes a reduction in the total number of turbines from 46 to 33. The modification will be done in accordance with section 75W of the *Environmental Planning and Assessment Act 1979*. As such, the proposed changes necessitate a supplementary assessment of the possible impacts on flora and fauna.

Crookwell Development Pty Ltd commissioned Brett Lane & Associates Pty Ltd to carry out such an assessment. The assessment involved:

- A review of previous literature documenting flora and fauna within the Crookwell 2 Wind Farm site; and
- An investigation of the possible impacts of the larger turbines on flora and fauna.

This current review addresses potential impacts under the following legislation:

- Federal *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act); and
- New South Wales *Threatened Species Conservation Act 1995* (TSC Act).

The scope of this work involved completing a desktop assessment of the potential impact upon flora and fauna of the revised proposal (Mod-2). An additional site visit was not considered necessary due to a lack of significant flora and fauna issues for the original project (URS 2004a; BL&A 2008b).

The revised proposal (Mod-2) seeks approval for the following changes to the wind farm:

- The upper maximum RSA height increases to 160 metres – 32 metres higher than the height specified in the current consent for the Crookwell 2 Wind Farm (Mod-1).
- The lower minimum RSA height (i.e. the height above ground of the lower rotor swept area) decreases to 30m, which is 2m lower than Mod-1.
- The total RSA of each turbine will increase to 13,267m<sup>2</sup> (Mod-2) from 7,235m<sup>2</sup> (Mod-1) due to the longer blade length.

URS (2004a) found the dominant habitat within the wind farm site to be introduced grassland. In addition, aquatic habitats were found to be degraded with poor cover and diversity of fringing vegetation. Large patches of woodland habitat occurred mostly outside the wind farm boundary. A few smaller woodland patches were scattered throughout the site, mostly to the north and west. Low bird diversity and abundance reflected the limited extent of treed habitat within and surrounding the wind farm site.

To inform an assessment of the impacts on birds of changed turbine dimensions, bird flight height data has been assembled from two other wind farm sites in similar agricultural landscapes in southern New South Wales (Brett Lane & Associates Pty. Ltd., unpublished data).

Analysis of height distribution of bird movements show that the vast majority (92.45%) of flights were recorded below the proposed Mod-2 lower RSA height. Very few bird movements (0.15%) were recorded above a height of 90 metres.

The proposed increase in the upper RSA height to 160 meters and reduction in the lower RSA height to 30 metres will have an insignificant effect on birds at the Crookwell 2 Wind Farm given so few birds fly above a height of 30 metres. It is worth noting that the original approval in 2005 involved a lower RSA height of 28 metres.

The proposed change in the blade length from 47 meters (Mod-1) to 64 meters (Mod-2) will result in the RSA area for each turbine increase from 7,235m<sup>2</sup> to 13,267m<sup>2</sup>. This will result in a proportional increase in risk of birds flying at RSA height of collision. Given the current proposal also involves a reduction in the number of turbines from 46 to 33. Overall these modifications will increase total wind farm RSA area by 32% from 332,780m<sup>2</sup> to 437,795 m<sup>2</sup>. The reduction in turbine number will contribute to reducing potential impacts on bird and bats.

The risk of bird collision at wind farms is considered low. Most birds are able to detect turbines and take action to avoid colliding with them. It is likely that collisions will mostly involve common farmland species. Any additional collisions due to the net increase in RSA extent are unlikely to have a significant effect on the local or regional populations of these common species.

Any net increase in the extent of the RSA may result in an increase in number of bats exposed to a risk of fatal collision with the rotating turbines. In the current modification, the minimum RSA height is decreasing by 2 metres from 30 metres to 28 metres – and will place slightly more bats at risk of collision. However, bat activity typically decreases with increasing height. Thus, the effect of the changed RSA extent is not considered to substantially increase risk of collision as most bat activity would continue to remain below the lower RSA height and collisions, when they occur, almost certainly involving common, widespread species. In regards to lighting on turbines – due to their increased height – bird and bat mortality can be mitigated by reducing the period of illumination. This can best be achieved by using strobe lighting (at 20 to 60 flashes per minute) rather than using continuous lighting. Furthermore, reducing the beam intensity and using red lights will further mitigate any potential impacts.

Preparation and implementation of a Bird and Bat Adaptive Management Program is a requirement of the current development consent (DIPNR 2005). This requirement provides the means for monitoring bird and bat impacts.

Biosis Research (2009) determined that the large majority of the site supported exotic grassland (improved pasture), with small patches of native vegetation communities mapped within and adjacent to the wind farm site.

No areas of the native grassland and woodland communities recorded within the wind farm site would be impacted as a result of the proposed modifications (Mod-2). As per the approved Mod-1 development, a small number of paddock trees (<20) would either need to be removed or lopped for turbine installation and road network/creek crossing works. Removal and replanting of some existing windrows would also be required. Given the foregoing, it is considered that the Mod-2 proposal would have no additional impacts on flora and native vegetation compared with the approved Mod-1 layout.

It is recommended that, in consultation with OEH, arrangements be put in place to define, mitigate and offset significant impacts.

A *Turbine Micrositing Biodiversity Management Plan* has been prepared (BL&A 2016) to ensure that the proposed micrositing of turbines does not increase biodiversity impacts over those approved.

## 2. INTRODUCTION

Development consent was originally granted in 2004 for the Crookwell 2 Wind Farm – a wind farm located across a 2,088 hectare area centred 14 km south-east of Crookwell in the Southern Tablelands of New South Wales. In 2008, approval was sought to modify (Mod-1) the development consent by substituting larger turbines for those previously approved. This modification to the development consent was subsequently approved (DA 176-8-2004-i) in June 2009. Given subsequent further developments in wind turbine technology, Crookwell Development Pty. Ltd. now seek approval to modify the Mod-1 development consent by again increasing the size of proposed wind turbines. The revised proposal (Mod-2) also includes a reduction in the total number of turbines from 46 to 33. The modification will be done in accordance with section 75W of the *Environmental Planning and Assessment Act 1979*. As such, the proposed changes necessitate a supplementary assessment of the possible impacts on flora and fauna.

Crookwell Development Pty Ltd commissioned Brett Lane & Associates Pty Ltd to carry out such an assessment. The assessment involved:

- A review of previous literature documenting flora and fauna within the Crookwell 2 Wind Farm site; and
- An investigation of the possible impacts of the larger turbines on flora and fauna.

This current review has addressed potential impacts under the following legislation:

- Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- New South Wales *Threatened Species Conservation Act 1995* (TSC Act).

The scope of this work involved completing a desktop assessment of the potential impact upon flora and fauna of the revised proposal (Mod-2). Field work was not necessary due to a lack of significant flora and fauna issues for the project.

This report is divided into the following sections:

**Section 3** details the methods and sources of information used for this assessment.

**Section 4** outlines the modified proposal for the Crookwell 2 Wind Farm.

**Section 5** documents the existing flora and fauna conditions as detailed in previous literature.

**Section 6** discusses the potential impacts upon flora and fauna of the new turbine model proposed for the wind farm.

This investigation was undertaken by a team from Brett Lane & Associates Pty Ltd, comprising Teisha Lay (Zoologist), Elinor Ebsworth (Botanist), Bernard O'Callaghan (Senior Ecologist) and Alan Brennan (Senior Ecologist and Project Manager).

### 3. SOURCES OF INFORMATION AND METHODS

#### 3.1. Sources of information

The reports and development plans relating to the study area, listed below, were reviewed.

- *A Survey and Impact Assessment of the Terrestrial Flora and Fauna of the Proposed Crookwell II Wind Farm* (URS 2004a);
- *Crookwell II Wind Farm – Environmental Impact Statement* (URS 2004b);
- *Crookwell Stage II Wind Farm – Flora and Fauna Assessment Review*, Report No. 8172 (1.0)(BL&A 2008a);
- *Crookwell Stage II Wind Farm – Review of Original Environmental Impact Assessment*, Report No. 8172 (2.0) (BL&A 2009);
- *Crookwell Stage II Wind Farm – Ecological Impact Assessment of Proposed Modifications*, Report 8172 (3.1) (BL&A 2008b);
- *Crookwell II Wind Farm – Modifications to DA-176-8-2004-i Ecological Assessment* (Biosis Research 2009);
- *Crookwell II Wind Farm – Conditions of Consent* (DIPNR 2005); and
- *Crookwell 2 Wind Farm – Site Boundary and Layout* (Plan by Union Fenosa Wind Australia Pty Ltd provided to BL&A July 2015).

#### 3.2. Methods

The sources of information listed in Section 3.1 were reviewed to determine the ecological values within the Crookwell 2 Wind Farm site. The modified proposal for the Crookwell 2 Wind Farm (Mod-2) was then considered in light of these ecological values to determine potential impacts of the modified proposal.

The online *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (Department of the Environment 2015) and Schedule 1 to the NSW *Threatened Species Conservation (TSC) Act 1995* were consulted to determine whether ecological communities listed after the 2009 assessment undertaken by Biosis Research potentially occurred in the study area based on the ecological conditions described in URS 2004a, URS 2004b and Biosis Research 2009.

#### 3.3. Limitations

The current assessment has been undertaken on a desk-top basis and as such the results and advice contained within this report rely on the accuracy of flora and fauna surveys undertaken by URS in 2004 (documented in URS 2004a and URS 2004b) and Biosis Research (2009). No validation of the accuracy of these surveys and associated mapping has been undertaken as part of this assessment.



## 4. MODIFIED PROPOSAL (MOD-2) FOR CROOKWELL 2 WINDFARM

This section describes the modified proposed (Mod-2) for the approved Crookwell 2 Wind Farm. Specifications for the new turbines and the revised layout have been compared with specifications relating to the approved Mod-1.

In this report, 'RSA' refers to 'rotor swept area', or the zone encompassing the blades of an operating wind turbine, defined in terms of an upper and lower RSA height, and the circular area of the RSA.

### 4.1. Turbine specifications

The Mod-1 approved development included 46 turbines comprising an 80 meter tower, with a blade length of 47 meters, upper RSA height of 128 meters and lower RSA height of 32 meters.

Crookwell Development Pty Ltd is seeking approval to vary the turbine dimensions specified on the permit. The new turbine envelope will encompass the measurements listed in Table 1 and impacts on flora and fauna will be assessed using these maximum measurements.

**Table 2: The maximum measurements of the proposed new turbine model to be constructed at Crookwell 2 Wind Farm.**

	Blade length (m)	Rotor diameter (m)	Hub height (m)	Upper RSA height (m)	Lower RSA height (m)	Rated Capacity (MW)
Generic Turbine	64	130	95	160	30	3.5

Preferred turbine models include the following:

- Vesta V126 (180 metres Upper RSA height)
- GE- GE130 (175 metres Upper RSA height)
- Senvion – M122 (178 metres Upper RSA height)

The revised proposal (Mod-2) seeks approval for the following changes to the wind farm:

- The upper RSA height increases to 160 metres – 32 metres higher than the height specified in the current planning permit for the Crookwell 2 Wind Farm.
- The minimum RSA height (i.e. the height above ground of the rotor swept area) decreases to 30m – 2m lower than Mod-1.
- The RSA extent will increase to 13,267m<sup>2</sup> from 7,235m<sup>2</sup> due to the longer blade length

### 4.2. Revised Layout

Proposed access track locations have not altered from the Mod-1 approved development. However, as the number of turbines has been reduced from 46 to 33, there will be some consolidation in the access track system to reduce the overall footprint of the project. The site layout for the proposed Mod-2 development is shown in Figure 1. To maintain flexibility within design, Crookwell Development Pty Ltd is seeking approval to micro-site turbines and associated infrastructure within a 100 meter radius of the proposed turbine locations shown Figure 1.

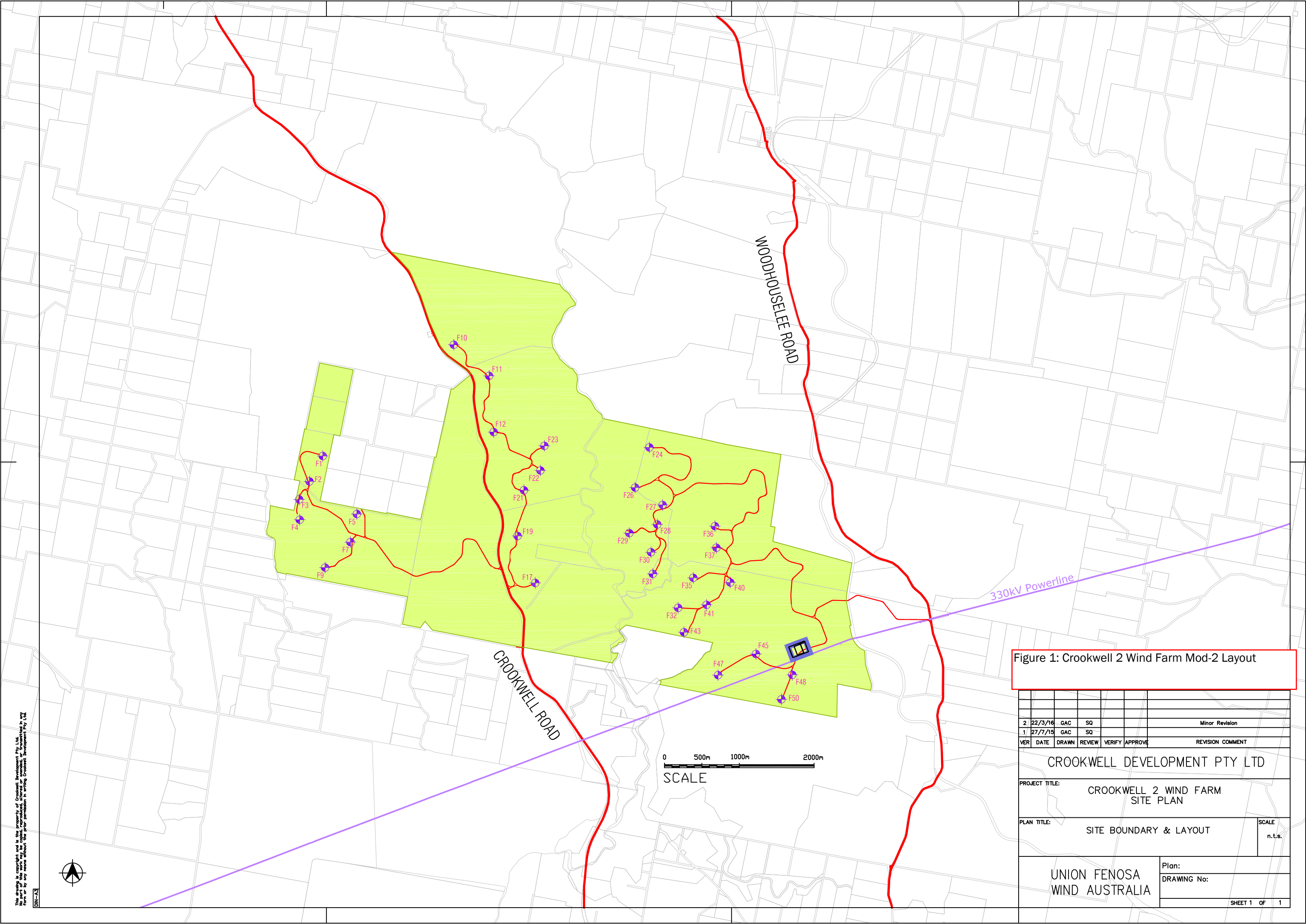


Figure 1: Crookwell 2 Wind Farm Mod-2 Layout

VER	DATE	DRAWN	REVIEW	VERIFY	APPROVE	REVISION COMMENT
2	22/3/16	GAC	SQ			Minor Revision
1	27/7/15	GAC	SQ			

**CROOKWELL DEVELOPMENT PTY LTD**

PROJECT TITLE: CROOKWELL 2 WIND FARM SITE PLAN

PLAN TITLE: SITE BOUNDARY & LAYOUT

SCALE: n.t.s.

UNION FENOSA WIND AUSTRALIA

Plan: DRAWING No:

SHEET 1 OF 1

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## 5. FLORA AND FAUNA WITHIN THE STUDY AREA

### 5.1. Fauna

Fauna within the Crookwell 2 Wind Farm site was assessed by URS (for the original development) as part of an EIS (Environmental Impact Assessment) in 2004 (URS 2004b). BL&A reviewed the ecological component of the Original EIS and assessed the implications of the Mod-1 proposal (BL&A 2009).

#### 5.1.1. *Fauna Habitats*

Fauna habitats within the Crookwell 2 Wind Farm site are documented in URS 2004a. Dominant habitat types for fauna include the following:

- Introduced grassland;
- Native grassland;
- Woodland;
- Gully reedland/sedgeland;
- Paddock trees and windrows; and
- Aquatic habitat including farm dams.

URS (2004a) found the dominant habitat within the wind farm site to be introduced grassland. In addition, aquatic habitats were found to be degraded with poor cover and diversity of fringing vegetation. Large patches of woodland habitat occurred mostly outside the wind farm boundary. A few smaller patches were scattered throughout the site, mostly in the north and west. Low bird diversity and abundance reflected the lack of extensive treed habitat within and surrounding the wind farm site.

It was concluded that no major waterbird habitat occurs on the wind farm site or in the locality. As water storages, Pejar Dam, Lake Pejar and Lake Edward do not provide suitable habitat for a wide diversity or high abundance of waterbirds and shorebirds that typically require gentle sloping shorelines, substantial areas of fringing vegetation and mudflats for feeding (URS 2004a).

Given the lack of suitable habitat, the likelihood of threatened fauna occurring in important numbers or regularly within the proposed wind farm is considered low.

#### 5.1.2. *Threatened Fauna Species*

The Original EIS identified seven species of threatened fauna (excluding microbats) listed under the TSC Act and/or EPBC Act that been recorded from the site or the vicinity, comprising:

- Regent Honeyeater
- Diamond Firetail
- Speckled Warbler
- Hooded Robin
- Brown Treecreeper
- Little Whip Snake

- Macquarie Perch

BL&A reviewed the EIS and as a result, numerous species were added to the threatened species list (including Gang Gang Cockatoo, Swift Parrot, Green and Golden Bell Frog and Booroolong Frog), none of which were considered likely to be impacted by the proposed wind farm due to the lack of preferred habitats in and around the site. The EIS found there to be no habitat of value to the Koala.

Raptor numbers were low for all species recorded. Raptor populations would be expected to be much higher on the well timbered ranges outside the immediate locality of the wind farm site (Turralloo, Cookbundoon ranges) to the east of the study area (URS 2004a).

The EIS presents detailed eight-part tests for seven bat species that were either recorded or considered likely to occur on the wind farm site (URS 2004b). These species are listed below.

- Grey-headed Flying Fox
- Yellow bellied Sheath-tail-Bat
- Large-eared Pied Bat
- Eastern Falsistrelle
- Eastern Bent-wing Bat
- Eastern Greater Long-eared Bat
- Greater Broad-nosed Bat

With the exception of Yellow bellied Sheath-tail-Bat, all the above listed species were recorded at the wind farm site. There was less confidence in the recording of calls from two species – Eastern Falsistrelle and Eastern Bent-wing Bat – these species were considered to be “*possible identifications*” based on less confidence in the call interpretation (URS 2004b).

In summary, none are likely to be affected by the wind farm using the criteria of the eight part test mandated at the time of the assessment. The current assessment determined that none of these species are likely to be affected by the wind farm using the criteria of the seven part test now required. As such, no species impact statement is required.

It is recognised in the EIS that raptors (diurnal birds of prey such as eagles, hawks and falcons) are at moderate risk from collision by turbines. Since these species are widespread and their local populations are low, it was concluded that overall and regional populations should not be affected greatly by the operation of the wind farm (BL&A 2009). This conclusion still holds for the Mod-2 proposal.

## 5.2. Flora

Vegetation within the Crookwell 2 Wind Farm site was assessed by Biosis Research (for the Mod-1 development) in 2008 and was documented in Biosis Research (2009), which took into consideration the previous assessment undertaken by URS in 2004. Original vegetation mapping undertaken by URS in 2004 is shown in Figure 2.

Biosis Research (2009) determined that the large majority of the site supported exotic grassland (improved pasture), with small patches of the following vegetation communities mapped within and adjacent to the wind farm site:

- Frost Hollow Grassy Woodland;

- Tableland Basalt Forest;
- Tableland Grassy Box-Gum Woodland;
- Tableland Hills Grassy Woodland; and
- Western Tablelands Dry Forest.

Vegetation mapped within and adjacent to the site is shown in Figure 3.

URS (2004a) also identified several paddock trees and windrows within the proposed wind farm site (Figure 4).

The initial assessment (URS 2004a) found that *Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory* (EPBC Act) and *White Box – Yellow Box – Blakely’s Red Gum Woodland* (TSC Act, now also listed under the EPBC Act) occurred within the study area, but that these communities did not occur within areas proposed for development. Biosis Research (2009) found that no endangered ecological communities occurred within the wind farm site.

The current assessment determined that no further communities listed under the EBPC or TSC Act since 2009 were likely to occur within the study area.



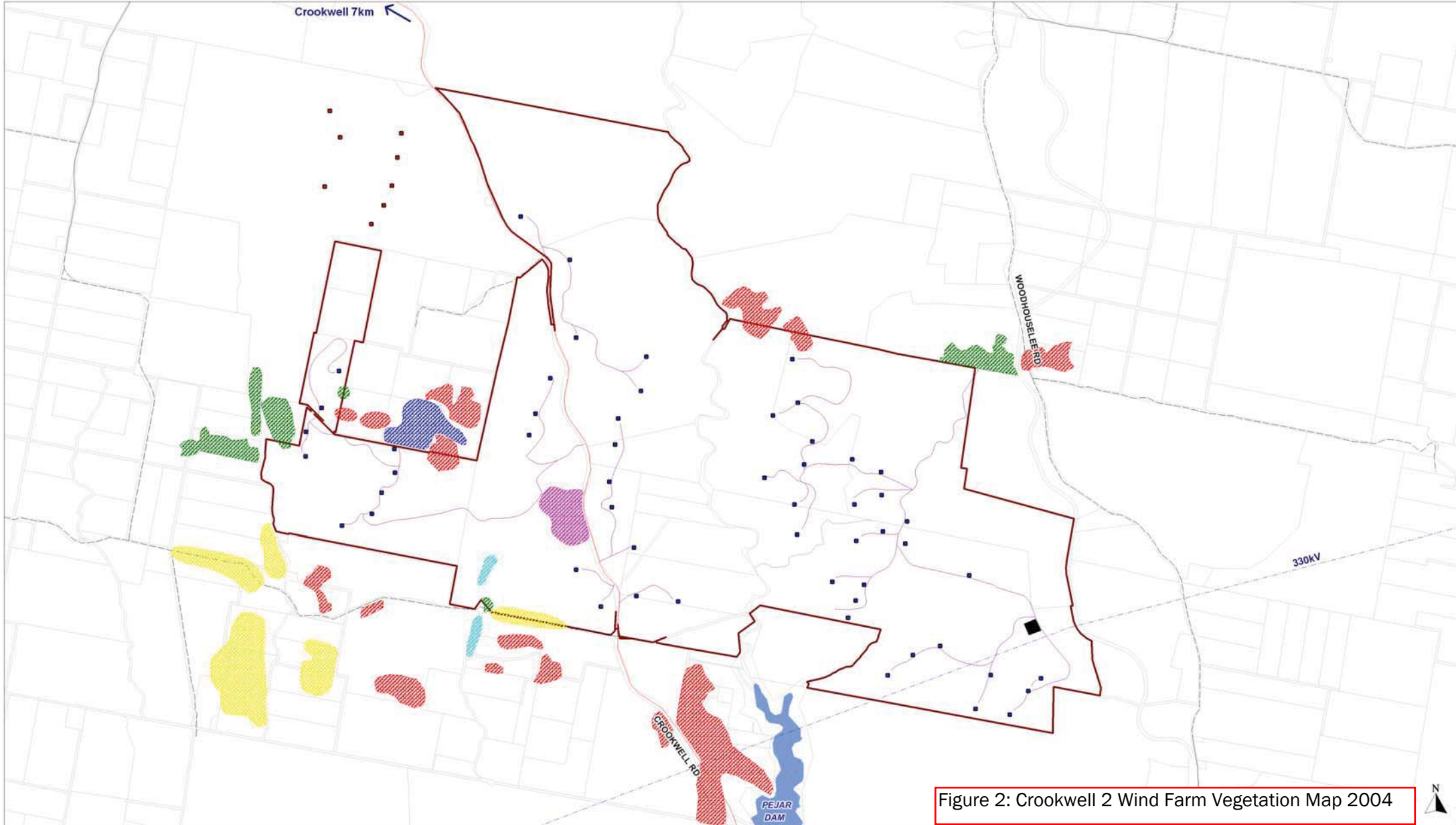


Figure 2: Crookwell 2 Wind Farm Vegetation Map 2004

**LEGEND**

**VEGETATION**

- Site Boundary
- Existing Wind Turbines
- Proposed Wind Turbines
- Proposed Tracks
- Main Road
- Sealed Road
- Unsealed Road
- Transmission Line
- Substation

- Broad-leaved Peppermint-Red Stringybark Woodland
- Manna Gum Snow Gum Woodland
- Secondary Grassland
- Typha-Phragmites Reedland
- Apple Box Yellow Box Woodland
- Themeda triandra* (grassland)

Note: Unmapped areas on site represent improved pasture. Refer to Figure 5 for windrow mapping.



**URS Australia Pty Ltd**

Date Printed: 21/07/04  
 Fig: 11-2

Author: CL  
 Approved: CDS  
 Status: FINAL

Client: Wind Farm Joint Venture

**Vegetation Map**

**Crookwell II Wind Farm**

File Location: T:\Proj\GIS\52848\0011\GIS\Workspaces\Fig 11-2.WOR



Projection: AGD66 Zone 55

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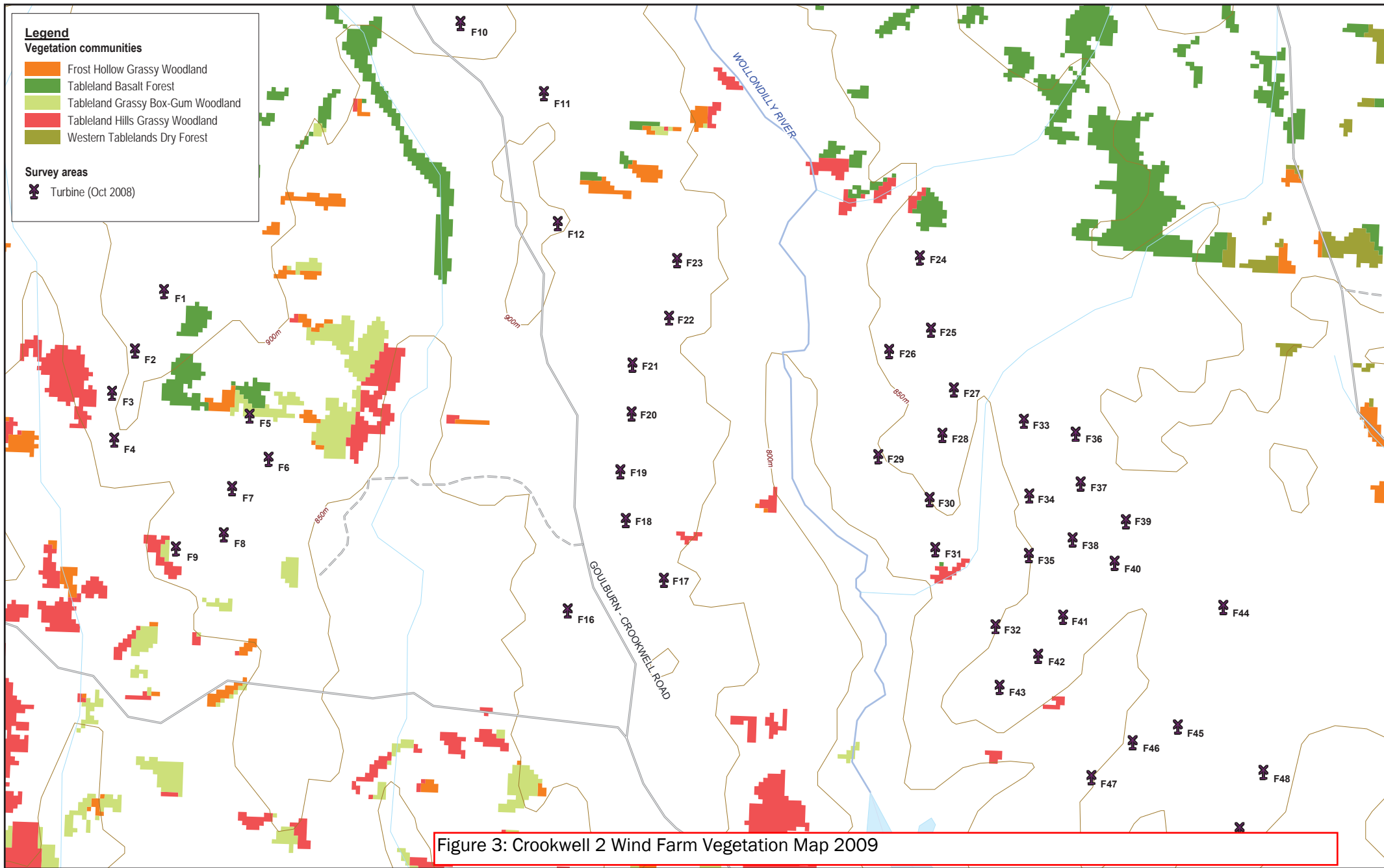




Figure 3: Crookwell 2 Wind Farm Vegetation Map 2009

 <p>BIOSIS RESEARCH Pty. Ltd. 18-20 Mandible Street Alexandria NEW SOUTH WALES 2015</p>	<p>Figure 4 : Vegetation communities</p>	<p>Figure 4: Vegetation communities</p>	
	<p>Date: 18 November 2008</p>	<p>Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres</p>	
	<p>Checked by: KMC</p>	<p>File number: S5258</p>	
<p>Location: -;50005200s5258;Mapping\S5258 vegcomm.WOR</p>			

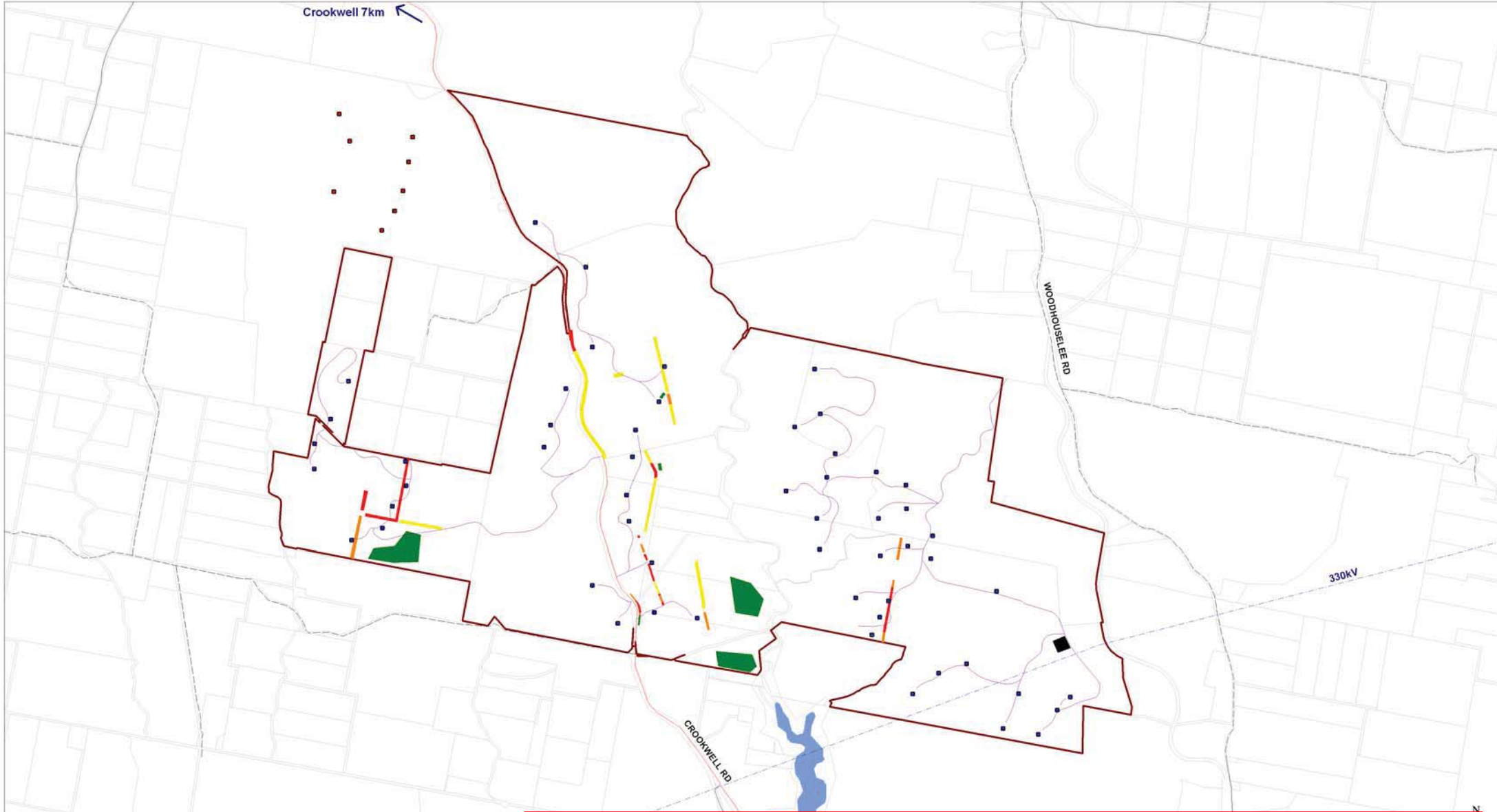


Figure 4: Crookwell II Wind Farm Proposed Site Vegetation Clearing and Replacement (URS 2004a)

**LEGEND**

Site Boundary	Main Road	Proposed Cleared
Existing Wind Turbines	Sealed Road	Proposed Cleared & revegetated
Proposed Wind Turbines	Unsealed Road	Proposed New Areas Of Planting
Proposed Tracks	Transmission Line	Retained Windrows
	Substation	

		<b>URS Australia Pty Ltd</b>	
Date Printed: 21/07/04	Author: CL	<b>Windrow Clearing &amp; Replanting Locations</b>	
Fig: 5	Approved: CDS		
Client: Wind Farm Joint Venture		Crookwell II Wind Farm	
File Location: T:\Proj\GIS\52848\001\GIS\Workspaces\Fig 5 Proposed Site Vegetation Clearing.WOR			Projection: AGD66 Zone 55

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## 6. ASSESSMENT OF MODIFIED PROPOSAL (MOD-2) ON FLORA AND FAUNA

### 6.1. Fauna

#### 6.1.1. Impacts on Birds

Bird utilisation studies, which measure the species diversity and numbers of movements at, above and below rotor swept area (RSA) height, have not been carried out for Crookwell 2 Wind Farm.

To inform an assessment of the impacts on birds of changed turbine dimensions, bird flight height data has been assembled from two other wind farm sites in similar agricultural landscapes in southern New South Wales (Brett Lane & Associates Pty. Ltd., unpublished data). Table 2 provides the flight heights of birds at these two sites and an average.

**Table 3: Percentage of bird flights at different heights at two wind farms in southern New South Wales**

Height class (m)	Wind Farm A	Wind Farm B	Average
0-19	92.1	92.8	<b>92.45</b>
20-39	5.8	4.5	<b>5.15</b>
40-49	0.9	2.4	<b>1.65</b>
50-69	1.1	0	<b>0.55</b>
70-89	0.1	0	<b>0.05</b>
90-99	0	0	<b>0</b>
100-149	0	0	<b>0</b>
>150	0	0.3	<b>0.15</b>
<b>Total birds counted</b>	<b>14,308</b>	<b>710</b>	

Analysis of the height distribution of bird movements show that the vast majority (92.45%) were well below the proposed Mod2 lower RSA height. Very few bird movements (0.15%) were recorded above a height of 90 metres.

The change that has the greatest potential to increase impacts on birds is a reduction in the lower RSA height. The vast majority (92.45%) of bird movements occur below 20 meters in height above ground (Table 2). The proposed reduction in lower RSA height at the Crookwell 2 Wind Farm from 32 metres to 30 metres will leave the vast majority of bird movements unaffected. It is worth noting that the original approval involved a slightly lower RSA height of 28 metres.

A change that has potential to increase impacts on Raptors (birds of prey) is an increase in the upper RSA height from 128 to 160 metres. Raptors more often fly at and above upper RSA height and are known to be vulnerable to collision with operating wind turbines (Thelander *et al.* 2003). Among raptors, the Wedge-tailed Eagle is most exposed to collision with wind turbines due to its common habit of soaring and circling at great heights while foraging.

The proposed increase in the upper RSA height to 160 meters and reduction in the lower RSA height to 30 metres will have an insignificant effect on birds at the Crookwell 2 Wind Farm given so few birds fly above a height of 30 metres.

The proposed increase in the blade length would also bring changes to the extent of the RSA. Blade length will increase from 47 metres to 64 meters attached to a 2 metre hub. Therefore, the area of the RSA will increase from 7,235m<sup>2</sup> to 13,267m<sup>2</sup>. This significant increase is likely to put birds that fly at RSA height at a proportionally greater risk of collision.

Notwithstanding this, the risk from bird collision at wind farms is considered low. It is likely that mortality will mostly comprise common farmland species such as Sulphur-crested Cockatoos, Ravens, Australian Magpies and Galahs given the dominance of these species at other wind farms in southern NSW (BL&A, unpubl. data). These species are common and widespread in southeastern Australia in agricultural landscapes. Any additional collisions are unlikely to have a significant effect on the local or regional populations of these common, widespread species.

The current proposal involves a reduction in the number of turbines from 46 to 33. The proposal involves increasing the total RSA 32% from 332,780m<sup>2</sup> to 437,795 m<sup>2</sup>. This reduction in turbine numbers will assist in minimising potential impacts on birds and bats due to changes in the turbine specifications.

### Impacts on Bats

Hoye (2004) found seven species of bat likely to be present on the Crookwell II wind farm site, including two listed as vulnerable in NSW that were (less than confidently) recorded – Eastern Bentwing Bat *Miniopterus schreibersii oceanensis* and Eastern Falsistrelle *Falsistrellus tasmaniensis*. The five other threatened bat species that have been recorded in a 20 km radius, or that potentially occur, are listed by Hoye (2004). These species are:

- Grey-headed Flying-fox *Pteropus poliocephalus*;
- Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*;
- Large-eared Pied Bat *Chalinolobus dwyeri*;
- Eastern Greater Long-eared Bat *Nyctophilus timoriensis*;
- Greater Broad-nosed Bat *Scoteanax rueppellii*;

Eight part tests for these seven threatened species are presented as part of the Original EIS. On the basis of the findings of Hoye (2004), it is probable that the Eastern Bentwing Bat and Eastern Falsistrelle would experience occasional mortality at the Crookwell 2 Wind Farm, since they sometimes fly at RSA height. Recording elsewhere in south eastern Australia (BL&A, unpubl. records) shows that fewer bat species and many fewer calls are recorded at or above 50 meters above the ground. The vast majority of bat calls are recorded between the ground and 25 metres in height (71%). A total of 18% of bat calls are recorded between 25 metres and 50 metres. Only 11% of all bat calls are recorded above a height of 50 metres.

In general, bat activity is found to be greater near woodland remnants, waterways and farm dams. The turbines at Crookwell 2 Wind Farm (Mod-2) are located mostly on ridgetops. In the context of the overall Australian populations of the two species, the likely impact upon the population of such mortality is expected to be small. These impacts would not lead to any significant decline in their populations.

It can be assumed that any increase in the extent of the RSA may lead to a proportionate increase in number of bats exposed to a risk of fatal collision with the rotating turbines. However, the effect of the changed RSA height range and extent are not considered to be

significant, with most bat activity likely to remain below the lower RSA height and collisions, when they occur, almost certainly involving common, widespread species.

The current assessment determined that none of these species are likely to be affected by the wind farm using the criteria of the seven part test now required. As such, no species impact statement is required. A comparison of the eight and seven part tests and the results of the current assessment are provided at Table 3.

**Table 3: Comparison of the eight and seven part tests and the results of the current assessment**

Eight Part Test	Seven Part Test	Significant Impact
<p>1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction;</p>	<p>a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,</p>	<p>No</p>
<p>2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;</p>	<p>b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,</p>	<p>No</p>
<p>3. In relation to the regional distribution of a habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;</p>	<p>c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</p> <ul style="list-style-type: none"> <li>(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or</li> <li>(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,</li> </ul>	<p>No</p>

<p>4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;</p>	<p>d) in relation to the habitat of a threatened species, population or ecological community:                      (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and                      (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and                      (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,</p>	<p>No</p>
<p>5. Whether critical habitat will be affected;</p>	<p>e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),</p>	<p>No</p>
<p>6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region;</p>	<p>f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,</p>	<p>No</p>
<p>7. Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process; and,</p>	<p>g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.</p>	<p>No</p>
<p>8. Whether any threatened species, population or ecological community is at the limit of its known distribution.</p>	<p>-</p>	<p>No</p>

## 6.2. Assessment of aviation lighting on avifauna

This section investigates the impacts of night lighting on fauna in general then discusses the aviation hazard lighting proposed for the Crookwell Stage II Wind Farm as a result of the proposed turbine modification, and its potential impacts on flora and fauna.

### Background

Night lighting for tall structures is required at times of poor visibility during day and night to assist in aircraft navigation. At wind farms, this lighting is required to clearly delineate the wind farm hazard from surrounding areas. The extremities of the wind farm as well as the high points must be illuminated sufficiently to be readily detected by pilots.

At the Crookwell 2 Wind Farm, the required night lighting is likely to comprise of 24 turbines (of the 33 proposed for construction) having lights installed on top of the nacelle. These are expected to be red LED lights with synchronised flashing of medium intensity at 20-60 flashes per minute, as recommended by the Civil Aviation Safety Authority (CASA).

### What causes collisions at night?

It has long been known that sources of artificial light attract birds, particularly night-migrating birds in North America and Europe. This is probably the most important factor under human control that affects mortality rates of birds and bats colliding with tall structures (Longcore *et al.* 2008). Most bird mortality, at communication towers for example, occurs in poor weather with low cloud in autumn and spring, i.e. during migration periods (Longcore *et al.* 2008).

It is postulated that bright lights may temporarily blind birds by bleaching the visual pigments of the retina, causing the birds to fly toward the light source and colliding with the structure (Ganthreaux and Belser 2006). Birds therefore become disoriented or 'trapped' in the field of light (Longcore *et al.* 2008).

Bats are also attracted to the increased numbers of insects that may congregate near bright light sources. They would appear prone to saturation of their retinas, causing temporary blindness when subjected to bright light (Beier 2006) and mortality of both birds and bats can result from collisions with lit structures.

Historically, lighthouses that previously used steady burning light but replaced them with strobe or flashing lights experienced a reduced rate of mortality (Longcore *et al.* 2008). The colour of lighting may also be important. Some studies have found that red lights resulted in a lower mortality than white lights (Longcore *et al.* 2008), but more recent research on oil rigs at sea suggests that blue or green lights may result in lower mortality than red or white lights (American Bird Conservancy 2008).

In most cases birds and bats are able to avoid colliding with large structures including wind turbines. Measured avoidance rates are invariably at least 90% (sources summarised in Kimber *et al.* 2001, p. 9). Unusual weather conditions such as fog is often implicated in collisions. Fog, which occurs at Crookwell, disperses the light emitted from hazard lighting and this can draw birds into the structure until a collision occurs.

### Susceptible species

Habitats on the site are limited in quality and extent so nocturnal bird diversity and abundance is not high and no species of significance is expected to occur regularly in the

vicinity of the wind farm site. Therefore, few species are considered vulnerable to collision with night-lit turbines.

One migratory passerine bird, the Silvereye *Zosterops lateralis*, could be affected by hazard lighting, since it migrates both by day and night (Higgins *et al.* 2006). A few other birds might be affected during their migratory passage (usually early spring or in autumn), such as the Australian Reed Warbler *Acrocephalus australis* and various cuckoos. These are all common, widespread species whose populations are unlikely to be greatly affected in the event of the occasional fatality.

Several studies have shown a high level of foraging activity by bats around artificial lights. Lights on turbines may attract moths and other nocturnal insects. This in turn provides a concentrated source of food for bats, thus increasing the probability of bat collisions.

### Mitigation measures

Based on experience with lighting of wind farms and communication towers in the United States (Shire *et al.* 2000; Kerlinger and Kerns 2003), the shortest possible flash of light is preferable to a longer duration flash or constant illumination. For example, strobe or LED red lights (i.e. those that flash for a very short time) are more preferable than yellow or white lights that are illuminated constantly or for short periods of up to three seconds (Kerlinger *et al.* 2010). Similarly, Gehring *et al.* (2009) found that communication towers lit at night with only flashing red or white lights had significantly fewer avian fatalities than towers lit with a combination of steady-burning and flashing lights.

Historically, bird and bat mortality has been mitigated at sites such as lighthouses by reducing the period of illumination from continuous to strobe (i.e. very short flash of less than 0.5 seconds), reducing the beam intensity, and changing the colour of light emitted, usually from white to red (Gauthreaux and Belser 2006; Rydell 2006). Red lighting is proposed for the Crookwell Stage II Wind Farm.

Insects (which attract bats) and night-flying birds are unlikely to be attracted to the wind farm by red lights that flash with very short duration such as those proposed for Crookwell which will flash at a rate of 20 to 60 flashes per minute as per CASA recommendations. Therefore, it is recommended that wind turbines be equipped with only flashing red lights and that steady burning red lights not be used on turbines.

The current proposal involves a reduction in the number of turbines be reduced from 46 to 33. All turbines are sited away from water and woodland habitats. These measures will assist in minimising potential impacts on bird and bats.

### 6.3. Flora

Under the original proposal, and the subsequent Mod-1 approved development, it was determined that turbine installation and access track network construction would occur within improved pasture, and that no areas of native grassland and woodland communities recorded would be impacted on as a result of the proposed works (URS 2004a,b; Biosis Research 2009). A small number of paddock trees (<20) would either need to be removed or lopped for turbine installation and road network/creek crossing works. The loss of a relatively small number of paddock trees was not expected to result in a significant decline in local native flora habitat (URS 2004a). Removal and replanting of existing windrows to assist in providing more favourable wind conditions across the site was also proposed. The planting of new windrows as compensation for the loss of existing

plantings was considered to result in a net benefit to the site by removing some of the exotic pine windrows and replacing them with indigenous plantings. Areas proposed for windrow removal and native replanting are shown in Figure 4.

The Mod-1 approved development was not considered to have any additional impacts to flora beyond those determined for the original proposal and documented above (BL&A 2008b; Biosis Research 2009). It is understood that the Mod-2 proposed development will utilise the same turbine and access track locations as the Mod-1 approved development, although there is some consolidation in the access track network as a result in the reduction in number of turbines.

Crookwell Development Pty Ltd is seeking approval for micro-siting of turbines within a 100 metre radius of the turbine locations shown in Figure 1.



Figure 1As the areas in which turbines are located are dominated by introduced pasture (URS 2004a,b; BL&A 2008b; Biosis Research 2009). Given that both the URS (2004a) and Biosis Research (2009) surveys identified only introduced pasture at these turbine locations and their vicinity, it is considered unlikely that micro-siting of turbines would impact on any mapped native vegetation. There has been no reported substantial change in the structure of the vegetation structure and system at the Crookwell 2 Wind Farm. Thus, the proposed tracks are still considered to have no additional impact on vegetation and the required removal. In addition, as a precaution, the Turbine Micro-siting Biodiversity Management Plan (BL&A 2016) includes a requirement for turbines to be micro-sited a minimum of 300 meters from scattered trees with known raptor nests, 100 metres from a group of trees (including woodland and forest vegetation) and 50 metres from native grassland.

Allowing for the proposed micro-siting of turbines within a 100 metre radius of each mapped turbine location potentially slightly increases the footprint of the development (as access tracks may need to be lengthened). However, as the turbine locations have not been found to support threatened flora species nor native vegetation the impact on these matters of the revised proposal (Mod-2) is no different to that of the currently approved development (Mod-1).

#### **6.4. Mitigation measures**

Both a Construction Flora and Fauna Management Sub Plan and an Operation Flora and Fauna Management Sub Plan must be prepared as part of the EMP. These sub-plans must include maps and plans, methods to manage impacts on flora and fauna species and their habitat (such as fencing), design details to reduce the risk of bird and bat strike, vegetation rehabilitation details, a weed management plan (detailing such matters as the use of certified weed-free mulch) and details for monitoring and reporting.

These mitigation measures are consistent with the original development consent conditions (DIPNR 2005).

A Turbine Micro-siting Biodiversity Management Plan has been prepared (BL&A 2016) to make certain that micro-siting within 100 meters of the approved turbine location for the Crookwell 2 Wind Farm project Mod-2 does not have an impact on biodiversity at the site beyond that approved in the Mod-2 development approval conditions (once issued).



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