10.2.3 Substations

Australian Standard AS 60076 Part 10 2009: *"Power Transformers – Determination of sound levels"* indicates that the 250 MVA transformer facilities may produce sound power levels up to 100 dBA. The dominant frequency of such transformers is 100 Hz.

Noise predictions for transformer substations have been made and compared to the appropriate NSW Industrial Noise Policy limit and was found to comply at all receptor locations.

10.2.4 Transmission line

SLR have previously measured corona (transmission line) noise. The results show that at a distance of 240m the noise level would be below 35 dBA. Assuming a minimum RBL value of 30 dBA, the minimum intrusive criteria as determined by the NSW INP would be 35 dBA. As such transmission line noise has also been assessed against NSW INP noise limits and has been found to be acceptable as all receiver locations are greater than 240 m from the proposed transmission line.

10.3 Construction

The appropriate criteria for construction noise are provided in the Interim Construction Noise Guidelines (DECCW, 2009).

Proposed construction activities associated with the wind farm include construction of access roads, establishment of turbine tower foundations and electrical substation, digging of trenches to accommodate underground power cables, erection of turbine towers, and assembly of turbines.

The construction period is anticipated to be 24-36 months, with civil works expected to span approximately 12 to 24 months, however, due to the large area of the wind farm site, intensive works will be located within close proximity to individual residential receivers for only very short and intermittent periods of time.

Construction activities associated with the project are planned to be undertaken during standard construction hours as set out in the Interim Construction Noise Guideline (ICNG). Any construction activities outside of the standard construction hours will only be undertaken in the following circumstances:

- Construction activities that generate noise that is:
    - no more than 5dB(A) above rating background level at any residence in accordance with the ICNG (Table 2 of the ICNG); and
    - no more than the noise management levels specified in Table 3 of the ICNG at other sensitive receivers; or
- for the delivery of material required outside those hours by the NSW police Force or other authorities for safety reasons (section 10.11.2); or
- where it is required in an emergency to avoid the loss of life, property and/or to prevent environmental harm; and
- works as approved through the out-of-hours work protocol outlined in the Construction Noise and Vibration Management Plan as part of the Construction Environmental Management Plan.

Construction noise has been predicted to all receivers using SoundPlan Noise modelling software. To examine the possible worst case construction noise impacts for all nearby receivers, four different construction scenarios were modelled at each turbine location and the highest noise levels for each receiver predicted. These are:

- Construction of Access Roads
- Establishment of Turbine Foundations
- Trench Excavation
- Turbine Erection and Assembly

In addition a number of concrete batching plants will be required to supply concrete onsite and modelling using SoundPlan has been carried out.

A number of receivers are deemed to be 'noise affected' under the NSW Construction Noise Guidelines. In order to ensure all appropriate measures are being taken to manage construction noise, a more detailed construction

management plan will be developed by the proponent. This document will provide detailed guidance on various noise mitigation strategies for the construction stage.

10.3.1 Blasting

Blasting impact has been assessed to the ANZECC Guideline and found to be acceptable. With a maximum instantaneous charge (MIC) of up to 98 kg, the airblast overpressure is anticipated to be below the acceptable level of 115 dB Linear for all existing residences.

10.3.2 Vibration

The activities and equipment with the potential to generate the highest levels of ground vibration are the operation of the vibratory roller during construction of access roads and the operation of the rock breaker during establishment of turbine tower foundations. It is evident that given the large distances between receptors and structures where construction works are likely to be undertaken (greater than 500m), the building damage and human comfort vibration criteria will easily be met during construction.

10.3.3 Traffic

Construction traffic noise impact has been assessed and the 'worst case' maximum construction traffic generated scenario would comply to the NSW Road Noise Policy requirements, due to the typically large setback of dwellings from the road network. Night-time deliveries are unlikely to cause sleep disturbance based on predicted maximum noise levels.

10.3.4 Mitigation for construction noise

The ICNGH recommend that where residences are deemed 'noise affected', that work practices and mitigation measures deemed feasible and reasonable should be applied. Possible mitigation measures may include:

- Scheduling construction works for less critical times of day
- Using alternative, quieter equipment
- Noise controls including temporary walls/earth beams and exhaust silencers
- Keeping the community informed about upcoming works in the area
- Detailing tracking regarding complaints about construction noise, including how each complaint was addressed.

A detailed construction noise management plan will be developed closer to the construction of the wind farm to ensure that all reasonable steps are taken to reduce noise from construction sources including batching plants, and that appropriate community engagement occurs with respect to construction noise.

10.4 Conclusion

The noise assessment has fed into iterations of the layout to produce the final layout. The predicted noise levels of the layout were determined to meet the relevant criteria at all receptor locations

As the project is yet to select and finalise the WTG make and model a revised noise prediction and assessment will be completed to confirm compliance once this is carried out.

Construction noise prediction has shown a number of receptors to be deemed 'noise affected' under the NSW Construction Noise Guidelines, as such this will be managed with a construction management plan. Construction traffic noise, blasting impact, vibration impact and transmission line noise has all been found to be acceptable.

11 Ecology

11.1 Introduction

A Biodiversity Assessment (BA) has been prepared to assess the ecological impacts of the proposal. The BA covers construction and operational impacts of the proposal.

The BA provides an assessment of impact under s.5a of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This specifies factors to be considered for species, populations and ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act). Additionally, the BA characterises the nature and potential magnitude of impacts on matters of national significance (MNES) including threatened and migratory species, communities and populations listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in accordance with the *Significant Impact Guidelines* (DEWHA 2009).

11.1.1 Site description

The Project Area is approximately 40 km (east-west) by 50 km (north-south) and is located between the towns of Coolah and Ulan on the Liverpool Range, central NSW. For the BA, the Project Area was assessed as two study areas: 1) Wind Farm Study Area (development envelope for 288 turbines and associated infrastructure); and 2) Transmission Line Study Area (development envelope for a 330 kV, 60 m wide easement).

11.1.2 Project area

The ranges and undulating terrain within the Project Area are characterised by cleared farmland, mostly derived from Box Gum Woodland on the lower slopes and flats, with Norton Box Woodland and to a lesser degree, Brittle Gum Stringybark Woodland or Mountain Gum Silvertop Stringybark Forest vegetation on the steeper sheltered slopes. Sandstone Forest is common within the flats of the southern half of the Project Area (i.e. Transmission Line Study Area).

In particular, the composition and structure of vegetation types have been modified as a result of managed stock grazing as well as grazing by feral goats. Remnant stands of the original vegetation remain as paddock trees or larger scattered patches of forest/woodland. The midslopes and steeper ridge tops contain the majority of remnant native vegetation, from sparse to moderately treed woodlands. The pasture ranges from exotic to native species dominated. This pattern of vegetation and landuse onsite is common across the locality.

11.1.3 Regional

The Project Area is located along a series of broad ridges and valleys, within the Liverpool Range of NSW. It occurs within three Catchment Management Authority (CMA) regions: 1) Central West CMA; 2) Hunter Central Rivers CMA; and 3) Namoi CMA and is located across four Local Government Areas (LGAs): 1) Warrumbungles; 2) Upper Hunter; 3) Liverpool Plains; and 4) Mid-Western Regional.

The following National Parks (NPs), Nature Reserve (NR) and State Conservation Area (SCA) occur in the vicinity of the Project Area:

- Coolah Tops NP is approximately 2 km east of the Wind Farm Study Area;
- Goulburn River NP is approximately 1.5 km south-east of the Transmission Line Study Area;
- Munghorn Gap Nature Reserve is approximately 4.5 km south of the Transmission Line Study Area at its nearest point; and
- Durridgere SCA will either fall within the transmission line easement, or lie 1.2 km east depending on its final alignment.

The region is largely agricultural, characterised by intensively modified broad floodplains (cereal cropping and grazing) beneath broad basalt ridges (grazing) which has resulted in a significant loss of biodiversity (CMA 2012). Regional biodiversity issues include inappropriate grazing management, habitat degradation and fragmentation, increasing dryland salinity, loss of native vegetation (i.e. clearing of native woodlands and grasslands), invasive

pest species (foxes, goats, environmental, agricultural and noxious weeds), and conserving remnant vegetation on private lands (CMA 2012).

11.2 Approach, Survey Methods and Effort

11.2.1 Impact assessment approach

The BA was preceded by a Biodiversity Constraints Analysis (**ngh**environmental 2012) to spatially identify key ecological values that represent a constraint to the proposal. All field surveys and the *Biodiversity Constraints Analysis* (**ngh**environmental 2012) were undertaken based on a development envelope, that is, a broad area within which the wind farm components and associated infrastructure would be located. A larger area than needed is considered, giving the proponent flexibility to make design changes in response to biodiversity values and constraints identified.

The development envelope has been progressively refined over the course of the assessment phase with indicative turbine locations sited and indicative alignment options investigated. An initial assessment was based on field work conducted in 2012. Additional survey work and was undertaken in spring 2013 following changes to the proposed layout and transmission line route options. The impact assessment has been applied to the worst case scenario which incorporates the longest transmission line route and assessment of all 288 turbine footings and associated infrastructure (i.e. proposed tracks, overhead powerlines, and substations).

11.2.2 Desktop assessment

A desktop assessment was undertaken involving database searches of NSW and Commonwealth threatened (and migratory) species, populations and communities. Database searches included the *Atlas of NSW Wildlife* database, searched by the three CMAs (searched 3 October 2012 and again on 5 November 2013) and an EPBC Act *Protected Matters Search Tool,* using the Project Area boundary as the search area with a 10 km buffer (searched 3 October 2012 and again on 5 November 2013).

Topographic maps, aerial imagery, previous surveys, web-based literature and other databases (i.e. Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) website for Species Profiles and Threats (SPRATs), Birds Australia and Shorebirds 2020 websites), recovery plans, conservation advice and policy statements for nationally listed species and ecological communities were also consulted. These information sources were used to identify known and potential ecological values, as well as analyse landscape connectivity.

11.2.3 Field work

The Project Area was visited three times during the preparation of the BA. An overview site reconnaissance was undertaken by three ecologists over a two day period in November 2009, prior to field surveys, to understand the variability of the site and broad habitat types and condition. Two Spring-time surveys were undertaken as part of the detailed assessment, the first over a 12 day period (the 8th to 19th October 2012) and the second over a nine day period (1st to 8th October 2013). The 2013 survey focussed primarily on the Transmission Line and was undertaken to address specific information gaps and survey alternative route options.

11.2.4 Flora methods and effort

Combined survey effort for flora over the wind farm and transmission line study area amounts to:

- 210 random meanders / flora plots including targeted searches;
- 166 rapid vegetation inspection points; and
- 133 person hours of survey effort.

11.2.5 Fauna methods and effort

Approximately 435 person hours were spent on fauna surveys (131.2 (WF) and 303.4 (TL)), excluding camera trap and Anabat survey effort. Habitat assessment was the primary survey method for species with potential to be affected by habitat loss. Targeted surveys focussed on fauna known to be most affected by wind farms, that is, fauna with potential for blade-strike impacts (birds and bats). Survey types and methods are listed below (refer to the appended BA for a full description):

- 133 habitat assessment plots;
- Targeted surveys including:
    - 80 bird utilisation surveys including recording abundance and classifying flight height (30 minute census);
    - 39 reptile hand searches targeting the potential threatened reptile habitat (30 minute search);
    - 434 rapid herpetofauna and bird surveys (10 minute census);
    - 58 microbat trap nights using 'Anabat' ultrasonic microbat call detection recording equipment (27 sites);
    - 134 nocturnal surveys including call playback and spotlighting, focussing on threatened owls and mammals in suitable habitat; and
    - 67 infra-red motion-sensitive camera trap nights, targeting threatened mammals.

- The following were recorded by hand-held GPS to assist spatial analysis:
    - All raptor sightings;
    - All threatened species sightings; and
    - All habitat features of importance.

11.3 Results: Vegetation and Flora

11.3.1 Vegetation types

Seventeen vegetation types were observed within the development envelope. Descriptions of the following are presented in the BA documents and their locations and condition are mapped in Appendix E.3 of the BA:

- Black Cypress Pine - Ironbark -/+ Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion (ID480);
- Bottlebrush riparian shrubland wetland (ID333);
- Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range (ID495);
- Derived Speargrass – Wallaby Grass – wire grass mixed forb grassland mainly in the Coonabarabran – Pilliga – Coolah region (395);
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region (ID483);
- Inland Scribbly Gum – Red Stringybark – Black Cypress Pine – Red Ironbark open forest on sandstone hills in the southern Brigalow Belt South Bioregion and northern NSW South Western Slopes Bioregion (ID477);
- Narrow-leaved Ironbark - Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills in the southern BBS Bioregion (ID468);
- Narrow-leaved Ironbark- Black Cypress Pine - Stringybark +- Grey Gum +- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern BBS - Sydney Basin Bioregions (ID479);
- Red Ironbark - Black Cypress Pine - Stringybark -/+ Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern BBS Bioregion (ID478);
- River Oak – Rough-barked Apple – Red Gum – box riparian tall woodland (ID084);
- Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern BBS and Upper Hunter regions (ID481);
- Rough-barked Apple – Blakely's Red Gum – Yellow Box woodland on alluvial clay to loam soils on valleys floors in the northern South-west Slopes and BBS Bioregions (ID281)

- Silvertop Stringybark – Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range (ID490);
- Silvertop Stringybark - Yellow Box – Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range (ID488);
- Yellow Box grassy woodland on lower hillslopes and valley flats in the southern Brigalow Belt South bioregion (ID437);
- Planted Vegetation (windbreaks); and
- Exotic Pasture and Crops

11.3.2 Threatened flora and vegetation communities

11.3.2.1 Threatened species / communities evaluation

The database searches (EPBC Act Protected Matters and NSW Wildlife Atlas databases) indicated 46 threatened species or their habitat and six endangered ecological communities could occur in the Project Area. A threatened species evaluation was undertaken to evaluate the presence of habitat in the Project Area and the likelihood of occurrence and impact from the proposal for each identified species and community. This evaluation is presented in full in Appendix C.1 and C.2 of the BA. Table 11-1 lists threatened flora species or EECs that are considered possible to occur and have at least marginal (or potential or known) habitat present in the Project Area.

Table 11-1 Threatened flora and ecological communities with potential to occur in the Project Area

Flora Species or EEC	*Status*	*Habitat*	*Identified on site?*
Box Gum Woodland	EEC TSC CEEC EPBC	Grassy woodland on flats, slopes or ridges on higher fertility soils.	Yes
Austral Toadflax (*Thesium austral*)	V TSC V EPBC	Grassy woodland and secondary grassland in areas with low grazing pressure	No
Ausfeld's Wattle (*Acacia ausfeldii*)	V TSC	Forest on sandstone	Yes
Bluegrass (*Dichanthium setosum*)	V TSC V EPBC	Woodland or native pasture on basalt soils	No
Finger Panic Grass *(Digitaria porrecta*)	E TSC E EPBC	Woodland or native pasture on basalt soils	No
Homoranthus darwinoides	V TSC V EPBC	Forest on sandstone	No
Capertee Stringybark (*Eucalyptus cannonii*)	V TSC V EPBC	Forest on sandstone	No
Kennedia retrorsa	V TSC V EPBC	Forest on sandstone	No
Ozothamnus tesselatus	V TSC V EPBC	Forest on sandstone	No
Calendula Geebung (*Persoonia marginata*)	V TSC V EPBC	Forest on sandstone	No
Lasiopetalum longistamineum	V TSC V EPBC	Forest on sandstone	No
Leek Orchid (*Prasophyllum* sp. Wybong)	CE EPBC	Open woodland and grassland, most likely vegetation community 481, which is less affected by grazing.	No
Philotheca ericifolia	V EPBC	Forest on sandstone	No

Flora Species or EEC	Status	Habitat	Identified on site?
Wollemi Mint Bush (*Prostanthera cryptandroides*)	V TSC V EPBC	Forest on sandstone	No
Mount Vincent Mint Bush (*Prostanthera stricta*)	V TSC V EPBC	Forest on sandstone	No
Pultenaea sp. Olinda	E TSC	Forest on sandstone	No
Rulingia procumbens	V TSC V EPBC	Sandy soils, often near water or in seasonally wet areas.	No
Silky Swainson-pea (*Swainsona sericea*)	V TSC	Grassy woodland and secondary grassland in areas with low grazing pressure	Yes

KEY: TSC Act – Threatened Species Conservation Act 1995; EPBC – Environment Protection and Biodiversity Conservation Act 1999; V – Vulnerable; E – Endangered; CE – Critically Endangered.

11.3.2.2 Endangered Ecological Community: Box Gum Woodland

The Box Gum Woodland EEC listed under the NSW TSC Act was recorded during the 2012 and 2013 surveys as the Yellow Box grassy woodland, Grey Box x White Box grassy open woodland, and Rough-barked Apple – Blakely's Red Gum – Yellow Box woodland vegetation communities. The EEC community may consist of (1) woodland areas with or without native understorey and (2) grasslands and pastures dominated by native grasses that are derived from the community. The Commonwealth EPBC Act sets more stringent criteria for the recognition of the Box Gum Woodland Critically Endangered Ecological Community (CEEC) listed under that Act.

The proposal would require the removal of both TSC and EPBC listed EEC as follows:

- TSC EEC Theoretical maximum of 462.8 ha to be removed or modified (of which 284.3 ha is considered to be in poor or poor-moderate condition) and
- EPBC EEC Theoretical maximum of 23 ha to be removed or modified.

Approximately 192.3 ha (42%) of the maximum 462.8 ha of Box Gum Woodland within the development envelope is in 'low condition' according to the NSW OEH Biometric condition definitions (DECC 2008), and the remaining 270.5 ha is considered to be in 'moderate-good' condition.

11.3.2.3 Vegetation Condition

Vegetation condition varies considerably throughout the Project Area and includes woodland and fragmented woodland which has been logged and is regenerating, native pasture with scattered trees, pasture dominated by exotic species, and, mainly in the Transmission Line Study Area, some large tracts of relatively undisturbed forest. Woodland areas do not support a mosaic of tree ages and consist largely of regrowth. The majority of the Wind Farm Study Area has been subject to long-term grazing (cattle and goats) which has reduced the diversity of native flora. In many areas, the canopy layer is present (often sparsely) but the mid- or shrub-layer is absent. The dry forest vegetation communities that are common throughout the Transmission Line Study Area consist of remnant and long-term regrowth vegetation, or have been selectively logged historically. These areas often contain a diversity of canopy tree species as well as numerous shrubs and groundcover species. Habitat features such as hollow-bearing trees, fallen timber, and rocky outcrops can be common or infrequent depending on the disturbance history of the locality.

Common pasture weeds associated with grazing are widespread and have invaded areas of more intact woodland and forest vegetation. Nine noxious weeds listed in the Mid-Western Regional and Warrumbungle Council control areas were recorded in the Project Area. Of these, only Sweet Briar (*Rosa rubiginosa*), St John's Wort (*Hypericum perforatum*) and Prickly Pear (*Opuntia* sp.) are common in restricted areas. The presence of large numbers of goats, either semi-feral or domestic, over much of the Wind Farm Study Area has contributed to keeping the extent of woody weed growth and invasion relatively low.

11.4 Results: Fauna

11.4.1 Habitat types

Fauna habitat in the Project Area includes open pasture (native or exotic) with scattered trees, open woodland, and dry forest. Additional habitat features occurring within the four main habitat types include hollow-bearing trees, fallen timber, rocky outcrops, and riparian/aquatic zones.

Habitat condition across the Project Area was variable due to differing soil types, disturbance histories and present land management. Habitat condition was generally of low to moderate quality due to past clearing and ongoing grazing; however, habitat quality increased in the north-eastern and southern sections of the Project Area which supported more intact forest in close proximity to protected areas (national parks and state reserves).

11.4.2 Threatened and migratory fauna

The database searches (EPBC Act protected matters search and NSW Wildlife Atlas) indicated 88 threatened species or their habitat had the potential to occur in the Project Area. A threatened species evaluation was undertaken to determine the presence of habitat in the Project Area and the likelihood of occurrence and impact from the proposal for each species and community identified. This evaluation is presented in full in Appendix C.3 of the BA. Table 11-2 lists threatened fauna species that are considered possible to occur and have at least marginal (or potential or known) habitat present in the Project Area. Species recorded during the survey are identified within the table.

Table 11-2 Threatened fauna with potential to occur in the Project Area

Species	*Status*	*Habitat*	*Identified on site?*
Reptiles			
Pink-tailed Worm Lizard (*Aprasia parapulchella*)	V TSC; V EPBC	Open woodland with predominantly native grasses and natural temperate grasslands on well-drained slopes with scattered, partially-buried rocks.	No
Birds			
Speckled Warbler (*Chthonicola sagittata*)	V TSC	Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy.	Yes
Brown Treecreeper (*Climacteris picumnus victoriae*)	V TSC	Occurs in eucalypt woodlands, mallee and drier open forest of eastern Australia, preferring woodlands lacking dense understorey.	Yes
Varied Sittella (*Daphoenositta chrysoptera*)	V TSC	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands.	Yes
White-fronted Chat (*Epthianura albifrons*)	V TSC	Damp open habitats along the coast, and near waterways in the western part of the state.	No
Painted Honeyeater (*Grantiella picta*)	V TSC	Inhabits dry open forests and woodland including Boree, Brigalow and Box Gum Woodlands and Box-Ironbark open forests, also paperbark and casuarinas.	Yes
Black-chinned Honeyeater (*Melithreptus gularis gularis*)	V TSC	Drier open forests or woodlands dominated by box and ironbark eucalypts, particularly Mugga Ironbark, White Box, Grey Box, Yellow Box and Forest Red Gum.	Yes
Regent Honeyeater (*Anthochaera Phrygia*)	E TSC; E EPBC; M EPBC	Most records are from box-ironbark eucalypt associations and it appears to prefer wetter fertile sites within these associations.	No
Hooded Robin (*Melanodryas cucullata cucullata*)	V TSC	Woodland remnants with high habitat complexity and uses stumps, posts or fallen timber for nesting and locating prey on the ground.	No
Scarlet Robin (*Petroica boodang*)	V TSC	Open forests and woodlands from the coast to the inland slopes. Scarlet robins breed in dry eucalypt forests and temperate woodland.	Yes
Flame Robin (*Petroica*	V TSC	Breeds in upland forests and woodlands and migrates to more open	No

Species	Status	Habitat	Identified on site?
phoenicea)		lowland habitats in winter.	
Diamond Firetail (*Stagonopleura guttata*)	V TSC	Restricted largely to ungrazed or lightly grazed woodland remnants of grassy eucalypt woodlands, including Box-Gum and Snow Gum Woodlands, grassland and riparian areas.	Yes
Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)	V TSC	Prefers Box Gum Woodlands although also inhabits open forests, scrub lands, even farmlands and suburbs.	Yes
Little Lorikeet (*Glossopsitta pusilla*)	V TSC	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also forages in Angophoras, Melaleucas and other tree species, as well as riparian habitats.	Yes (off-site)
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	V TSC	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species are present.	Yes
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	V TSC	Often a seasonal altitudinal migrant, moving to lower altitudes and more open forests and woodlands (particularly Box-Ironbark assemblages for winter.	Yes
Turquoise Parrot (*Neophema pulchella*)	V TSC	Occurs in grassy woodland and open forest carrying a mixed assemblage of White Box, Yellow Box, Blakely's Red Gum, Red Box and Red Stringybark.	No
Square-tailed Kite (*Lophoictinia isura*)	V TSC	Occurs primarily in coastal and sub-coastal open forest, woodlands and mallee and has been recorded inland along timbered watercourses.	Yes
Little Eagle (*Hieraaetus morphnoides*)	V TSC	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	No
Grey Falcon (*Falco hypoleucos*)	E TSC	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast.	No
Spotted Harrier (*Circus assimilis*)	V TSC	Occurs in a variety of habitats including grassy open woodland and riparian woodland.	No
Barking Owl (*Ninox connivens*)	V TSC	Occurs in dry box-dominated forest and woodlands and roosts in dense foliage of Acacia, Casuarina or Eucalyptus species. It nests in large hollows of large, old eucalypts.	No
Powerful Owl (*Ninox strenua*)	V TSC	This species occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests on undulating, gentle terrain nearer the coast.	Yes
Masked Owl (*Tyto novaehollandiae*)	V TSC	Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m.	No
White-throated Needletail (*Hirundapus caudacutus*)	M EPBC	Recorded in the airspace above woodlands, forests and farmlands. Often seen 'patrolling' favoured feeding grounds above ridges and hilltops. This species migrates to Australia from mid-October and is a regular summer migrant until April when it returns to breed.	No
White-bellied Sea-eagle (*Haliaeetus leucogaster*)	M EPBC	Occurs around coastal areas, islands and estuaries, but is also found in inland areas around large rivers, wetlands and reservoirs.	Yes (off-site)
Mammals			
Squirrel Glider (*Petaurus norfolcensis*)	V TSC	Mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest.	Yes
Koala (*Phascolarctos cinereus*)	V TSC; V EPBC	Occurs in woodland communities, coastal forests, woodlands of the tablelands and western slopes and the riparian communities of the	No

Species	Status	Habitat	Identified on site?
		western plains.	
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V TSC; V EPBC	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. It roosts in caves (near their entrances), crevices in cliffs, old mine workings.	Yes
Little Pied Bat (*Chalinolobus picatus*)	V TSC	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, bimbil box.	No
Little Bentwing-bat (*Miniopterus australis*)	V TSC	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.	No
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	V TSC	Roosts and raises its young in caves and mine tunnels. The species appears to forage above the forest canopy in a diverse range of forest types.	Yes
Corben's Long-eared Bat (*Nyctophilus corbeni*)	V TSC; V EPBC	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species.	Yes
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	V TSC	It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	Yes
Eastern Cave Bat (*Vespadelus troughtoni*)	V TSC	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW.	Yes
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V TSC	Found in wet sclerophyll forest and coastal mallee. It appears to prefer wet sclerophyll forest although also utilises open forest at lower altitudes.	No
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V TSC	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.	No
Greater Long-eared Bat (*Nyctophilus timoriensis*)	V TSC V EPBC	Inhabits a variety of vegetation types, including mallee, bulloke but more commonly box/ironbark/cypress-pine communities that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.	No

11.4.3 Raptors

Seven species of common raptors were seen in the Project Area and include: Brown Falcon (*Falco berigora*); Nankeen Kestrel (*Falco cenchroides*); Australian Hobby (*Falco longipennis*); Black Kite (*Milvus migrans*), Whistling Kite (*Haliastur sphenurus*), Black-shouldered Kite (*Elanus axillaris*); and Wedge-tailed Eagle (*Aquila audax*). These raptors were seen in a variety of landscape positions, mostly in pasture with scattered trees or along the edges of forest or woodland. In addition to the common species, an adult White-bellied Sea-eagle (*Haliaeetus leucogaster*) was observed off-site in the Transmission Line Study Area, and a Square-tailed Kite (*Lophoictinia isura*) utilising an active nest was recorded along the Goulburn River. White-bellied Sea-eagles are not listed as threatened in NSW, however they are considered a migratory species under the EPBC Act due to the potential for young birds and some adults to disperse over large distances. The Square-tailed Kite is listed as a vulnerable species under the TSC Act, and is a summer breeding migrant to the south-east region.

11.5 Design Measures to Avoid Impact

The proposal has been developed with input from a biodiversity constraints analysis to assist in avoiding biodiversity impacts as a starting point. Detailed mitigation prescriptions have been developed to address the remaining risks, aimed at avoiding a significant impact on any listed threatened entity. The development of an offset site to be managed for biodiversity conservation in perpetuity forms part of the proposal.

The calculation of estimated impact area has been defined as the 'worst case impact area' and was identified as the longest transmission line route option being considered. It also includes the upper number of turbines (288)

and associated infrastructure (i.e. proposed tracks, overhead powerlines, and substations). The impact assessment was applied to the Project Area, but focused on this worse cast scenario.

Avoidance measures to minimise vegetation clearing have included:

- a substantial reduction in the size of the wind farm, from 417 turbines to 288 turbines, to mitigate impacts on birds and bats;
- the assessment of two additional alternative transmission line routes to determine which route will minimise impacts on biodiversity, including vegetation clearing; and
- modifying the proposed transmission line routes to avoid particularly sensitive sites of high biodiversity value (e.g. relocating the transmission line to avoid any impacts on the active Square-tailed Kite nest).

11.6 Impact Assessment

11.6.1 Types of impacts

Three primary adverse biodiversity effects were assessed:

- Habitat loss (vegetation clearance);
- Blade-strike (bird and bat collisions with turbines or barotrauma); and
- Alienation or barrier effects (behaviour change in fauna).

11.6.2 Habitat loss (vegetation clearance)

The proposal originally included scope for the development of up to 417 turbines. This was reduced to 288 turbines due to the north-eastern section of the wind farm potentially impacting the birds and bats of Coolah Tops National Park. The proposal would result in the removal of vegetation within the development footprint, as a result of (1) turbine towers, surrounding hardstand and crane operation areas, substations, control building, access tracks and overhead powerlines and (2) an extended (approximately 38 km) 330 kV transmission line that joins to the existing grid near Ulan. Electrical cabling would be installed adjacent to disturbed areas for the access tracks where possible.

Quantitative worst-case clearing estimates of permanent habitat loss are given below for each vegetation type and condition class and for Box-Gum Woodland. Impact areas by vegetation type were calculated using GIS mapping software, however it should be noted that total habitat loss figures are *overestimated* due to (1) the assessment of a 60 m-wide clearing effort despite the actual extent of clearing being considerably less, and (2) overlaps of infrastructure, for example tracks crossing hardstand areas (Table 11-3).

The Project Area covers approximately 7,127.7 ha. Within the development envelope the bulk of vegetation clearance affects exotic vegetation (approximately 750 ha, of which the bulk falls within the Wind Farm Study Area). Of the native vegetation types identified within the Project Area, few were recorded in moderate-good condition; those most evident included (1) Sandstone Forest on the sandstone soil flats in the south of the Project Area supported up to 45.9 ha of good condition forest, which was substantially higher than any other vegetation type and (2) Norton Box Woodland on basalt slopes of the Project Area (ridges) supports 11.5 ha of good or 9.5 ha of moderate-good condition vegetation. Norton Box Woodland is considered to be 'vulnerable' by Benson *et al.* (2010), as substantial areas have been cleared or subject to grazing. The Sandstone Forest vegetation communities are considered to be of least concern by Benson *et al.* (2010), as substantial areas are conserved in protected areas in the region.

Over the vast majority of the Project Area, the Box Gum Woodland EEC is characterised by low diversity native pasture in poor condition. Within the development envelope, the estimated amount of EEC to be cleared accounts for up to 462.8 ha (depending on the realised transmission line route), of which 284.3 ha of is in poor or poor-moderate condition and 164.5 ha are of moderate condition. High-quality areas estimated to be cleared account for up to 23 ha of the area assessed, with substantially lower areas for the preferred and 2nd alternative routes. These high-condition areas also fall under the definition of the EPBC-listed Box Gum Woodland CEEC.

Table 11-3 Estimated permanent impact areas by vegetation condition

Vegetation Type	Condition							Total (ha)
	Good	Mod-Good	Moderate	Poor-Mod	Poor	Exotic	Not Assessed	
Wind Farm Study Area								
Brittle Gum Stringybark Woodland			1.8		1.8			3.7
Mountain Gum Silvertop Stringybark Forest					1.0			1.0
Norton's Box Woodland	11.5	9.5	20.3	26.1	37.9			105.4
Riparian Forest - Rough-barked Apple, Blakely's Red Gum and Yellow Box					45.1			45.1
River Oak Woodland					15.7			15.7
White Box / Grey Box Grassy Woodland			5.2	27.7	103.2			136.1
Yellow Box Woodland					3.6			3.6
Native Pasture			167.0	17.6	39.8			224.4
Exotic Pasture						737.7		737.7
Not Assessed							131.2	131.2
Total	**11.5**	**9.5**	**194.4**	**71.4**	**248.2**	**737.7**	**131.2**	**1404.0**
Transmission Line Study Area								
Riparian Forest - Rough-barked Apple and Blakely's Red Gum	12.1	2.0	2.9	9.5				26.5
Riparian Forest - Rough-barked Apple, Blakely's Red Gum and Yellow Box	1.3	2.6			0.4			4.3
Sandstone Forest - Black Cypress Pine dominant			2.9					2.9
Sandstone Forest - Inland Scribbly Gum dominant	7.8	23.7						31.5
Sandstone Forest - Narrow-leaved Ironbark dominant	7.5	27.7	15.3	0.5	0.2			51.1
Sandstone Forest - Red Ironbark dominant	2.8	15.0						17.8
White Box / Grey Box Grassy Woodland				1.8	8.9			10.7
Native Pasture			0.4	106.8	5.1			112.3
Exotic Pasture						14.4		14.4
Not Assessed							87.7	87.7
Total	**31.6**	**71.1**	**21.5**	**118.6**	**14.6**	**14.4**	**87.7**	**359.4**

11.6.3 Blade-strike (bird and bat collisions)

A range of direct and indirect impacts of wind farms on birds and bats have been recognised in recent years, with mortality via direct collision with moving turbine rotors being an obvious impact (Madders and Whitfield 2006; Smales 2006). Collision risk can be defined as the likelihood of individual species migrating, feeding or roosting in the proximity of a wind farm which may lead to collisions with wind turbines and other infrastructure (Drewitt and Langston 2006). Industry research reveals that the species that appear to be most susceptible to population scale impacts due to blade-strike are common species and are of the groups: large sedentary raptors, fast high flying microchiropteran bats, and fast high flying non-passerines (MacMahon 2010, Roaring 40s Renewable Energy 2010, Smales 2006).

The potential magnitude of operational impacts upon populations of individual species is difficult to predict without undertaking population viability analysis, outside the scope of this assessment. However, we can assume population scale impacts are likely to be greater for species with low fecundity and that occur at naturally low numbers in the landscape. Based on the analysis presented in the BA documents, the following species are most likely to be at high risk from operational impacts of the proposal: Little Lorikeet, Wedge-tailed Eagle; Little Eagle; Brown Falcon; Eastern Bentwing Bat; White-striped Freetail-bat; and Gould's Wattled Bat; Yellow-bellied Sheathtail-bat; and Eastern Cave Bat.

Based on the collision risk modelling, suggesting birds avoid turbines 98-99% of the time (with the exception of Wedge-tailed Eagles which have an avoidance rate of 90-95%), it is considered that the proposal will not have an adverse effect on these raptor species. Additionally, these species were not recorded in high abundance during the field survey, especially Brown Falcons. The high risk bat species generally forage above the canopy and are at risk of blade-strike. Carcasses of the White-striped-bat and Gould's Wattled Bat have been found at a number of monitored wind farms in NSW and Victoria (Richards, unpublished). The implementation of an Adaptive Bird and Bat Management Plan with focus on these raptor and microbat species will provide detail on habitat utilisation and foraging patterns.

11.6.4 Alienation or barrier effects (including landscape connectivity)

Alienation involves changes in behaviour (such as avoiding nesting or foraging resources) and habitat utilisation (such as diverging around the broad area where turbines are located). A barrier effect may cause birds and microchiropteran bats to alter their flight pathways to avoid the wind farm area (Brett Lane & Associates 2009).

Within the proposed layout the turbines will be placed around 300-600 m apart. The current distance between turbine clusters (e.g. ridgelines or properties) and the distance between individual turbines is likely to allow for safe passage between turbines for birds and bats, without creating a barrier effect; however, within areas of intact woodland or forest the greater the turbine spacing (i.e. 600 m apart) the better for biodiversity. A minimum buffer of 100 m from the turbine blades has been recommended for areas of high habitat value for birds and bats (i.e. areas of moderate-good or good condition woodland / forest). For high risk fauna, a 50 – 100 m buffer around nest sites is also prescribed to avoid locating turbines in these areas. It is considered that tracks and other infrastructure can be micro-sited to avoid impacting such features.

As the development layout is largely within a highly disturbed and fragmented agricultural landscape there is limited opportunity for the turbine layout to sever movement corridors for faunal species. However, two areas were highlighted as a potential barrier effect to fauna and included the north-east section (near Coolah Tops NP) and the southern section of the wind farm (near Durridgere SCA and Goulburn River NP). Operational impacts to the Powerful Owl, microchiropteran bats or habitat loss (fragmentation or breeding sties) for the Squirrel Glider, Glossy Black-cockatoo and woodland birds are most worthy of consideration and have been discussed further in the BA documents.

11.6.5 Indirect and peripheral impacts

As well as direct impacts already discussed, ecological impacts may arise from vehicle access and parking, as well as the laydown and stockpiling of materials. Peripheral impacts may include smothering of vegetation, soil compaction and erosion, introduction and spread of weed species, pollution associated with the generation of dust and use of concrete, fuels, lubricants and construction chemicals, and noise, vibration and activity during the construction phase.

With the implementation of specific measures for these peripheral impacts such as weed control, erosion and sediment control, these risks are considered manageable. Further it is noted that indirect impacts are likely to be of low magnitude temporally and spatially, considering the spread and design of infrastructure proposed.

11.7 Assessment of Significance

Assessments of Significance (AoS) were undertaken for threatened species that are present or will potentially occur in the Project Area and were considered to be at moderate or high risk of being impacted. The assessments are presented in Appendix D and discussed in Section 10 of the Wind Farm Study Area BA report.

11.7.1 Flora and vegetation communities

Assessments of Significance have been undertaken for Box Gum Woodland. The proposal would result in the removal of up to 462.8 ha of the TSC-listed Box Gum Woodland EEC, of which a considerable portion (284.3 ha) is in poor to poor-moderate condition with little chance of recovery. The proposal would also remove up to 23 ha of the Commonwealth Box Gum Woodland CEEC, although will likely remove less than 10 ha. Assessments of significance under TSC and EPBC Acts concluded that the removal of this extent of Box Gum Woodland from the region is not considered to be significant. However, this is subject to the implementation of the controls and recommendations of the BA, including offsetting impact to the CEEC. In particular, the proposal would not produce impacts on this community such that the local extent would be placed at risk of extinction.

Assessments of Significance were also undertaken for the plant species Dichanthium setosum, Digitaria porrecta, Bothriochloa biloba and Swainsona sericea, and Acacia ausfeldii. No known individuals are expected to be removed by the proposal, although some habitat may be removed temporarily and a smaller amount will be removed permanently. These AoSs determined that there is unlikely to be a significant impact on any of the threatened flora species known or expected to occur within the boundaries of the Project Area.

11.7.2 Fauna

Assessments of Significance have been undertaken for: Speckled Warbler; Brown Treecreeper; Diamond Firetail, Varied Sittella; Painted Honeyeater; Black-chinned Honeyeater; Grey-crowned Babbler; Scarlet Robin; Turquoise Parrot; Little Lorikeet; Glossy Black-cockatoo; Square-tailed Kite; Powerful Owl; Masked Owl; Barking Owl; Squirrel Glider; Eastern Bentwing-bat; Yellow-bellied Sheathtail-bat; Eastern Cave Bat; Corben's Long-eared Bat; and the Large-eared Pied Bat.

Seven threatened small woodland/forest bird species were recorded within Project Area: the Speckled Warbler; Brown Treecreeper; Varied Sittella; Painted Honeyeater; Black-chinned Honeyeater; Grey-crowned Babbler; and the Scarlet Robin. An eighth species, the Little Lorikeet, was recorded to the north of the Project Area during the survey period. These species were considered unlikely to occur over the majority of the Wind Farm Study Area due to the degradation, fragmentation and open nature of habitats.

Glossy Black-cockatoos were recorded a number of times in 2013 (despite not being recorded in 2012), often in the larger tracts of Sandstone Forest communities in the Transmission Line Study Area, where the two species of feed trees, *Allocasuarina diminuta* and *A. gymnanthera*, were relatively abundant.

Of the threatened owl species predicted to occur in the region, only Powerful Owls were recorded during the surveys. Masked and Barking Owls are considered to be possible occurrences, based on local records and habitat characteristics. These owls may be impacted by loss of habitat, including potential roost hollows and loss of habitat affecting the prey base for these species (e.g. arboreal mammals for the Powerful Owl).

A TSC-Act listed vulnerable Square-tailed Kite was observed nesting on the proposed transmission line route, which has since been relocated to avoid impacting this sensitive site. As the species is a slow flyer (frequently circling immediately above the canopy) and at little risk of being impacted by the turbines or transmission line infrastructure, the proposal is not considered likely to significantly impact this species. The threatened raptor species Little Eagle and Grey Falcon are considered 'possible' and 'possible but unlikely' occurrences, respectively. Operational impacts (blade-strike) have some potential to affect these species. As no active nests of these species were found or considered likely within 100 metres of surveyed proposed turbine locations, the risk to fledging Little Eagles is considered low to moderate. The Grey Falcon is highly unlikely to nest in the locality, and any records of the species in the region are likely to be vagrants because the core distribution of the species is further inland.

Squirrel Gliders were recorded in open woodland vegetation along a valley floor within the Wind Farm Study Area, and in an ecotone of forest and woodland communities in the Transmission Line Study Area. Squirrel Gliders are unlikely to occur on higher elevation ridges to be affected by any tree removal for turbine location or ridgetop tracks. The distance that Squirrel Gliders can travel in a single glide is a function of the height of the tree from which they take off. Tree heights in good quality forest areas of the transmission line easement were generally 25 m or less and a clearing of 60 m (although likely to be less) for the transmission line easement may impact on movement opportunities for the Squirrel Glider. It is possible that the proposal could affect a viable local population within the locality and mitigation strategies related to removal of hollows (potential denning sites) have been incorporated into the BA documents. Recommendations have been provided in Section 9 of the Transmission Line Study Area report to minimise the clearance for the transmission line in areas of good Sandstone Forest habitat and site glide poles along the route to support movement of this species.

The Eastern Bentwing Bat, Eastern Cave Bat, Large-eared Pied Bat, Corben's Long-eared Bat, and Yellow-bellied Sheathtail Bat were recorded during the Anabat survey program. The Eastern Bentwing Bat and Eastern Cave Bat roost in caves and are not considered likely to be affected by loss of tree hollows. No roost or maternity caves are known nearby the Project Area. Activity of these species was highest in good quality Sandstone Forest communities. With implementation of recommendations, the proposal is considered generally consistent with recovery objectives, and will not be likely to cause a significant impact on any threatened bat species.

Of the species assessed, the Glossy Black-cockatoo, Powerful Owl, Squirrel Glider, and microchiropteran bats were specifically highlighted in the 2012 BA document as species requiring follow up survey work before development proceeds within specific locations of the Project Area. This assessment considers that there will be low potential for significant impact to woodland birds, mammals and bats, particularly considering (1) the removal of over 100 turbines from the proposal, (2) the selection of a transmission line route that minimises impacts to biodiversity, and (3) the specific mitigation measures that have been recommended.

The specific mitigation measures that have been prescribed in Section 9 of the BA to mitigate impact to threatened species include micrositing infrastructure, pre-clearance surveys for hollow-bearing trees, installation of gliding poles, application of buffers in areas of good quality habitat, and the creation of a draft offset strategy. In particular, these species would be considered a focus species in the Flora and Fauna Management Plan and/or the Adaptive Bird and Bat Management Plan. In addition to the design measures already implemented, a number of recommendations are given to offset the impacts of the proposal upon the species.

11.8 Management Measures

A Flora and Fauna Management Plan and/or the Adaptive Bird and Bat Management Plan should be prepared prior to construction and would be the vehicle to manage species and communities with a moderate and high risk of impacts. Prescriptions for inclusion in the plan are set out below. These measures are required to ensure a significant impact is avoided where possible, reduced as much as practical and that the residual impact is offset. Together, this ensures an overall 'maintain or improve' outcome is met for the proposal. Where uncertainty exists, a precautionary approach has been adopted to guard against unforseen impacts; specifically, follow up surveys, threatened species preclearance surveys for species considered to have potential for adverse impact, and operational monitoring for birds and bats.

11.8.1 Measures to avoid impacts

During the process of biodiversity assessment the design of the proposal has been refined, taking into account biodiversity constraints and constraints analysis. The proposal has been refined to focus on avoidance of good condition patches of vegetation where possible; avoidance of sensitive fauna sites; avoidance of moderate-good quality EEC and development of detailed recommendations for moderate-high constraint areas to ensure a significant impact is avoided. Table 11-4 details the area of interest, the target species / vegetation communities of concern, and recommendations to avoid potential impact.

11.8.2 Measures to minimise impacts

Measures to minimise impact during the design, construction and operational phase of the wind farm proposal are highlighted in Table 11-5. In particular, a Flora and Fauna Management Plan as well as an Adaptive Bird and Bat Management Plan should be prepared prior to construction. These management plans would focus on migratory and at-risk bird and bat species to address inherent uncertainty related to bird and bat collision risks at this site.

11.8.3 Measures to offset impacts

Measures to offset impacts are provided within Table 11-6 to ensure that an overall 'maintain or improve' outcome is met for the proposal. Where impacts cannot be avoided, or sufficiently minimised, the residual impact will be offset in perpetuity. Appendix F of the BA (Draft Offset Strategy) details how offsets are best identified, managed, and the offset ratios to be applied.

11.9 Conclusion

The pattern of development proposed would comprise a series of sparsely distributed discrete footprints (turbines, substations and control buildings) and narrow linear footprints (transmission line and tracks). Considering the habitat within and surrounding these areas and the ecological characteristics of the Project Area, the impacts identified appear able to be managed such that significant impacts can be avoided and a maintain or improve outcome can be met for the proposal. On balance, the impacts are considered acceptable. The proposal would have benefits as the development of a large scale renewable energy project would address, to some extent, rising greenhouse gas emissions, which may assist in avoiding dangerous climate change.

Table 11-4 Design measures to avoid impacts

MEASURES TO AVOID IMPACTS					
Item	***Area***	***Target Species***	***Objective***	***Timing***	***Recommendation***
Design Phase					
Moderate – good quality Box Gum Woodland (CEEC and EEC areas)	Wind Farm and Transmission Line Study Areas	N/A	Keep clearance of good quality Box Gum Woodland to a minimum and avoid where possible	After final alignment / development envelope is confirmed	If areas of moderate – good quality Box Gum Woodland are not avoided, turbines and infrastructure are to be microsited with input from an ecologist and the area is to be offset at a ratio of 1:10.
Good quality habitat for threatened species (supporting breeding and/or foraging habitat)	Southern half of Transmission Line Study Area	Glossy Black-cockatoo Woodland Birds Mammals (Squirrel Glider) Microchiropteran bats Threatened plants associated with Sandstone Forest	Targeted survey work and assessment to determine the importance of area for threatened species / habitats	Before any development of these areas	No clearing works to be undertaken in these patches unless targeted fauna / flora surveys have been undertaken for the relevant area. Further survey work will involve a targeted hollow-bearing tree survey to determine the significance of hollows as important breeding or roosting sites for threatened species within these areas. Based on the survey results, either: No development to occur if survey results indicate development will result in 'significant impact' and cannot be mitigated with management controls. OR Development to only occur if survey results indicate adverse impacts to threatened species and/or their habitats will not be incurred. In this case microsite infrastructure with input from an ecologist, where required.
Threatened Native Grasses	Wind Farm Study Area	Finger Panic Grass and Bluegrass	Pre-clearance survey in good quality Box-Gum Woodland (CEEC)	After final alignment / development envelope is confirmed	A pre-clearance survey is to be conducted for Finger Panic Grass and Bluegrass within good quality Box-Gum Woodland (CEEC) during flowering season from mid-January to late February. If found, turbines and infrastructure are to be microsited to avoid areas of at least moderate quality condition of these species in this vegetation type.
Threatened Reptiles	Wind Farm Study Area	Pink-tailed Worm-lizard	Pre-clearance survey in good quality Box-Gum Woodland (CEEC)	After final alignment / development envelope is confirmed	Turbines and infrastructure would be micro-sited to avoid rocky outcrops in this habitat.
Hollow-bearing Trees	Transmission Line Study Area within sandstone forest	Focus species: Squirrel Glider, Glossy Black-cockatoo,	Targeted hollow-bearing tree survey to accurately record the	After final alignment / development envelope is confirmed	Pre-clearance survey within final development envelope and alignment for hollow-bearing trees. Infrastructure micro-sited to avoid hollow-bearing trees, where

MEASURES TO AVOID IMPACTS					
Item	***Area***	***Target Species***	***Objective***	***Timing***	***Recommendation***
	vegetation communities Wind Farm Study Area within moderate or moderate-good quality Box Gum Woodland	microchiropteran bats Other species: other threatened hollow dependent fauna considered to be at moderate risk from development (i.e. woodland birds)	number of hollows to be cleared		possible. Ideally, construction and any required tree clearance should avoid the peak breeding time for fauna and nesting time for birds (e.g. spring-summer). In particular, clearance of hollow-bearing trees potentially suitable for Glossy Black-cockatoo and Squirrel Gliders should not be undertaken within a 100 m radius over the breeding season between March and August for Glossy Black-cockatoo and latter half of the year for Squirrel Gliders. For hollow-bearing trees to be cleared a management plan should be prepared by an ecologist detailing: procedures to minimise impacts to, and relocate resident fauna; timing of works to avoid breeding periods; number and type of hollow-bearing trees to be removed and offset (to be included in Flora & Fauna Management Plan). Where hollow-bearing trees are to be cleared a standard pre-clearance survey, such as that described in *Biodiversity Guidelines* (**ngh**environmental / RTA 2011), should be undertaken and details of hollow-bearing trees cleared including number and size of hollows and number of hollow-bearing trees recorded.

Table 11-5 Design, construction and operational measures to minimise impacts

MEASURES TO MINIMISE IMPACTS					
Item	*Area*	*Target Species*	*Objective*	*Timing*	*Recommendation*
Design Phase					
General Measures	Wind Farm Study Area	High risk birds and bats	Turbine infrastructure design to minimise operational impacts on birds and bats	Prior to operation	Turbines and infrastructure would be micro-sited to avoid rocky outcrops in this habitat. Red flashing lights should be fitted to turbine towers to reduce insect attraction and potentially night-flying birds. No guy lines to be fitted to turbine towers. Flags and/or marker balls to be fitted to wind monitoring mast guy lines Turbines (e.g. nacelles) should minimise perching opportunities.
Construction Phase					
Box Gum Woodland and good quality fauna habitat	Wind Farm Study Area	Box Gum Woodland areas and threatened species	Prevent unauthorised clearance Minimise track and transmission line impacts in areas of high conservation value	During construction	Clearly demarcate works areas nearby or within Box Gum Woodland areas to strictly define permitted clearance zone. Minimise track width to the minimum required for safe access and operation. Install the 33 kV powerlines (co-aligned with roads) as underground where possible. Removal of topsoil and subsoil for trenching to be replaced and revegetate disturbed areas with local native grasses (i.e. Kangaroo Grass, Wallaby Grass or Spear Grass).
General Measures	Wind Farm Project Area	All species and vegetation communities	Minimise clearance and disturbance	During construction and as required	Clearly demarcating works areas and restricting impacts to these. Including vehicle and equipment parking and access routes. Co-locating underground and overhead 33 kV powerlines with the track network to minimise additional impact area, where possible. Establish construction compound in a disturbed area. Use disturbed areas for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and deposition and retrieval of spoil, wherever practicable. Fill in trenches as soon as possible. Trenches left open overnight to be inspected at first light for trapped fauna. Trapped fauna to be released appropriately in a nearby location. Hollow-bearing trees and sensitive features to be retained to be

MEASURES TO MINIMISE IMPACTS					
Item	*Area*	*Target Species*	*Objective*	*Timing*	*Recommendation*
					communicated to staff via inductions and other methods.
Riparian Area Management	Project Area	All species and vegetation communities	Minimise clearance and disturbance	During construction	Creek crossing to be designed in accordance with: NSW Fisheries Policy and Guidelines for Fish Friendly Waterway Crossings (2003). Creek works not to be undertaken when heavy rain is forecast and should be avoided when there is flow. Implement sedimentation and erosion controls in accordance with best practice guidelines.
General Habitat Management	Project Area	All species and vegetation communities	Minimise disturbance	During construction	Bird and bat activity levels are generally concentrated around areas of vegetation. A buffer of 100 m from the turbine blades is recommended for areas of high habitat value for birds and bats. Fallen timber > 50cm to be left in place or moved to a nearby area to retain fauna habitat. Where rocky outcrops cannot be avoided, replace rock in nearby areas in consultation with an ecologist.
Weed Management	Project Area	All species and vegetation communities	Pre-construction inspection for noxious weeds within Project Area Prevention of spread of weeds and pathogens Weed monitoring	Before commencement of works and as required Monitoring – late spring / early summer after construction	Control noxious weeds in works area according to plans and control measures of the LGAs. Minimise use and adhere to best practice guidelines for herbicide treatment in environmentally sensitive areas (i.e. Box Gum Woodland). Establish hygiene plan to ensure vehicle and machinery is absent of organic matter pre- and post-site access. Sign environmentally sensitive areas (i.e. CEEC areas) and designate clean-down area for entry / exit points into these areas. Monitoring and weed control in areas of known noxious or invasive species. Understorey vegetation in easements should be managed to maintain composition and quality to prevent weed invasion
Pollution Prevention	Project Area	All species and vegetation communities	Prevention of contaminants and erosion outside works zones	As required	Establish a spill plan to prevent chemicals or pollutants from having an adverse effect on the environment. Backfill cable trench where cement is used; at least 20 cm of cement free topsoil to be replaced as the top layer in the back fill. Establish an erosion and sediment control plan so appropriate controls are in place prior to commencement of works.

MEASURES TO MINIMISE IMPACTS					
Item	*Area*	*Target Species*	*Objective*	*Timing*	*Recommendation*
Site Management	Project Area	All species and vegetation communities	Stabilisation of soil, rehabilitation and revegetation to be undertaken progressively to re-establish ground cover	As required	Lightly mulch exposed soils with chipped vegetation or sterile hay in areas dominated by exotic groundcover species. Sow with an appropriate cover crop in consultation with land owners. Lightly mulch exposed soils with chipped vegetation or sterile hay in areas dominated by native grasses using local provenance species. Fertiliser should not be used to promote revegetation in areas dominated by native grasses.
Operational Phase					
Flora & Fauna Management Plan	Project Area	All species and vegetation communities	To avoid significant impact to flora and fauna outside of the accepted clearance boundaries and prevent 'unassessed' impacts occurring	Implement prior to construction	An ecological professional to develop and implement a Flora and Fauna Management Plan to report on and manage impacts. The management plan should highlight ecological important areas (vegetation communities and threatened fauna species habitat) and their management. Specific areas requiring monitoring or management should be highlighted as well as timing for monitoring. Weed species should be highlighted along with prescriptions for their management.
Adaptive Bird & Bat Management Plan	Wind Farm Study Area	High risk raptors and bats Threatened Owls (Powerful Owl, Masked Owl, Barking Owl)	Development of an 'insurance' monitoring program to address uncertainty inherent in the assessment	Implement prior to construction. Survey and monitor during 'high risk' periods, when species may be moving through or foraging in the area	An ecological professional to develop and implement a Bird and Bat Monitoring Program to report on, and manage impacts with potential to be significant. Monitoring surveys should include an understanding of breeding activity (i.e. nest locations) and foraging movements. Baseline (pre-construction) and operational collision and abundance data would be collected, focused on higher risk species and higher risk locations in order that actions can be taken to address unforseen impacts, should they occur. Management Plan methods would utilise AusWEA (2006) best practice guidelines. Management Plan should include management response options (i.e. restriction of lambing on ridges with high raptor activity to reduce collision risks) to be implemented where significant impacts are anticipated.

MEASURES TO MINIMISE IMPACTS					
Item	*Area*	*Target Species*	*Objective*	*Timing*	*Recommendation*
Habitat Connectivity	Transmission Line Study Area	All common species, as well as threatened fauna, particularly owls, gliders and bats	Minimise fragmentation of landscape connectivity	After construction	Promote growth of vegetation under the transmission line to the maximum allowable height to maintain fauna habitat connectivity. Understorey vegetation in easements should be managed to maintain composition and quality to prevent weed invasion. Install gliding poles for glider species, particularly the Squirrel Glider, if clearing for the transmission line easement exceeds 40m in areas of habitat for this species. Near areas of intact woodland or forest a spacing of 600m should be considered for turbines.

Table 11-6 Offset measures to maintain or improve biodiversity

OFFSET MEASURES TO MAINTAIN OR IMPROVE BIODIVERSITY					
Item	***Area***	***Target Species***	***Objective***	***Timing***	***Recommendation***
Construction Phase					
Development of offset strategy and offset plan	Project Area	Box Gum Woodland, Hollow-bearing trees, Threatened species habitat	Proponent will develop an offset plan to offset all permanent native vegetation removal to maintain or improve biodiversity in the longer term	Prior to construction	Develop an offset strategy with input from OEH, the CMA and an ecological professional which will be finalised prior to any construction impacts an ecological professional, in accordance with the Draft Offset Strategy provided in Appendix F. Develop an offset plan with input from OEH and the CMA prior to operation, demonstrating the suitability of the final offset site and providing detailed management actions specific to the site. Ensure the offset strategy complies with the *Principles for the use of biodiversity offsets in NSW* guidance document. The offset ratio will be determined with reference to: the conservation status of the vegetation; the condition of the vegetation; and the actual threatened species habitat value lost (i.e. known threatened species habitat, not potential habitat). Where Box Gum Woodland and threatened species habitat is to be cleared and cannot be avoided an offset ratio to be applied at: 1:20 for good condition areas; 1:10 for moderate-good condition areas; 1:5 for moderate condition areas; and 1:2 for poor condition areas. Where non-threatened vegetation is cleared an offset ratio to be applied at 1:1. Where hollow-bearing trees are to be cleared and cannot be avoided an offset ratio to be applied at 1:1 and is supplementary to other areas offset. Include provisions for offsetting Commonwealth listed EEC to demonstrate compliance with the Commonwealth offset policy.

12 Aboriginal and European Heritage

12.1 Overview

New South Wales Archaeology Pty Ltd was commissioned by Epuron Pty Ltd to undertake an Aboriginal cultural and archaeological heritage assessment in relation to the proposed Liverpool Range Wind Farm Stage 1. This report documents the proposed impact areas, the assessment process, findings, interpretation of results and recommendations.

The assessment was conducted in accordance with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005), the NSW Office of Environment and Heritage's Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH, 2011) and the Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b).

12.2 Methodology

A process of Aboriginal community consultation was undertaken in accordance with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) and OEH's Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW, 2010a).

The study sought to identify and record Aboriginal cultural areas, objects or places, assess the archaeological potential of the subject areas, and to formulate management recommendations based on the results of the community consultation, background research, field survey and a significance assessment.

12.3 Survey

The wind farm subject area has been found to be of generally very low cultural and archaeological potential and significance. There are no previously recorded sites known to be present, however, three Aboriginal object locales (stone artefact sites) were recorded during the field survey. Micro-siting of turbines, roads etc., to avoid impacts are a potential management strategy in respect of these. Undetected or subsurface stone artefacts are predicted to be present in densities which range from low to very low/negligible. Five European heritage items have been recorded in the wind farm area. None of these warrant heritage listing, however, micro-siting to avoid impacts is recommended.

One of the transmission line options was surveyed during the assessment, while the others were subject to a desk top assessment only. Previously recorded Aboriginal objects sites are located along these routes, and several new recordings (3 stone artefact sites and a rock shelter with potential archaeological deposit) were made during the field assessment. Micro-siting of power poles to avoid impacts is recommended. Two European heritage items were recorded in the transmission line option surveyed. They do not warrant heritage listing, but micro-siting to avoid impacts is recommended. When a final transmission line route is selected, and if it differs to that surveyed during this assessment, it is recommended that a field survey of the alignment is undertaken in order to formulate detailed management strategies in respect of micro-siting power pole locations, as required.

A total of 169 kilometres of turbine alignments, roads and transmission lines was surveyed (walked) during the field inspection. The coverage achieved is considered sufficient to characterise the nature of Aboriginal object distribution. The survey results are therefore assessed to be a relatively accurate reflection of the archaeological status and artefact density in the two subject areas. Accordingly, based on the relevant predictive model of site distribution and the results of the field survey, the proposed impacts are assessed to be of generally low potential to cause harm to cultural and archaeological values. This assessment forms the basis for the formulation of recommendations relating to the proposal.

The Aboriginal object locales (and any undetected and subsurface artefacts) and heritage values do not surpass archaeological and cultural significance thresholds which would act to preclude the construction of the proposed wind farm.

12.4 Results

Based on a consideration of the predictive model applicable to the environmental context in which impacts are proposed, the results of the study, and the nature of proposed impacts, the following conclusions and recommendation are made:

- Based on a consideration of the small and discrete nature of proposed impacts and the identified archaeological and cultural values, the subject areas do not warrant subsurface test excavation. The level of assessment achieved during the field survey is considered to have been adequate for the purposes of determining the cultural and archaeological status of the proposal area.
- The recorded Aboriginal object locales and the predicted generally very low density subsurface artefact distribution in the proposal area does not surpass archaeological significance thresholds which would act to entirely preclude the proposal. There are no identified Aboriginal archaeological and cultural constraints.
- It is recommended that when the design is finalised, additional archaeological assessment is conducted in any areas which are proposed for impacts that have not been surveyed during the current assessment. Significant Aboriginal objects can occur anywhere in the landscape and, accordingly, they need to be identified and impact mitigation strategies implemented prior to impacts. This applies particularly to the transmission line route, which in the sandstone country at its southern end, has the potential to traverse areas in which significant Aboriginal heritage items and values occur.
- The proponent should, in consultation with an archaeologist, develop a Cultural Heritage Management Protocol, which documents the procedures to be followed for impact mitigation and management. The development of an appropriate Cultural Heritage Management Protocol should be undertaken in consultation with an archaeologist, the registered Aboriginal parties and the NSW Office of Environment and Heritage. It would aim to ensure the effectiveness and reliability of mitigation and management strategies.
- Personnel involved in the construction and management phases of the project should be trained in procedures to implement recommendations relating to cultural heritage, as necessary.
- Cultural heritage should be included within any environmental audit of impacts proposed to be undertaken during the construction phase of the development.

13 Traffic and Transport

13.1 Approach

A Traffic Impact Study was prepared by Epuron. A full copy of the study is presented in Appendix E. The assessment considered the potential impacts of the proposed wind farm and provides mitigation measures to minimising potential traffic impacts associated with the project. The Traffic Impact Study is primarily focused on the construction phase as it is considered that the construction phase would generate the greatest volume of traffic.

The methodology adopted for the assessment included:

- reviewing the RMS checklist for preparing traffic impact studies;
- mapping of the proposed wind farm site and surrounding area;
- review of planning documentation for other wind farm developments in the area;
- roads were inspected and photographed;
- RMS data was reviewed to establish traffic volumes on the main roads;
- personal communication with the RMS;
- consultation with Local Shire Councils;
- information on road conditions from property owners at the Information Day on 01/11/2012; and
- information from turbine suppliers on access track requirements and turbine component transport.

13.2 Existing Environment

The roads in the vicinity of the project area are generally classified as follows:

- State Highway – Golden Highway is owned and maintained by the RMS.
- Regional Roads – Part funded by a grant agreement administered by the local RMS.
- Local Roads – All other roads that are owned by the council.

The southern end of the wind farm site is located 2 km north of the Golden Highway near the regional town of Cassilis. The Golden Highway provides a safe connection with up to 100 km/h travel speed.

Access requirements for the proposed wind farm can be separated into the following categories:

- Standard road vehicles ranging from 2 wheel drive cars to B-Double trucks. These vehicles are required to access the site as far as the construction compound and associated equipment storage area. They represent the largest portion of vehicles. It would be anticipated that light vehicles would be the source of transport within the construction area of the site.
- 4 wheel drive vehicles may be required for most transport to the turbine locations and would provide ongoing maintenance.
- Specialist vehicles may include off-road construction vehicles, for example vehicles with nonstandard axle combinations. These may include tracked vehicles and reconfigured trailers used to tow components into position. This type of vehicle would not generally be able to be used on sealed local roads
- Over-dimension vehicles transporting turbine components and oversize construction machinery. These vehicles would generally be wider and longer but weights of loads would not be excessive (generally up to 70 tonnes carried over 7 axles).
- Over-mass and over-dimensional vehicles transporting electrical transformers of up to 200 tonnes. These vehicles would possibly require the strengthening of bridges and drainage structures because of the close spacing of axles. Only a small number of these vehicles are anticipated during construction.

13.3 Assessment

Construction and decommissioning phase

Table 13-1 Approximate dimensions and weights of the components of a typical wind turbine

Wind Turbine Component	No. of parts per turbine	Total number of parts for 288 turbines	Approximate component weight (tonnes)
Towers	3 - 5	864 – 1,440	Up to 60
Nacelle	1	288	Up to 80
Hub	1	288	Up to 23
Blades	3	864	Up to 12

Over-mass and over dimension vehicles

The larger vehicles would occupy most of the width of the roadway at many locations thereby requiring traffic control procedures to ensure safe passage for local road users. For nearby property owners, there is likely to be an increase in traffic noise and dust nuisance in addition to the need to control stock from straying on the roads which are not fenced. Dust generated on unsealed roads could impact visibility and result in the loss of pavement materials. Gravel road surfaces would deteriorate and potholes would form under the increased traffic loads, particularly during wet weather when water ponds or drains across a road. Structural damage may occur to some of the culverts, concrete causeway crossings, stock grids and traffic islands. The location of trees and other roadside objects have the potential to obstruct the passage of long wide loads and high loads. Lack of roadside delineation in some locations may impact traffic safety during periods of poor visibility. Some intersections have inadequate pavement width to safely accommodate the turning manoeuvres of the over-size vehicles.

It is considered that these impacts would be temporary, as the equipment haulage is not a continuous program. Most of the heavy haulage would be in the form of convoys and would be managed through a number of specific mitigation measures developed and implemented in conjunction with RMS and Local Councils. These measures usually include escort vehicles.

Decisions on the final routes for these vehicles would be the subject of negotiations between the haulage contractor and the road authorities.

Haulage Route Status

The haulage route from port to Cassilis along the New England and Golden Highways is an approved RMS B-Double route and is suitably designed to accommodate oversize and over mass loads. Where the transport route leaves the Golden Highway on Warrumbungle Way, the RMS B-Double route becomes an '*Approved Area with Conditions*' and any road upgrades required for the project will be updated with the local councils. The assessment of the haulage route capacity from port to Cassilis has found that the existing road design capacity is more than sufficient to accommodate the short term construction impacts.

Traffic impacts at specific location

Golden Highway

The route from the Port of Newcastle to Cassilis, the Golden Highway, provides a safe, single and dual carriage highway for the vast majority of the distance from port to destination. During the construction phase there would be an increase in traffic travelling along this route including standard road vehicles, B-Double trucks and over dimension vehicles transporting turbine equipment.

Impacts on access route roads

There is potential to impact local traffic through the use of standard road vehicles, B-Double trucks and over dimension vehicles transporting turbine equipment. The delivery of equipment along these roads would be done as per the TMP. This increase in traffic volume would require improvements to ensure the safety of road users particularly in relation to conflicts between vehicles and stock.

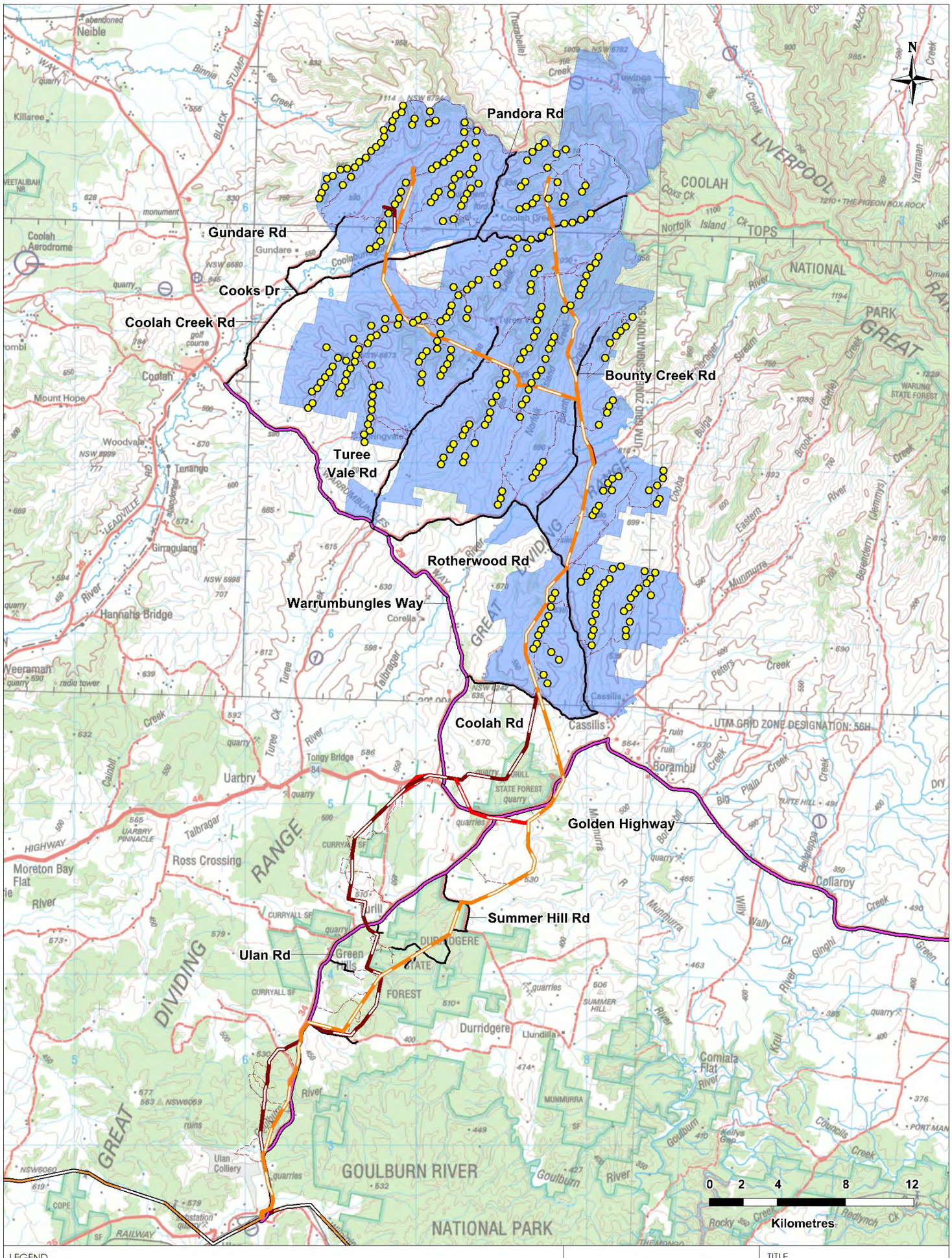
Isolated curves and crests on looser gravel surfaces could result in drivers losing control. Several drainage structures may need to be upgraded to ensure continued wet weather access.

Several mitigation measures have been developed to manage traffic impacts during the construction phase; key areas are highlighted in Section 13.4. These centre on the development of a TMP, consultation with roads authorities and

affected members of the community, to finalise the routes and ensure that safety and protection of assets is managed effectively.

Operation phase

Once operational, the wind farm would be managed and maintained by several crews of technicians, likely to be based at Mudgee or Coolah. The proposed wind farm may generate interest as a visual feature in the locality however, it is considered that this would not significantly increase the number of tourists visiting the Coolah / Cassilis region and therefore the increase in traffic volumes and subsequent impacts are likely to be low. No specific mitigation measures are considered warranted to manage operational traffic impacts.



LEGEND

- Project area
- Proposed wind turbine
- Proposed access track
- Major road access
- Minor road access
- Preferred overhead powerline
- Alternative overhead powerline
- Second alternative overhead powerline
- Existing 330 kV transmission line

EPURON

PROJECT: Liverpool Range Wind Farm

TITLE: Public Road Access to the Wind Farm Site

SCALE	DATE	DRAWN
1:200,000 at A3	15/11/13	MK

Figure 13-1 Proposed access routes to the Liverpool Range Wind Farm

13.4 Mitigation Measures

The following measures would be adopted to minimise the impacts from construction traffic:

- Development of a Traffic Management Plan that will identify detail actions such as scheduling of deliveries, managing timing of transport near major centres (Mudgee) and local towns (Coolah / Cassilis) to avoid peak times (beginning / end of school), consultation activities during haulage activities, designing and implementing modifications to intersections and street furniture and managing the haulage process.
- Use of a licensed and experienced haulage contractor, to be responsible for obtaining all necessary permits and approvals from the RMS and Councils and for complying with conditions of consents.
- Escorts for oversize and over-mass vehicles will be provided in accordance with RMS requirements.
- The Traffic Management Plan will establish a procedure to monitor traffic impacts during construction such as noise, dust nuisance and travel timings so adjustments can be made to minimise impacts.
- Re-instating pre-existing conditions after temporary modifications, if required.
- Providing a 24hr telephone contact during construction to enable any issue or concern to be rapidly identified and addressed.
- Consult with the local Councils prior to construction and agree any road upgrade or rehabilitation responsibilities and requirements including potential contribution towards road maintenance funding and/or road dilapidation reports prior to the commencement of construction and following completion of construction to determine any damage attributable to the project.

Should deterioration of roads occur during construction activities, an inspection and maintenance program would be established, if required by the Council.

14 Hazards and Risks

14.1 Aviation

14.1.1 Background

The proposed development of the Liverpool Range Wind Farm would involve the construction of wind turbines with a maximum height of up to 165 meters to the blade tip. Due to the height of the wind turbines, potential impacts to the safety of aviation activities have been assessed. This includes:

- identifying nearby aerodromes and local landing strips within 5km of proposed turbines;
- consultation with aviation authorities, lanowners and associations; and
- assessing the risk and impacts to aerial agricultural activities.

Information regarding the existing environment, activities and aircraft, and the nature of landing strips and their operation have been sourced from CASA, ASA, AAAA, previous development applications, relevant reports and local landholders.

14.1.2 Existing Environment

Aerodromes

The closest Civil Aviation Safety Authority (CASA) certified and registered aerodromes to the proposed wind farm site can be seen below in Table 14-1. The table shows Coolah aerodrome is closest to the proposed site at 17.3km.

Table 14-1 CASA registered and certified aerodromes near the proposed site

Aerodrome	*Certification or Registration Number*	*Operator Name*	*Distance from site (km)*
Coolah	R035	Coolah Shire Council	17.3
Quirindi	R150	Liverpool Plains Shire Council	51.0
Coonabarabran	R115	Warrumbungle Shire Council	66.4
Mudgee	1-15S3M	Mudgee Shire Council	70.0
Scone	R131	Upper Hunter Shire Council	76.9
Gunnedah	R139	Gunnedah Shire Council	80.7
Tamworth	1-6FXI	Tamworth Regional Council	102.8
Dubbo	1-6EDH	Dubbo City Council	120.0

CASA uses a term called Obstacle Limitation Surfaces (OLS) to manage the area around an aerodrome. An OLS is a series of surfaces that define the limits to which objects may project into the airspace, and above which, become obstacles to aircraft operations and must be reported to CASA. An assessment of the Coolah aerodrome will take place as it is within 30 km to the development. The location of these airports in relation to the project is presented in Figure 14-1.

Landing Strips

18 private landing strips (known as Aircraft Landing Areas or ALAs) have been identified on private properties within 5 km of the project, which have historically been used for aerial agriculture. The majority of these landing strips are on properties associated with the project. ALAs are not registered or regulated by CASA. Locations of the landing strips are shown in Table 14-2 and Figure 14-2.

Table 14-2 Location of existing landing strips

Ref	Runway Orientation	Location		Distance from nearest wind turbine (metres)	Involved / Non-Involved
		Easting	Northing		
1	NW-SE	779,331	6,492,263	3,240	Involved
2	NW-SE	773,037	6,489,708	160	Involved
3	SW-NE	764,756	6,485,117	760	Involved
4	SW-NE	770,387	6,483,603	1,656	Involved
5	NW-SE	776,442	6,483,091	150	Involved
6	NW-SE	769,005	6,481,568	1,190	Non-Involved
7	NW-SE	762,187	6,477,752	2,610	Non-Involved
8	SW-NE	766,980	6,471,772	150	Involved
9	NW-SE	770,771	6,471,224	660	Involved
10	NW-SE	771,066	6,473,591	950	Involved
11	SW-NE	773,382	6,474,366	1,241	Involved
12	N-S	775,758	6,468,715	790	Involved
13	SW-NE	777,795	6,470,874	240	Involved
14	SW-NE	781,202	6,468,817	100	Involved
15	N-S	783,963	6,464,665	970	Non-Involved
16	SW-NE	777,759	6,461,855	110	Involved
17	WNW-ESE	786,049	6,461,881	2,420	Non-Involved
18	E-W	780,136	6,455,446	2,700	Involved

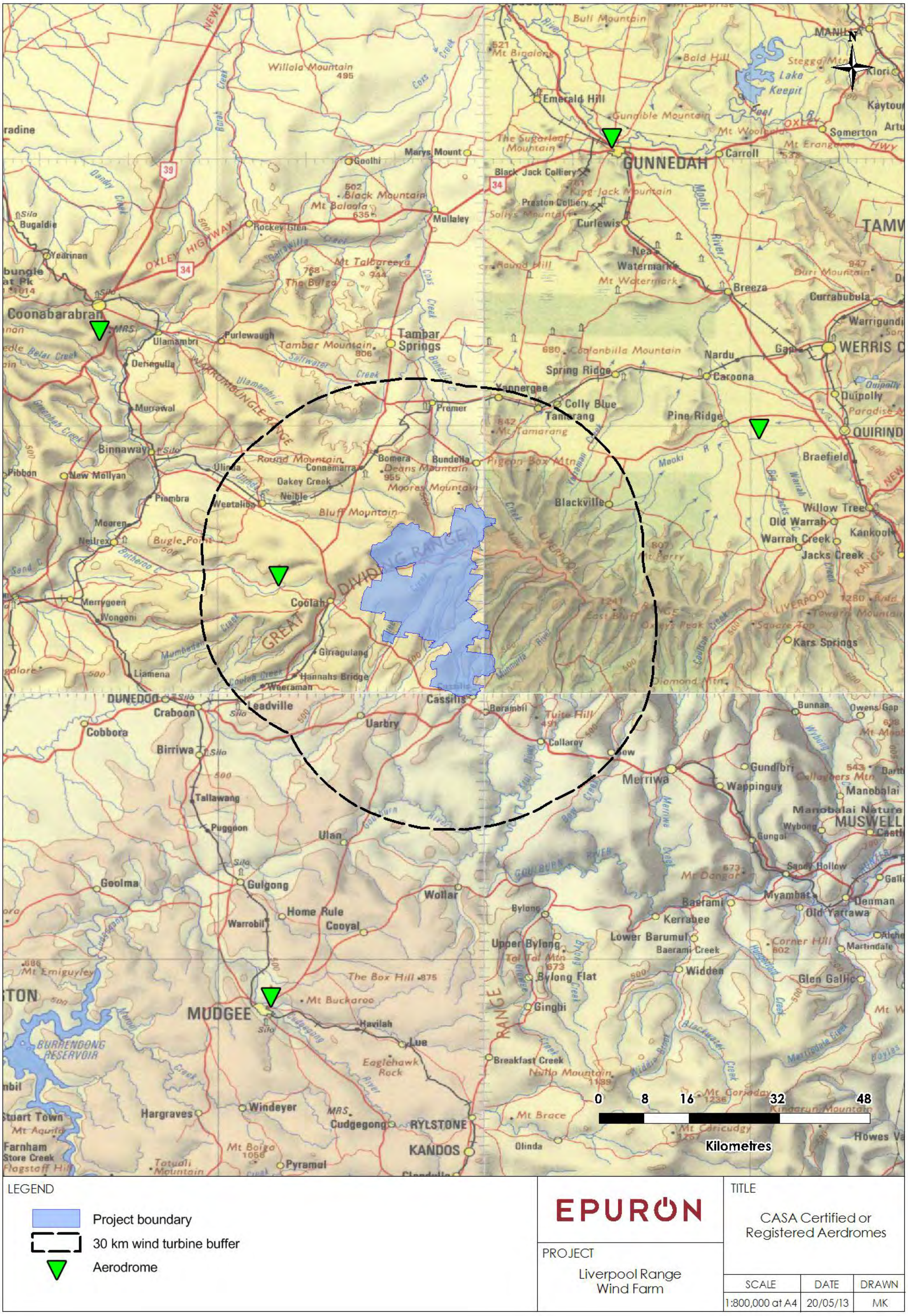


Figure 14-1 Aerodromes within vicinity of the proposed wind farm

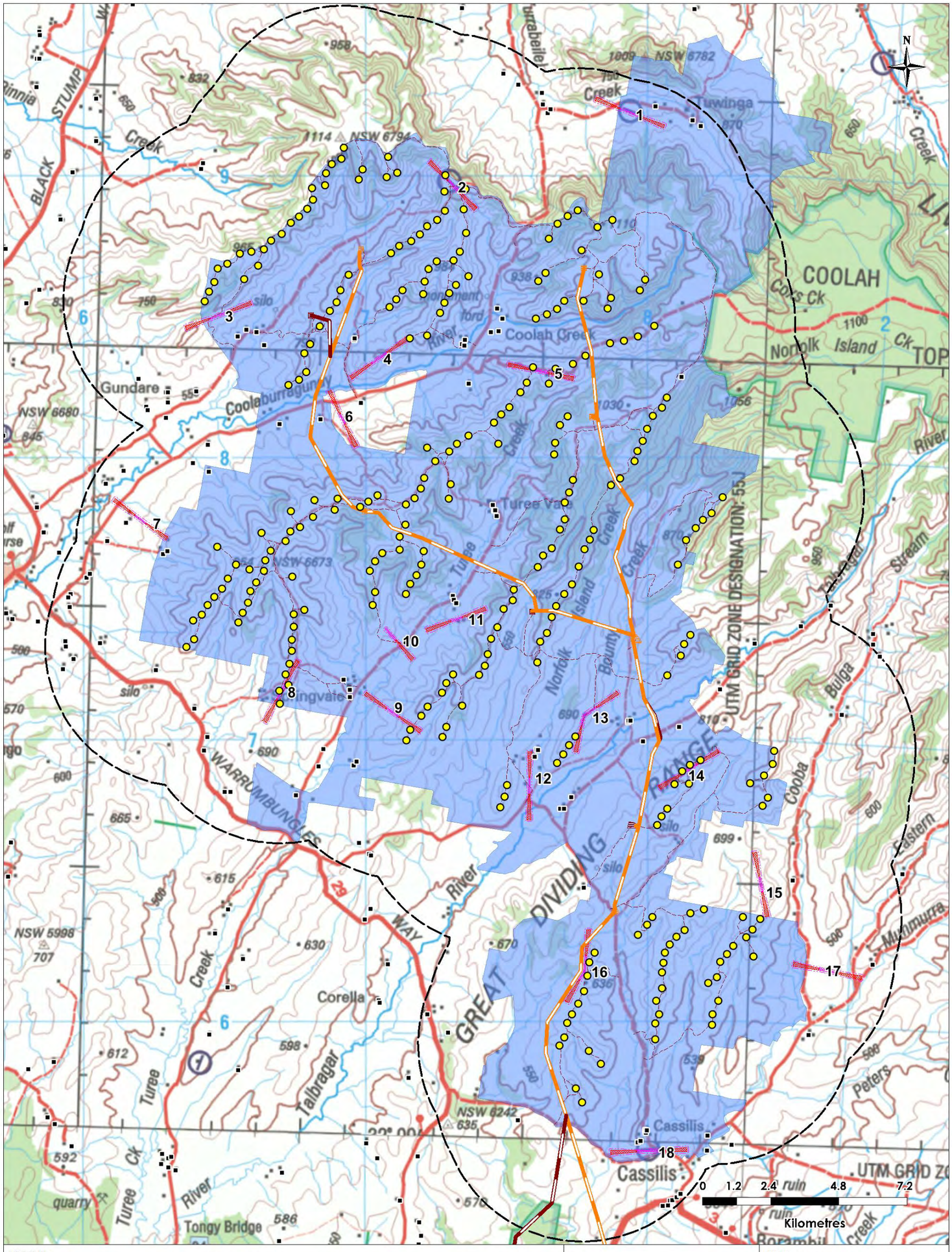


Figure 14-2 Landing strips within 5 km of a turbine

14.1.3 Consultation

Epuron has consulted with the Civil Aviation Safety Authority (CASA), Airservices Australia (ASA), Aerial Agricultural Association of Australia (AAAA), the Department of Defence and local landholders with landing strips in relation to the project.

On the 12th of November 2012 Epuron wrote to the Department of Defence in relation to the project. The Department of Defence is responsible for ensuring that new developments would not conflict with existing military aircraft operations, radio communications and the operation of navigational aids and radars. The Department of Defence responded on the 5th of June 2013 and stated that although a deployable radar site Mt Coolah may be unusable once the wind turbines are constructed, "Defence has no objection to the proposal". The Department of Defence response is attached in Attachment 8.On the 9th of November 2012 Epuron wrote to CASA in relation to the project. CASA is an independent statutory authority whose primary function is to conduct the safety regulation of civil air operations in Australia. No concerns have been raised thus far in relation to the project.

Due to the height of the proposed turbines (greater than 110m), notification to CASA is required in accordance with the C*ivil Aviation Safety Regulations 1998 (CASR)* Part 139, Subpart 139E Obstacles and hazards.

CASA previously recommended that obstacle lighting be provided as per section 5.5 of *Advisory Circular 139-18(0) - Obstacle Marking and Lighting of Wind Farms*, however this Advisory Circular was withdrawn in September 2008. The withdrawn Circular defined that the interval between turbines and obstacle beacons should not exceed 900m.

Since the withdrawal of the Advisory Circular in 2008 there have been no updated recommendations and as such there are currently no CASA guidelines to conform to in relation to obstacle marking of wind farms. CASA has indicated that they are reviewing their position and it appears likely that CASA will align their advice with international guidelines. Epuron does not expect obstacle lighting to be required for the Liverpool Range Wind Farm.

Epuron provided Airservices Australia (ASA) with details of the project on the 9th of November 2012. ASA is responsible for air traffic management and has the expertise to assess the potential impacts of wind farm proposals on precision / non precision navigational aids, HF/VHF communications, radar and satellite links in the area. ASA is also able to provide advice on whether the project would impact Lowest Safe Altitudes (LSALTs). On the 28th of November 2012 ASA responded to Epuron detailing the need for an Aviation Impact Study in relation to the project. Epuron is currently in the process of performing the study and will work with ASA should any issues arise.

The AAAAs formal policy position on all wind farm developments and wind monitoring towers is to automatically oppose such developments, unless the developer is able to clearly demonstrate they have openly and honestly consulted local aerial operators, sought independent expert opinion, ensured no long or short term effect on safety standards and provided a legally binding agreement for compensation for loss of income (AAAA, 2011).

Epuron has consulted with all involved and non-involved landowners that have private landing strips within 5km of the wind farm, as listed in Table 14-2 and shown in Figure 14-2. Consultation has occurred through a mix of personal meetings, written correspondence and follow up phone calls with these landowners. Fourteen out of eighteen of these landowners are involved in the project, and the potential for impact on aviation has been discussed with all these landowners and no concerns have been raised to date. The design and layout of the wind farm has considered and taken into account the landowers farming parctises when siting turbines near exisiting landing strips. As stated in Table 14.2, the distances between the non-involved landowner airstrips and the nearest wind turbines are large, often greater than 2km with the nearest being 1,190m. Due to these large distances between non-involved landowner airstrips and wind turbines it is considered that there will be no material impact to aviation practices for these non-involved landowners. No impacts to aviation are considered likely when turbines are sites more than 500m from non-involved landowner airstrips as considered by independant aviation experts, Amdidji Group.

14.1.4 Assessment

Aerodromes

The Proponent has consulted with CASA and Airservices Australia in order to seek comment on the Coolah Aerodrome. CASA advised that they do not hold any information regarding the OLS for the Coolah Aerodrome, while ASA informed Epuron that no comprehensive OLS information exists for the Coolah Aerodrome due to the small scale and infrequent use of the aerodrome, but Warrumbungle Shire Council should be contacted to obtain any information available. On the 4th of December 2013, the Warrumbungle Shire Council provided Epuron with Coolah Aerodrome survey data as performed by Airport Survey Consultants on the 14/11/2013. The survey includes approach splays, slope, gradient, length, and divergence, as well as surveyed points of obstacles such as trees in the vicinity of the aerodrome. This information has been used in the design of the wind farm and confirms that the Liverpool Range Wind Farm will not have any impact on the operation of the Coolah Aerodrome. The Coolah Aerodrome survey document has been included in Attachment 8 – Consultation Material.

The Proponent will continue to assess and incorporate any further requirements into the design of the wind farm if further information becomes available.

Landing Strips

Eighteen landing strips have been identified within 5 kilometres of the proposed development, two of which are within 2 km of non-involved landowners. These strips are classed as "Aeroplane Landing Areas" by CASA in accordance with Civil Aviation Safety Regulations Part 139.

CASA guidelines for these landing strips are contained in their *Civil Aviation Advisory Publication 92-1 (1) - Guidelines for Aeroplane Landing Areas* (CAA, 1992). The publication contains physical characteristics that define the 'surfaces' which should be clear from obstacles around the runway approaches. These characteristics are shown in Figure 14-3 for day operations.

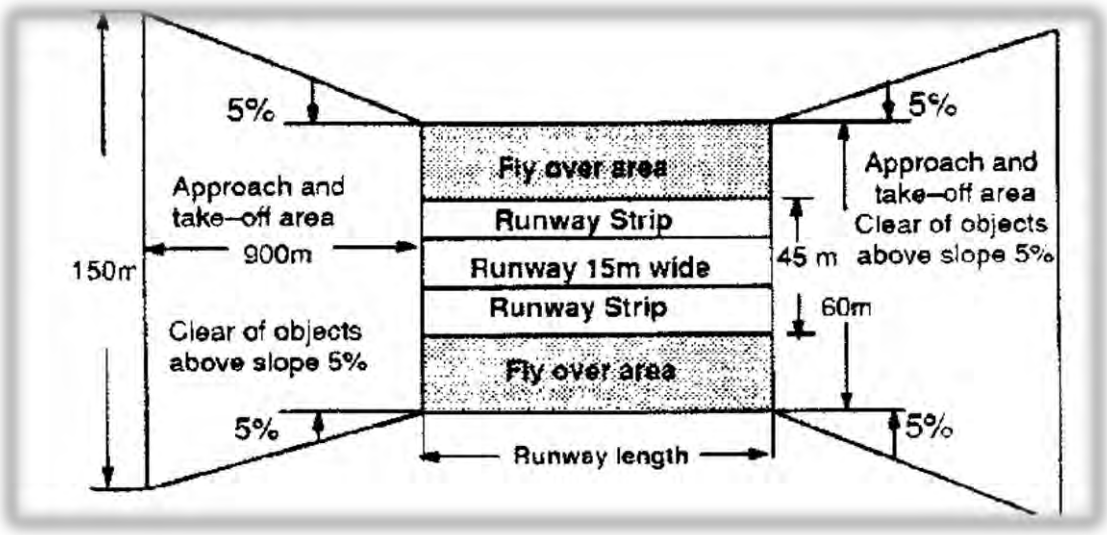


Figure 14-3 CASA's guideline for characteristics of an Aeroplane Landing Area (CAA, 1992)

For this assessment a worst case scenario basis had been chosen and all landing strips will be assessed as if they were for Single Engine and Centre-Line Thrust Aeroplanes not exceeding 2000 kg maximum take-off weight (MTOW) for day time operations, as stated in *Civil Aviation Advisory Publication 92-1 (1) - Guidelines for Aeroplane Landing Areas* (CAA, 1992). By using this definition of aeroplane landing areas, it increases the clearance required between wind turbines and the approach and take-off areas and will ensure greater safety for both pilots and the wind farm.

A zone extending 900 metres from the approach and take off area is required to be free from obstacles at an angle of 5% extending out from the end of the runway.

The wind farm layout has been designed so that none of the proposed turbines encroach on the CASA designated clearance even though 5 proposed turbines occur within 500 m (they are adjacent to the landing area not at each end).

Figure 14-4 demonstrates that the clearances are in excess of the CASA guidelines for landing strip No. 5. Landing strip No. 5 is shown as an example, the CASA guidelines have been applied to all landing strips listed in Table 14-2. No wind farm infrastructure is within the Aeroplane Landing Area of any of these landing strips.

As these private airstrips rely on visual rather than instrument based landing techniques, and as the turbines being highly visible, it is unlikely that the proposed development would pose any additional hazard to users of these airstrips. It is expected that pilots will continue to use the local landing strips for their farming pratises and have expressed no concerns to date.

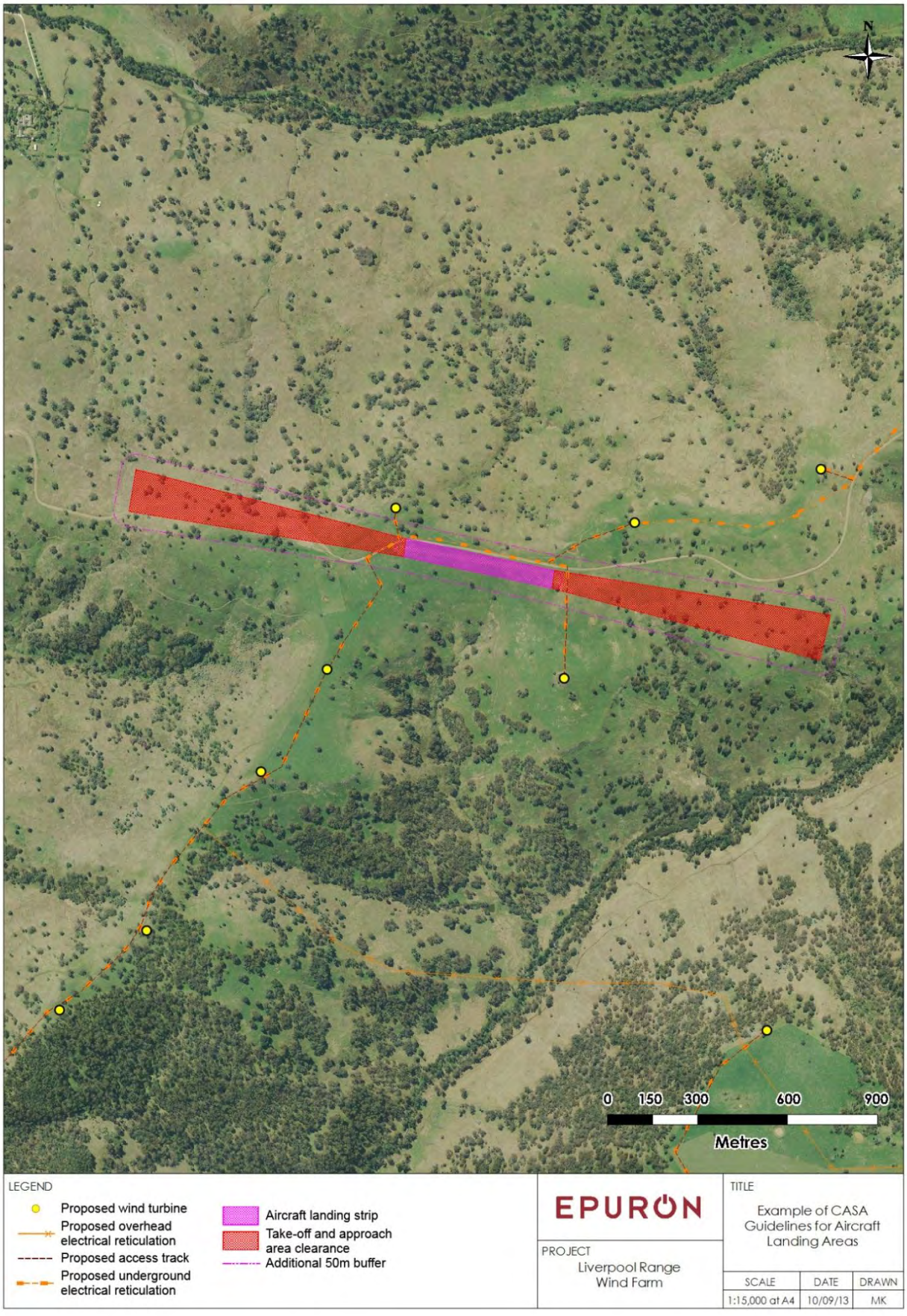


Figure 14-4 Example of CASA guidelines being applied for local landing strip No. 5

Aerial Agriculture

The Proponent acknowledges that the wind farm will likely impact aerial spraying in the area immediately adjacent to the turbine locations. Accordingly, should spraying or spreading of fertilisers be required in this vicinity, ground based methods will need to be considered, potentially at a higher cost.

A report conducted by the Ambidji Group Pty Ltd for the Berrybank Wind Farm concluded that a buffer zone of 500 m should be applied when planning aerial spreading in the close proximity to an installed wind farm (Foster, 2010). This would mean that more time would be required in the pre-planning process as the approach may need to be varied to avoid turbines. The report states:

> *"A standard agricultural aircraft loaded to maximum capacity takes approximately 500 metres to complete this turn. This would have an impact on the direction at which some of the spraying operations would need to be conducted. A distance of 500 metres from the nearest turbines would be required as a buffer zone for this operation."*

This report therefore assumes that aerial spreading would impact the area within 500m from a constructed turbine. Although the project will have some impact on the operations of aerial agriculture on these properties, alternate spreading methods are available, and the overall impact on farming operations is negligible & considered acceptable.

Lighting

Due to the significant physical separation between the wind farm and the closest airports, the fact that the overall wind turbine height will be below the lowest safe altitude for aviation and consideration of general community views on turbine obstacle lighting at night being visually intrusive, it is not considered appropriate to install obstacle lighting on turbines at the Liverpool Range Wind Farm site. The use of private landing strips is restricted to daytime operation and hence there would be no reason to install obstacle lighting for private aviation purposes.

Accordingly, the Proponent would only install obstacle lighting if required to do so by CASA, and to the extent required by CASA.

It should also be noted that the night time lighting installed on the Cullerin Wind Farm has been decommissioned by Origin Energy following a risk based aviation assessment. As a result of this assessment, new wind farm developments do not require individual assessment for night time lighting. A number of recent similar wind farm developments in New South Wales have been approved without requirement for night time lighting or individual assessment, including the Gullen Range and Glen Innes wind farms.

14.1.5 Mitigation Measures

Epuron will continue to liaise with all relevant authorities (CASA, ASA, and Department of Defence) as well as the operators of local airports and airstrips, local aerial agriculture contractors and the AAAA, and supply location and height details once the final details of the wind turbines have been determined and before construction commences. Should any issues arise, Epuron will manage the issues with the relevant authority to ensure the issues are dealt with appropriately.

Epuron will also comply with any requirements of CASA in relation to obstacle marking of wind turbines, although Epuron would not otherwise install obstacle beacons on any wind turbine.

Epuron have advised local landholders with landing strips of the impact on aerial agriculture within 500m of the wind turbines. As the impact on overall farming operations is considered negligible, no further mitigation methods are required. Epuron will continue to consult with landowners and provide any relevant aviation information. This could include funding the cost difference between the pre-wind farm aerial agricultural activities and a reasonable alternative method.

14.2 Communications Impacts

14.2.1 Background

Wind turbines have the potential to interfere with television and radio broadcasting, mobile phone reception, microwave links and other radio links such as mobile and CB radio. There are three mechanisms by which wind turbines may cause interference: reflection, diffraction and near field effects.

Reflection or scattering occurs when a signal becomes obstructed between the transmitter and a receiver, this could be due to a tower or moving blade component as shown in Figure 14-5.

Diffraction occurs when a signal is both absorbed and reflected by an object in the signal path.

Near field effects are caused by electromagnetic fields. This is no longer an issue due to advances in wind turbine technology and compliance with Electromagnetic Emission Standards.

A communication impact assessment report was prepared by Epuron for the Project. The objectives of this investigation were to identify the potential for impacts from the proposed Liverpool Range Wind Farm on existing telecommunications services in the vicinity of the project, and to identify appropriate mitigation strategies for potential impacts. The full investigation including a glossary of acronyms used in the investigation, maps, footnotes and references is presented in Appendix F.

The following approach was adopted to identify the potential impact of the project on telecommunications:

- Identify holders of telecommunications licenses (under the Radiocommunications Act 1992) within a 25km radius of the project, as well as point-to-point links in the vicinity of the project, using information provided on the Australian Communications and Media Authority (ACMA) RADCOM database.
- Provide written notification of the project and seek comments from each license holder identified via the ACMA RADCOM database search.
- Record and review all responses received to identify any issues raised by license holders.
- Discuss issues raised with relevant license holders with the aim to resolve or identify mitigation options.
- Carry out an assessment of the “Fresnel zone” associated with each fixed point-to-point communications link in the vicinity of the project.
- Determine appropriate ‘exclusion zones’ for the proposed turbine layout based on these calculations and advice from license holders.
- Confirm that all turbines (including blades) are located outside the ‘exclusion zone’.
- Determine appropriate additional mitigation measures which may be required.

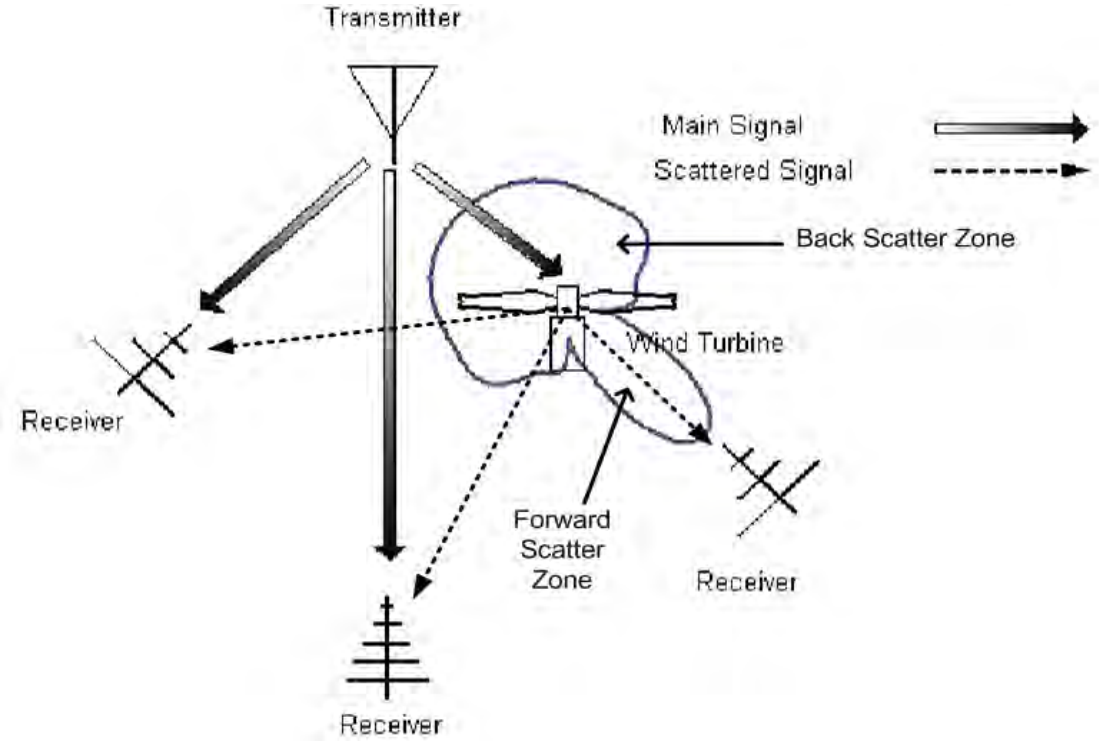


Figure 14-5 Scattering of a signal from a wind turbine

14.2.2 Existing Environment

The potential impacts of the proposed Liverpool Range Wind Farm on the four most commonly used telecommunications services have been investigated separately and are summarised below.

These services include:

- television broadcast services;
- radio broadcast services;
- mobile phone services; and
- radio communication services.

Television Broadcast

The ACMA RADCOM database lists the following broadcasters for television, under postcode 2843, Coolah, NSW.

Television broadcasting

- ABC30, ABC55, SBS52, CBN58, WIN61, CTC64, NBN33, NBN39, ABC42

The closest transmitter of television programs is at Queensborough, Coolah located about 5 kilometres North of Coolah.

Television Interference (TVI) is dependent on a range of factors including: existing environment factors (topography, direct signal strength, transmitter type, and receiver type) and wind farm design factors (turbine elevation, rotor size and orientation, speed of rotation, blade material and pitch). Due to the variability of local conditions and the characteristics of antennae used in particular installations, there is a degree of uncertainty regarding predicted levels of interference.

A Kordia report commissioned by the Long Gully Wind Farm in New Zealand stated that analogue television would be the most likely transmission service to experience interference from a wind farm development, although only within a limited distance. Very High Frequency (VHF) TV reception at dwellings within approximately 1 km of an installed wind turbines would have some probability of noticeable “ghosting” at times (Kordia, 2009).

However, analogue television signals have been 'switched off' and replaced with digital signals in the Coolah by the end of 2013. Digital TV is not susceptible to visible "ghosting" degradation. Any impact of reflections from the turbines would be a minor reduction of coverage at the limit of the service area.

Satellite based television or internet services may also be received at various locations throughout the area. These services are not subject to the same topographic screening that can affect the land based TV transmissions. Due to the distance of residences from the wind farm it is very unlikely that satellite based television services would be subject to interference due to the wind farm's operation as the wind turbine would have to be within the line of sight from the antenna to the satellite.

Radio Broadcast

The ACMA RADCOM database lists the following broadcasters for radio, under postcode 2843, Coolah, NSW.

Radio broadcasting

- 2TRR

The level of radio broadcast interference experienced can be influenced by a variety of factors including abnormal weather conditions, multi-path distortion (reception of a signal directly from a transmitter and also a reflected signal from hills, structures etc.), overloading (when an FM receiver receives too strong a signal) and electrical interference.

Potential wind farm impacts on FM radio are highly unlikely and therefore the stations serving the area have not been listed.

License holders have been contacted regarding possible impacts to television or radio broadcasting services. The Proponent will work with organisations to resolve issues, should any be identified.

Mobile phone services

A mobile phone network consists of a system of adjoining zones called 'cells', which vary in size with a radius of 2 - 10 km. Each cell has its own base station that sends and receives radio signals throughout its specified zone. Mobile phone antennas need to be mounted clear of surrounding obstructions such as buildings to reduce 'dead spots' and allow the base station to effectively cover its intended cells.

Mobile phone coverage is available in some of the area around Coolah and Cassilis but it is worse further away from these towns and the main highways and where topography limits coverage, especially in the vicinity of the wind farm to the north east.

Due to the separation distance between base antennas for providing mobile phone services and turbine structures due to the wind farm location, transmission of mobile phone signals is not expected to be affected by the wind farm.

Radio Communications

The ACMA issues radio communications licenses in accordance with Part 3.5 of the Commonwealth Radiocommunications Act 1992. The ACMA issues licenses to use specific segments of the radio broadcasting frequency spectrum for different purposes and maintains a register (the ACMA RADCOM Database) of all the licenses issued.

The register allows the ACMA to create a 'density' classification of areas across Australia as high, medium or low depending on the number of licenses in operation in a particular area. According to the ACMA RADCOM database, the area in the vicinity of the proposed wind farm is classified as a "Low Density Area".

License holders operate a range of radio communications services, including fixed link microwave communication and mobile communication systems within a 25 km radius of the proposed wind farm. Multiple license holders use some sites, while sole users employ others. Radio communications site licence holders within a 25 km radius are listed below.

Each license holder has been contacted and asked to provide independent comment on the wind farm development with respect to possible impacts to communication links. The Proponent will work with organisations to resolve issues, should any be identified.

Table 14-3 Radio communication license holders within 25km of the Liverpool Range Wind Farm site

ACMA Licence Holder	ACMA Site ID No.
Ambulance Service of NSW	201640
Australian Broadcasting Corporation	6202, 11281
Australian Communications and Media Authority	137123
Coolah Community UHF Users Group	11282
Department of Finance and Services	11022, 11281, 11282, 54746, 201640
Electrostar Pty Limited	11282
Essential Energy	6202, 11283, 201640
Fire and Rescue NSW	11279
Hello Radio Pty Ltd	54514
Liverpool Plains Shire Council	201640
NBN Ltd	6202
NSW Police Force	6202, 11283, 201640
NSW Rural Fire Service	11282, 11283, 54746, 201640
NSW Volunteer Rescue Association Inc	6201, 11280
Office of Environment and Heritage	54746
Optus Mobile Pty Limited	9012296, 9013052,9014793
Paspaley Pearls Properties Pty Ltd	11282
Prime Television (Southern) Pty Limited	11281
Singtel Optus Pty Limited	201640, 9012296, 9013052
Soul Pattinson Telecommunications Pty Limited	11022
SPECIAL BROADCASTING SERVICE CORPORATION	11281
Talbragar Broadcasters Incorporated	48392
Telstra Corporation Limited	7011, 11022, 11284, 132138, 133163, 205756, 9012347
Warrumbungle Shire Council	11283, 137597
WIN Television NSW Pty Limited	11281

14.2.3 Consultation

License holders identified via the ACMA RADCOM database within a 25 km radius of the wind farm were notified of the project in relation to potential impacts and asked to provide comments. Table 14-4 summarises the organisations that were consulted and their comments received. Responses are included in Attachment 8.

Table 14-4 Consultation with license holders

Organisation	Response	Comment
Ambulance Service of NSW	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.

Organisation	*Response*	*Comment*
Australian Broadcasting Corporation	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Australian Communications and Media Authority	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Coolah Community UHF Users Group	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Department of Finance and Services	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Electrostar Pty Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Essential Energy	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Fire and Rescue NSW	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Hello Radio Pty Ltd	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Liverpool Plains Shire Council	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
NBN Ltd	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
NSW Police Force	No Concern	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
NSW Rural Fire Service	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
NSW Volunteer Rescue Association Inc	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Office of Environment and Heritage	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Optus Mobile Pty Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Paspaley Pearls Properties Pty Ltd	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Prime Television (Southern) Pty Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.

Organisation	*Response*	*Comment*
Singtel Optus Pty Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Soul Pattinson Telecommunications Pty Limited	More Information Requested	More Information provided
Special Broadcasting Service Corporation	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Talbragar Broadcasters Incorporated	Concerns Raised	Discussion ongoing. Further study may be required prior to construction.
Telstra Corporation Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
Warrumbungle Shire Council	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.
WIN Television NSW Pty Limited	No Response	Epuron has followed up with stakeholder but received no additional feedback to date. Consultation continues.

14.2.4 Assessment

Television and radio broadcast services

In the event that Television Interference (TVI) is experienced by existing receivers in the vicinity of the wind farm, the source and nature of the interference would be investigated by the Proponent using a before and after approach as detailed in the mitigation measures.

Analogue TV transmission is currently planned to be phased out by 2013 and replaced by digital. Digital TV is not susceptible to visible "ghosting" degradation. Any impact of reflections from the turbines would be a minor reduction of coverage at the limit of the service area.

Should investigations determine that the cause of the interference can be reasonably attributable to the wind farm; the Proponent would put in place mitigation measures at each of the affected receivers in consultation and agreement with the landowners.

Radio communications services

A fixed link radio transmission is a point to point transmission path typically between two elevated topographical features. Radio links could make use of a number of transmission frequencies including UHF, VHF or microwave. The transmission path may become compromised if a wind farm is located within the direct line of sight or what is known as the 'Fresnel Zone' around the line of sight between the sending and receiving antennae.

The potential impact zone will vary with the distance between the transmitter and receiver, frequency of transmission and the location of any particular point along its path. The maximum extent of the Fresnel zone occurs at the midpoint along the path of the microwave link as shown in Figure 14-6. Communications are only likely to be affected if a wind farm is in the line of sight between two sending and receiving antennae or within a zone of the line of sight of these antennae. In general, microwave links (which have very narrow Fresnel zones) are more liable to interference as a greater portion of the Fresnel zone can be impacted by the wind turbine.

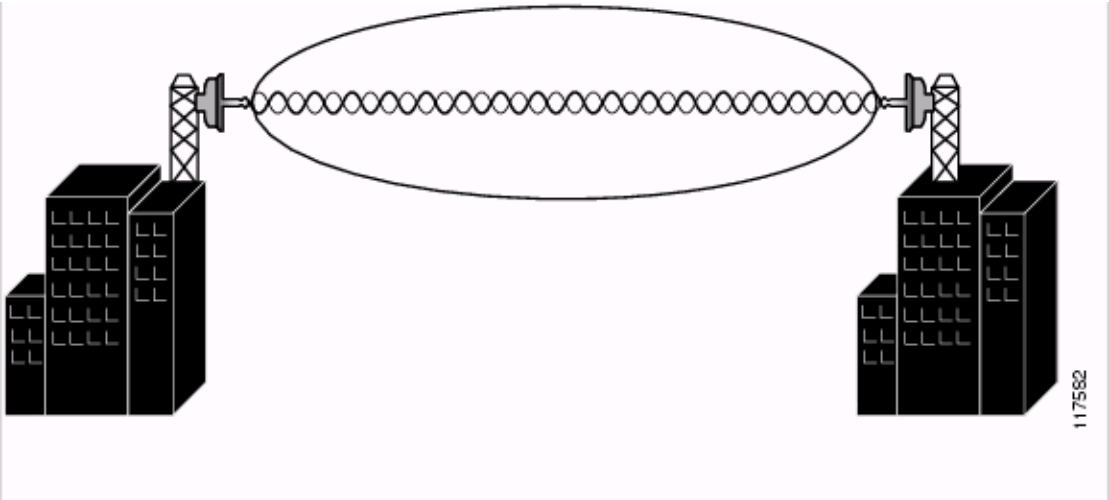


Figure 14-6 The Fresnel zone between a transmitter and a receiver

EPURON has identified and mapped all point to point radio communication links existing in the vicinity of the proposed Liverpool Range Wind Farm site. Table 14-5 lists the eight radio communication links that travel in close vicinity to the location of proposed wind turbines, and Table 14-6 lists radio communication towers within 500 m of wind turbines. Figure 14-7shows an aerial overview of the location of all fixed radio communication links in the vicinity of the Liverpool Range Wind Farm, the two radio communication towers referred to in Table 14-6 are found in the north-west and shown in detail in Figure 14-8. [6]

Table 14-5 – Point to point radio communication links in the vicinity of the Liverpool Range Wind Farm

Link ID	Client Number	Licensee	License Number	Frequency (Hz)
255024	5832	NSW Rural Fire Service	1427518	460350000
255024	5832	NSW Rural Fire Service	1427518	450850000
257595	5832	NSW Rural Fire Service	1229825	460775000
257595	5832	NSW Rural Fire Service	1229825	451275000
328352	1141565	Electrostar Pty Limited	1566428	414100000
328352	1141565	Electrostar Pty Limited	1566428	404650000
367069	5832	NSW Rural Fire Service	1204074	451125000
367069	5832	NSW Rural Fire Service	1204074	460625000

Table 14-6 - Radio communication towers within 500m of wind turbines

Site ID	Site Name	Easting (MGA 94)	Northing (MGA 94)	Zone (MGA 94)	Turbines within 500 m
11,282	Prime Comms site adjacent Oakey Trig Station (9km North of Coolah)	769,000	6,491,150	55	2
48,392	Three Rivers Radio Mast adjacent to Oakey Trig Station (MT OAKY)	768,980	6,490,500	55	3

6 Based on data contained in the ACMA RADCOM database, June 2012

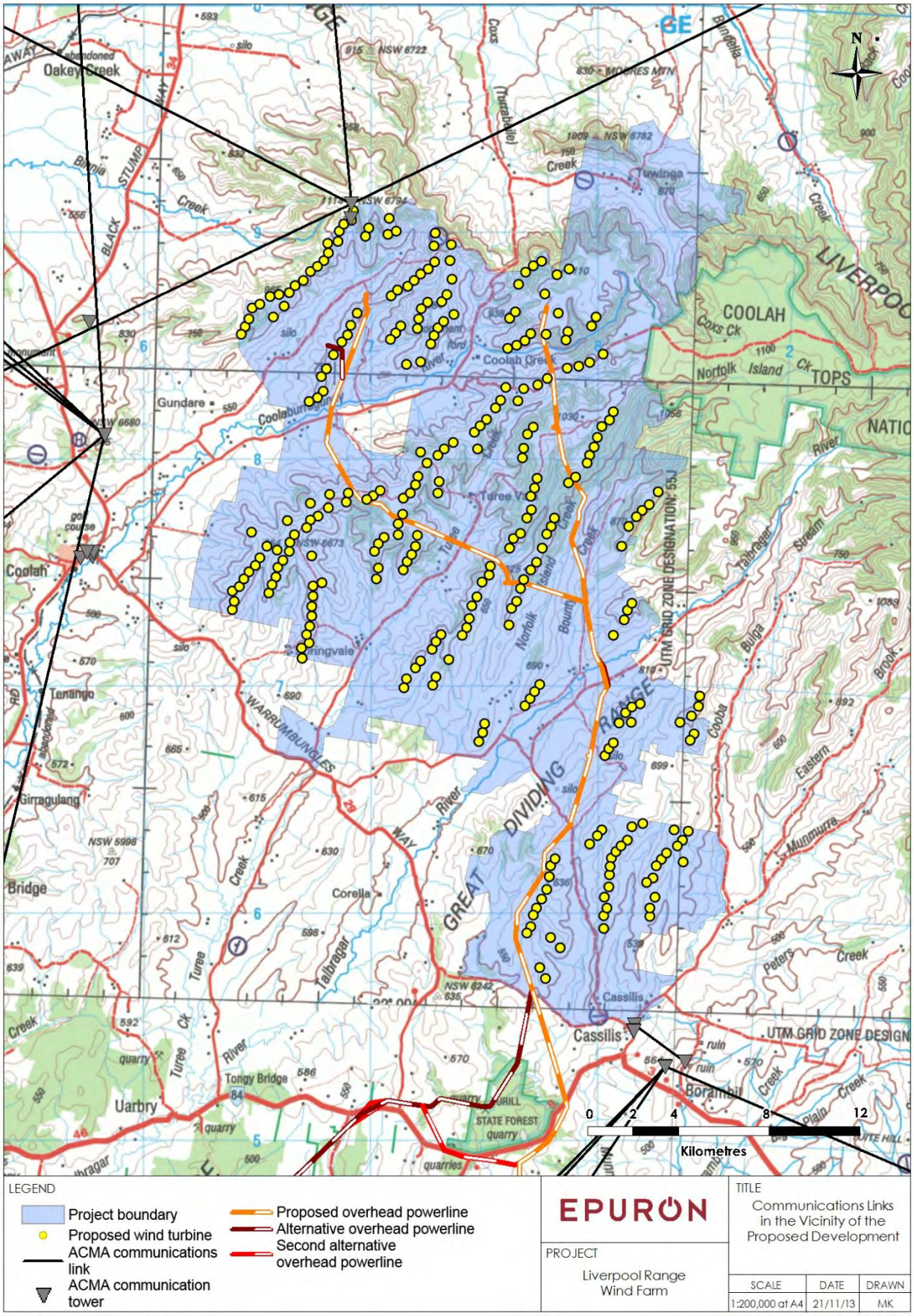


Figure 14-7 Point to point radio communication links in the vicinity of the Liverpool Range Wind Farm

In order to ensure that obstruction to the signal transmission path does not occur, calculations of the 2nd order Fresnel zone of the point to point communications links in close vicinity to the wind turbines were undertaken.

It is suggested that beyond the 2nd Fresnel zone, the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver (Bacon, 2002).

Completion of this Fresnel analysis showed that no turbines were to be located within the 2nd Fresnel zone, in the direct line of sight path of the point to point links. Despite this, there are wind turbines planned within 500 m of one omnidirectional radio broadcast tower and one point to point radio communication tower.

Figure 14-8 shows the proximity of the turbines to the two radio communication towers. Due to the proximity of the wind turbines to the broadcast towers, there is the possibility that near field scattering interference can occur. Epuron is currently in correspondence with the owners and operators (Three Rivers Talbragar Radio) of these two radio communication towers and will ensure that mitigation measures are implemented where required, at the proponent's expense, so that impact on existing services does not occur. Further qualified study may be required to determine the potential impact on these broadcast towers.

Therefore, based on:

- The results of the above literature research;
- Location of turbine layout avoids 2nd order Fresnel zones of all radio communication links, and;
- Discussion with owners and operators of radio communication towers within 25 km of the project;

Interference to the existing point to point communication links from the Liverpool Range Wind Farm is not expected.

Epuron previously contacted all organisations identified as operating radio communication licences (including fixed link communications) within 25 km of the Cullerin Range wind farm proposal, which is now operational and without communications issues in the area.

Each license holder was asked to provide independent comment on the wind farm development with respect to possible impacts to communication links. At that time, no organisation within the 25km radius raised concerns.

Optus, Vodafone and Telstra provided general guidelines to assist in the planning of wind farm.

In response to these enquiries, the following comments were noted,

> *"Provided wind turbines are located well outside the 2nd Fresnel zone of the point to point microwave links, no interference to communications is expected" (pers. comm. Mr. Trong Ho, Optus Mobile)*(Taurus Energy, 2006*)*
>
> *"Clearance criteria is the same for all carriers. Please use the same criteria as proposed by Optus" (pers. comm. Mr. Ganesh Ganeswaran, Senior Engineer / Transmission, AAP Communications Services 22/11/05)*
>
> *"Provided wind turbines are greater than 100 m away from Mobile tower (or in the case of directional panel antennae) not in direct line of sight for panel antennas, wind turbines will have minimal effect on existing coverage." (pers. comm. Mr. Ivan D'Amico, Area Team Manager (Country) - NSW&ACT, Telstra Services, Wireless Access Solutions, Mobile Coverage Delivery)*

The above suggestions have been incorporated in the planning of the Liverpool Range Wind Farm proposal.