Valley of the Winds

APPENDIX I
AVIATION IMPACT ASSESSMENT

RAMBOLL Bright ideas. Sustainable change.

January 2022

AVIATION IMPACT ASSESSMENT

VALLEY OF THE WINDS WIND FARM

Prepared for UPC\AC Renewables

AVIATION PROJECTS

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ACRONYMS

AAAA	Aerial Application Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
CAAP	Civil Aviation Advisory Publications
CAO	Civil Aviation Orders
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
CNS	communications, navigation and surveillance
CTAF	common traffic advisory frequency
DAH	Designated Airspace Handbook
DME	distance measuring equipment
DPIE	Department of Planning, Industry and Environment
ERC-H	en-route chart high

ERC-L	en-route chart low
ERSA	En Route Supplement Australia
GA	general aviation
GNSS	global navigation satellite system
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
LGA	local government area
LSALT	lowest safe altitude
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	non-directional radio beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RNAV	area navigation
RPT	regular public transport
RSR	route surveillance radar
SARPs	standards and recommended practices
VFR	visual flight rules
VFRG	visual flight rules guide
VHF	very high frequency
VOR	VHF omni-directional radio range
VMC	visual meteorological conditions
WMTs	wind monitoring towers

WTGs	wind turbine generators

UNITS OF MEASUREMENT

ft	feet	(1 ft = 0.3048 m)
km	kilometres	(1 km = 0.5399 nm)
m	metres	(1 m = 3.281 ft)
nm	nautical miles	(1 nm = 1.852 km)

DEFINITIONS

Definitions of key aviation terms are included in **Annexure 2**.

NOTES

5 m error budget has been applied for an assessment of the wind turbines maximum height.

EXECUTIVE SUMMARY

Introduction

UPC Renewables Australia Pty Ltd, operating as UPC\AC Renewables Australia (UPC\AC) (the Proponent), proposes to construct and operate the Valley of the Winds wind farm (the project).

The project would consist of approximately 148 wind turbines and supporting infrastructure, including a high voltage transmission line which would run approximately 13 kilometres from the Girragulang Road cluster to a connection point with the Central-West Orana REZ Transmission line proposed by TransGrid and the NSW Government. The project would supply approximately 800 megawatts (MW) of electricity into the National Electricity Market (NEM).

The wind farm would be located close to the townships of Coolah and Leadville, with the transmission line running generally south to its connection with the Central-West Orana REZ Transmission line. The project would be entirely within the Warrumbungle Local Government Area (LGA).

The project would involve the construction, operation and decommissioning of three clusters of wind turbines, that would be connected electrically. These are:

- Mount Hope cluster – approximately 76 turbines
- Girragulang Road cluster – approximately 51 turbines
- Leadville cluster – approximately 21 turbines.

The capital value of the project would be more than $30 million. Accordingly, the project is a State Significant Development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SR&D) and Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). Under Section 4.12(8) of the EP&A Act, a development application (DA) for SSD must be accompanied by an environmental impact statement (EIS) that is lodged with the NSW Department of Planning, Industry and Environment for Development Consent.

The project was also referred to the Commonwealth Department of Agriculture, Water and the Environment for potential impacts to matters of national environmental significance protected by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). On 13 July 2020, a delegate of the Federal Minister for the Department of Agriculture, Water and the Environment determined that the project was a controlled action under section 75 of the EPBC Act and therefore requires assessment and approval under the EPBC Act. This assessment is to be undertaken under the *Amended Bilateral Agreement* between the Department of Agriculture, Water and the Environment and the Department of Planning, Industry and Environment.

This report has been prepared to inform the environmental impacts statement (EIS) and development application (DA) for the project.

Project description

The project includes the following key components:

- Approximately 148 wind turbines with a maximum tip height of 250 metres and a hardstand area at the base of each turbine
    - Electrical infrastructure, including:
        - substations in each cluster and a step-up facility at the connection to the Central-West Orana REZ Transmission line
        - underground 33 kilovolt electrical reticulation connecting the turbines to the substations in each cluster
        - overhead transmission lines (up to 220 kilovolt) dispatching electricity from each cluster
        - other electrical infrastructure as required including a potential battery energy storage system (BESS)
        - a high voltage transmission line (up to 330 kilovolt) connecting the wind farm to the Central-West Orana Transmission line
- other permanent on-site ancillary infrastructure:
    - permanent operation and maintenance facilities
    - meteorological masts (up to 13)
- access track network:
    - access and egress points to each cluster from public roads
    - operational access tracks and associated infrastructure within each cluster on private property
- temporary construction ancillary facilities:
    - construction compounds
    - laydown areas
    - concrete batching plants
    - quarry sites for construction material (rock for access tracks and hardstands)

Conclusions

Based on a comprehensive analysis and assessment detailed in this report, the following conclusions were made:

Planning considerations

The *Warrumbungle Shire Council Local Environmental* Plan does not incorporate any reference to the development of wind farms or the protection of aeronautical infrastructure.

Certified airports

1. The Project site is located close to the certified Coolah Airport (YCAH). YCAH is approximately 6 km (north) from the nearest WTG MH39.
2. The Project site is beyond 30 nm (55.56 km) of any of the other identified certified airports. The next closest certified airport is Mudgee Airport (YMDG). Mudgee Airport lies approximately 56 km to the south of the closest VotW WF boundary.
3. The Project will not impact the 25 nm MSAs of any certified airport, and therefore there will not be any impacts on the instrument flight procedures.

Obstacle Limitation Surfaces

4. The Project is located outside the horizontal extent of obstacle limitation surface (OLS) for certified airports. Therefore, the Project will have no impact any OLS surfaces.

Aircraft Landing Areas (ALAs)

5. As a guide, an area of interest within a 3 nm radius of an aircraft landing area (ALA) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.
6. A search on OzRunways, which sources its data from Airservices Australia (AIP), returned with 10 nearby ALAs from the Project site.
7. Proposed WTGs are located outside a nominal 3 nm buffer of 7 of the ALAs, so these ALAs will not be impacted by the Project. Ozton Tongy ALA, Coolah ALA and Unknown ALA 1 are the only identified landing areas which has proposed WTGs within the nominal 3 nm buffer around the air strip.
8. The proposed WTGs are located outside the horizontal extent of approach and take-off surfaces at Ozton Tongy ALA, Coolah ALA and Unknown ALA 1. Therefore, the Project will not impact approach and take-off surfaces of the ALA.
9. None of the proposed WTGs are located inside the horizontal extent of indicative flight circuits of Ozton Tongy, Coolah ALA and Unknown ALA 1. Therefore, the flight circuit of these ALAs will not be impacted by the Project.
10. It is likely that the identified ALAs are predominantly used by aerial application operators. The aerial application operators would likely use an abbreviated circuit pattern.
11. All bar 2 of the ALAs are outside the prescribed effect of possible wake turbulence distance (16 times rotor diameter (2880 m) zone).

12. Wake turbulence may affect aircraft operations in the circuit at Coolah ALA and Ozton Tongy ALA.
13. UPC\AC should engage with land hosts and aerial operators of Coolah Airport (YCAH)(Wurrumbungle Shore Council), Ozton Tongy, and Coolah ALA as a courtesy due to the proximity of WTGs.

Air Routes and Lowest Safe Altitude

14. The Project is split between 2 grids. The northern grid has a grid lowest safe altitude of 1646 m AHD (5400 ft AMSL) with a MOC surface of 1341 m AHD (4400 ft AMSL). The southern grid has a grid lowest safe altitude of 1524 m AHD (5000 ft AMSL) with a MOC surface of 1219 m AHD (4000 ft AMSL).
15. The highest WTG, which is MH25, with a maximum overall height of 1028 m AHD (3373 ft AMSL) will be below the LSALT MOC of 4000 ft AMSL by approximately 191 m (627 ft) (using most limiting MOC between the grids).
16. The Project will not impact grid LSALTs.
17. The Project WILL have an impact on nearby designated air routes (W627). W627 has a MOC of 3300 ft and the highest WTG, MH25 is 3373 ft AMSL. W627 MOC will have to increase to 3400 ft to cater for WTG MH25 elevation.

Airspace

18. The Project is located outside of controlled airspace (wholly within Class G airspace).
19. The Project is located with a Danger Area D538B and a Restricted Area R559B.
20. The Project could potentially impact on flight operations within the Danger Area D538B (as vertical flight restrictions are between ground surface and 10,000 ft AMSL). R559B vertical limits do not impinge on the Project.

Aviation Facilities

21. The Project will not penetrate any protection areas associated with aviation facilities.

Radar

22. The closest aviation radar facility is the Mount Sandon SSR, which is located approximately 170 km (92 nm) east of the Project. The second closest radar facility is Mount Boyce RSR, located approximately 179 km (54 97 nm) south of the Project.
23. The Project is located in Zone 4 (accepted zone) and outside the radar line of sight of both radar facilities and will not interfere with the serviceability of the aviation facility. Therefore, it is unlikely that the Project will impact the Mount Sandon SSR or Mount Boyce RSR.

Aviation Impact Statement

24. Based on the Project layout and overall turbine blade tip height limit of 250 m AGL, the blade tip elevation of the highest wind turbine, which is wind turbine MH25, will not exceed 1028 m AHD (3373 ft AMSL).

25. This AIS concludes that the Project:

    a. will not penetrate any OLS surfaces;

    b. will not penetrate any PANS-OPS surfaces;

    c. WILL have an impact on nearby designated air routes (W627);

    d. will not have an impact on the grid LSALT of 5000 ft AMSL and 5400 ft AMSL;

    e. will not have an impact on prescribed airspace;

    f. is wholly contained within Class G airspace;

    g. lies within Danger Area D538B Surface to 10 000 ft. (Military Flying Training);

    h. is outside the clearance zones associated with aviation navigation aids and communication facilities; and,

    i. wake turbulence may affect aircraft operations in the circuit at Coolah ALA and Ozton Tongy ALA.

Obstacle lighting risk assessment

26. Aviation Projects has undertaken a safety risk assessment of the Project and concludes that WTGs and WMTs will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Consultation

27. An appropriate and justified level of consultation was undertaken with relevant parties. Refer to Section 5 for details of the stakeholders consulted and a summary of the consultation.

Summary of key recommendations

A summary of the key recommendations of this AIA is set out below.

The full list of recommendations and associated details are provided in Section 11 'Recommendations' at the end of this report.

1. 'As constructed' details of wind turbine and WMT coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development, using the following email address: land.planning@defence.gov.au;
3. To facilitate the flight planning of aerial application operators, the location and height of WTGs and WMTs should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.
4. UPC\AC should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project, noting that there is no statutory requirement to do so.
5. Details of the final Project layout should be provided to local and regional aircraft operators prior to construction in order for them to plan their operations.
6. The rotor blades, nacelles and towers of the WTGs should be painted in white, typical of most wind turbines operational in Australia.
7. Consideration should be given to marking the temporary and permanent wind monitoring towers according to the requirements set out in Manual of Standards (MOS) 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Aviation marker balls and painting the top 1/3 of WMTs structures in red and white bands is considered to be an acceptable mitigation strategy.

1. INTRODUCTION

1.1. Situation

UPC Renewables Australia Pty Ltd, operating as UPC\AC Renewables Australia (UPC\AC) (the Proponent), proposes to construct and operate the Valley of the Winds wind farm (the project).

The project would consist of approximately 148 wind turbines and supporting infrastructure, including a high voltage transmission line which would run approximately 13 kilometres from the Girragulang Road cluster to a connection point with the Central-West Orana REZ Transmission line proposed by TransGrid and the NSW Government. The project would supply approximately 800 megawatts (MW) of electricity into the National Electricity Market (NEM).

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This report has been prepared to inform the environmental impacts statement (EIS) and development application (DA) for the project.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and progress any ongoing dialogue through the planning process.

The assessment specifically responds to the:

- Environmental Planning and Assessment Act 1979
- National Airports Safeguarding Framework (NASF) Guideline D: Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers.

Assistance will be provided in support of stakeholder consultation and engagement in preparing the assessment and negotiating acceptable mitigation to identified impacts.

1.3. Methodology

Aviation Projects conducted the task in accordance with the following methodology:

- confirm the scope and deliverables with UPC\AC
- review client material
- conduct a site visit to properly investigate aviation safety aspects of the proposal
- review relevant regulatory requirements and information sources
- prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA report includes an AIS and a qualitative risk assessment to determine need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators
- identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management –Guidelines*
- consult with relevant Council(s), Part 173 procedure designers and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
- consult/engage with stakeholders to negotiate acceptable outcomes (if required)
- finalise the AIA report for client acceptance when response received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement

The AIS includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.56 km) of the Project
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s)

Air Routes:

- Nominate air routes published in ERC-L & ERC-H which are located near/over the Project and review potential impacts of Project operations on aircraft using those air routes
- Specify two waypoint names located on the routes which are located before and after the obstacles

Airspace:

- Nominate the airspace classification – A, B, C, D, E, G etc where the Project is located

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by UPC\AC for preparation of this assessment included:

- NSW Government, Planning Secretary's Environmental Assessment Requirements, dated 09/06/2020.
- UPC\AC Scoping Report, dated May 2020
- UPC\AC Dataroom file folder received via email 17 November 2021
- Ramboll_VoW_ProjectBoundary_20210830.shp
- Ramboll_VoW_TxLOverhead_20211001.shp
- VoW_18019_MGA2055_Elevations[32].xls (received 24 November 2021)
- VoW_18019_TMM.kmz (received 24 November 2021)
- VoW_18019_PMM.kmz (received 24 November 2021)
- VoW_18019_148wtg.kmz (received 24 November 2021)
- Project description and reference terms for specialist reports_v3[2] (received 03 December 2021)

2. BACKGROUND

2.1. Site overview

The project location is shown in Figure 1 (source: UPC\AC, Google Earth). Land surrounding the wind farm site is characterised by rolling pastoral hills, open flat valleys and ridgelines with scattered vegetation. The hill slopes are generally gentle in gradient and predominantly cleared of vegetation, except for patches of denser remnant vegetation on steeper terrain, near rocky outcrops and between saddles.

The townships of Coolah and Leadville are the closest population centres to the proposed site. These townships are located on gently sloping to level land within valleys near creeks. Most built structures are of low to moderate scale. The main street of Coolah is the focus for local retail and community services in the local area.

Land uses within the locality include:

- farming – predominantly grazing cattle and sheep, with small patches of cropping (cereal and fodder)
- rural living – scattered rural dwellings and sheds present throughout the landscape, with a higher density of dwellings in the townships.

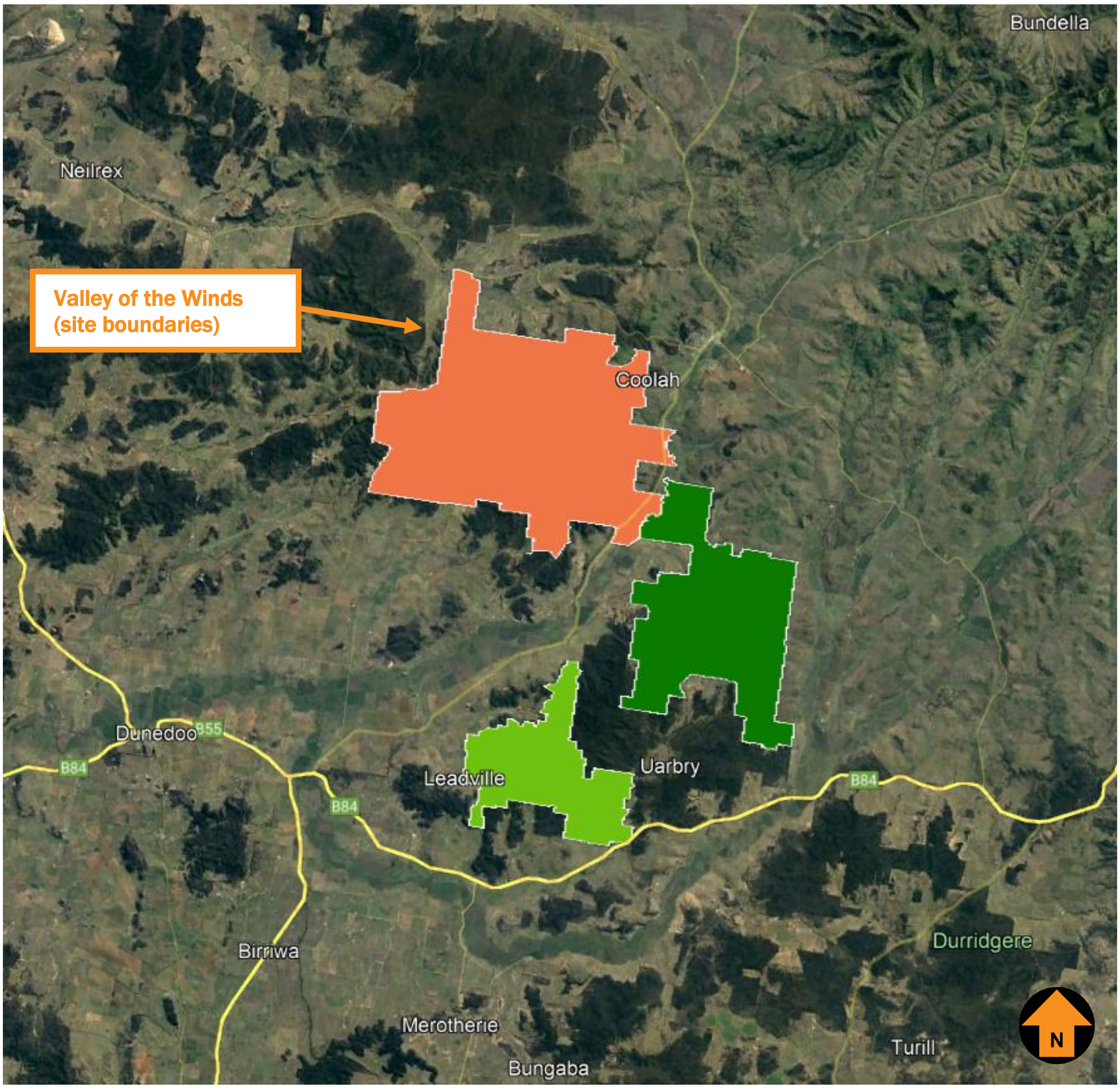

Figure 1 Project site overview

Figure 2 shows the boundaries and WTGs of the Project.

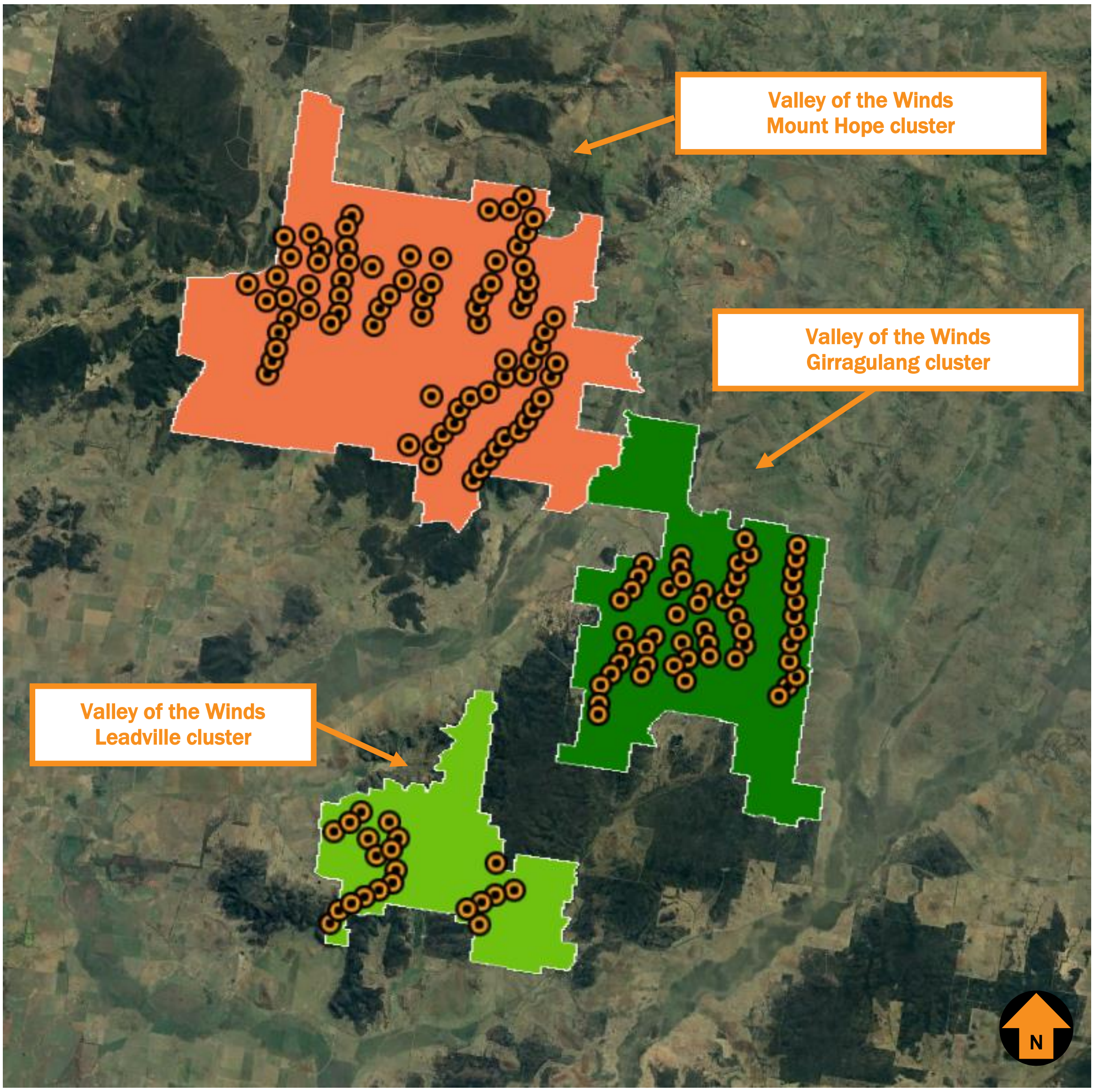

Figure 2 Project layout

2.2. Project description

The project would involve the construction, operation, and decommissioning of three clusters of wind turbines that will be connected electrically. These are:

- Mount Hope cluster – approximately 76 turbines
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The project includes the following key components:

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- temporary construction ancillary facilities:
    - construction compounds
    - laydown areas
    - concrete batching plants
    - quarry sites for construction material (rock for access tracks and hardstands)

Figure 3 shows the location of the Project site within the boundaries of Warrumbungle Shire Council and bordering the Upper Hunter Shire Council and Mid-Western Regional Council LGAs (source: Google Earth).

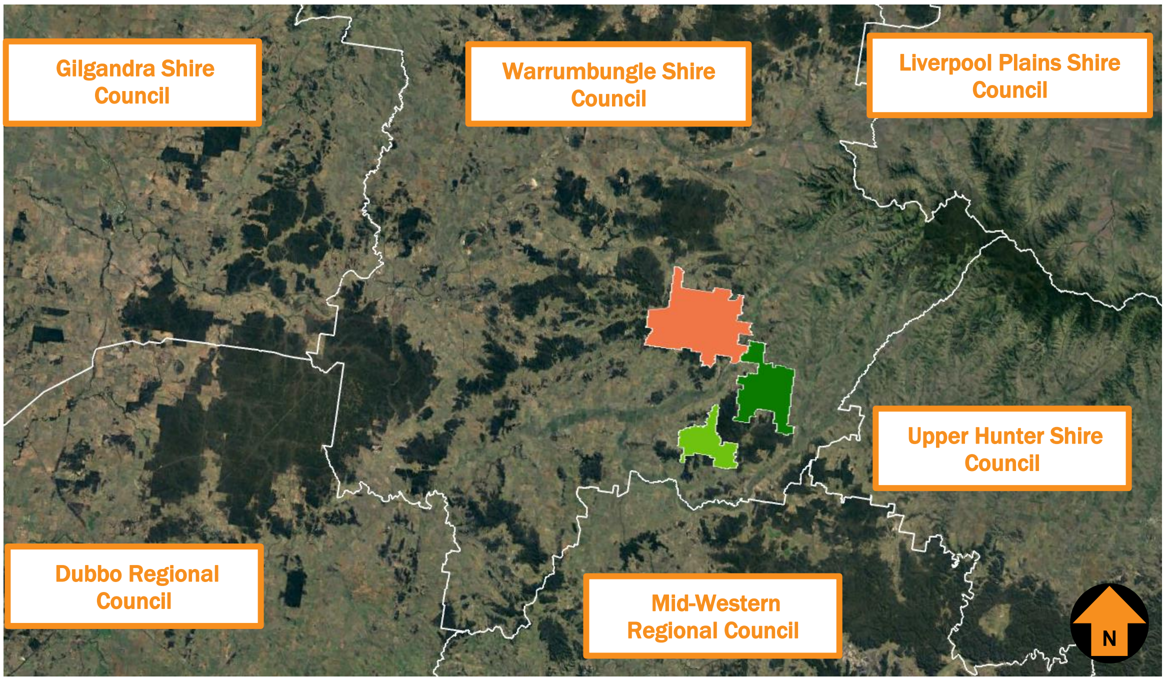

Figure 3 Project layout relative to LGAs

3. EXTERNAL CONTEXT

3.1. Planning context

UPC\AC seeks to increase wind power production while protecting individuals, communities, and the environment from adverse impacts from wind farms by complying with the NSW *Wind Energy Guideline for State significant wind energy developmen*t (2016).

The role of the NSW DPIE is to coordinate the planning process according to the applicable regulations, and in partnership with individual people, community groups, businesses and industry groups, other organisations, local councils, and State and Commonwealth Government agencies. The legal framework includes the *Environmental Planning and Assessment Act 1979* and *Environmental Planning and Assessment Regulation 2000*. Development projects such as wind farms in NSW must submit a development application for approval by the Minister for Planning and Public Spaces.

The Secretary's Environmental Assessment Requirements (SEARS) for the project relevant to this study are copied below for ease of reference:

> *Hazards and Risks – the EIS must include an assessment of the following:*
>
> - *Aviation Safety:*
>
> *- assess the impact of the development under the National Airports Safeguarding Framework Guideline D: Managing Wind Turbine Risk to Aircraft;*
>
> *- provide associated height and co-ordinates for each turbine assessed;*
>
> *- assess potential impacts on aviation safety, including cumulative effects of wind farms in the vicinity, potential wake / turbulence issues, the need for aviation hazard lighting, considering, defined air traffic routes, aircraft operating heights, approach / departure procedures, radar interference, communication systems, navigation aids;*
>
> *- identify aerodromes within 30 km of the turbines and consider the impact to nearby aerodromes and aircraft landing areas;*
>
> *- address impacts on obstacle limitation surfaces; and*
>
> *- assess the impact of the turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the turbines and transmission line;*
>
> - *Bushfire - identify potential hazards and risks associated with bushfires / use of bushfire prone land, including the risks that a wind farm would cause bush fire and any potential impacts on the aerial fighting of bush fires and demonstrate compliance with Planning for Bush Fire Protection 2019;*

3.2. National Airports Safeguarding Framework

The National Airports Safeguarding Advisory Group (NASAG) was established by the Commonwealth Department of Infrastructure and Transport to develop a national land use planning framework called the National Airports Safeguarding Framework (NASF). The purpose of this framework is to enhance the current and future safety, viability, and growth of aviation operations at Australian airports through:

- the implementation of best practice in relation to land use assessment and decision making in the vicinity of airports
- assurance of community safety and amenity near airports
- better understanding and recognition of aviation safety requirements and aircraft noise impacts in land use and related planning decisions
- the provision of greater certainty and clarity for developers and landowners
- improvements to regulatory certainty and efficiency
- the publication and dissemination of information on best practice in land use and related planning that supports the safe and efficient operation of airports.

NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers*, provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and wind monitoring towers.

The methodology for preparing the risk assessment is contained in the NASF Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*.

The risk assessment will have regard to all potential aviation activities within the vicinity of the Project site including recreation, commercial, civil (including for agricultural purposes) and military operations.

The AIS of this report identifies high level risks, risk mitigation measures and development constraints that are likely to be applicable to the aviation risk assessment.

3.3. Warrumbungle Shire Council

The Warrumbungle *Environmental Plan 2013* (current version dated 14 July 2021) does not include any reference to airports, aerodromes, or other aviation facilities. Nor does it refer to the development of wind farms or other renewable energies.

3.4. Mid-Western Regional Council

The Mid-Western *Environmental Regional Environment Plan 2012* (current version dated 14 July 2021) para 6.8 states,

> *6.8 Airspace operations—Mudgee Airport*
>
> *(1) The objectives of this clause are as follows—*
>
> *(a) to provide for the effective and ongoing operation of the Mudgee Airport by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or Operations Surface for that airport,*
>
> *(b) to protect the community from undue risk from that operation.*
>
> *….(a) the development will penetrate the Limitation or Operations Surface but it has no objection to its construction, or*

(b) the development will not penetrate the Limitation or Operations Surface.

(4) The consent authority must not grant development consent for the development if the relevant Commonwealth body advises that the development will penetrate the Limitation or Operations Surface and should not be constructed.

VotW WF is outside the interest of Mudgee Aerodrome.

3.5. Upper Hunter Shire Council

The *Upper Hunter Environmental Plan 2013* (current version dated 14 July 2021) para 6.7 and 6.8 states,

6.7 Airspace operations

(1) The objectives of this clause are as follows—

(a) to provide for the effective and ongoing operation of the Scone Memorial Aerodrome by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or Operations Surface for that airport,

...(b) the development will not penetrate the Limitation or Operations Surface.

6.8 Development in areas subject to aircraft noise

(1) The objectives of this clause are as follows—

(a) to prevent certain noise sensitive developments from being located near the Scone Memorial Aerodrome and its flight paths,

(b) to assist in minimising the impact of aircraft noise from that airport and its flight paths by requiring appropriate noise attenuation measures in noise sensitive buildings,

(c) to ensure that land use and development in the vicinity of that airport do not hinder or have any other adverse impacts on the ongoing, safe and efficient operation of that airport.

VotW WF is outside the interest of Scone Aerodrome.

3.6. Aircraft operations at non-controlled aerodromes

Civil Aviation Advisory Publications (CAAP) provide guidance, interpretation, and explanation on complying with the Civil Aviation Regulations 1988 (CAR) or Civil Aviation Orders (CAO). CAAP 166-01 v4.2 – *Operations in the vicinity of non-controlled aerodromes* – provides guidance with respect to CAR 166. The purpose of this CAAP is to support Common Traffic Advisory Frequency (CTAF) procedures. It provides guidance on a code of conduct (good airmanship) to allow flexibility for pilots when flying at, or in the vicinity of, non-controlled aerodromes.

CAAP 166-01 v4.2 paragraph 2.1.4 states the following:

2.1.4 CASA strongly recommends the use of 'standard' traffic circuit and radio broadcast procedures by radio-equipped aircraft at all non-controlled aerodromes. These procedures are described in the Aeronautical Information Publication (AIP) and Visual Flight Rules Guide (VFRG), and discussed in Section 5 of this CAAP (Standard traffic circuit procedures) and Section 7 (Radio broadcasts).

The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures are provided in Figure 4 and Figure 5.

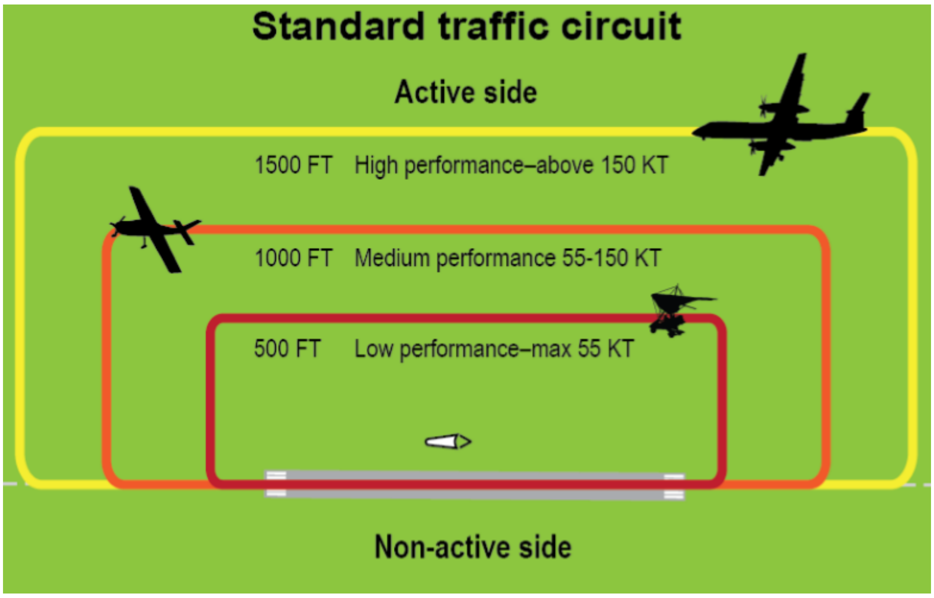

Figure 4 Lateral and vertical separation in the standard aerodrome traffic circuit

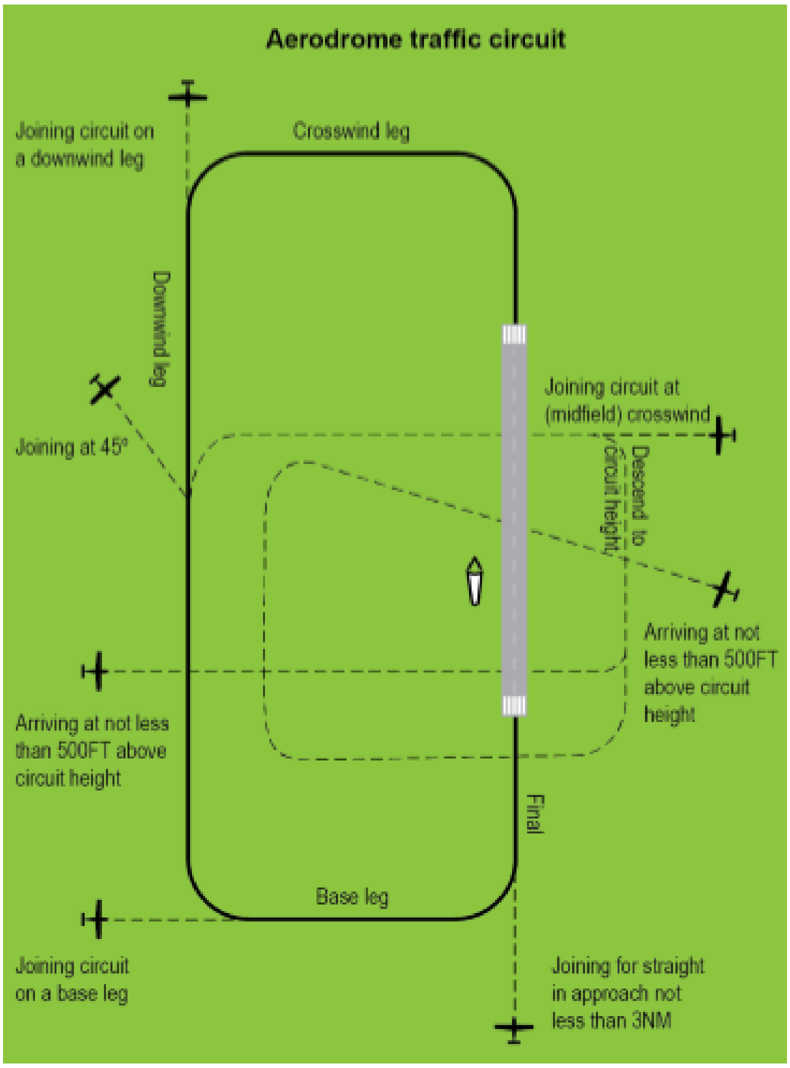

Figure 5 Aerodrome standard traffic circuit, showing arrival and joining procedures

CAAP 166-01 v4.2 paragraph 5.4.1 refers to a distance that is "normally" well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *5.4 Departing the circuit area*
>
> *5.4.1 Aircraft should depart the aerodrome circuit area by extending one of the standard circuit legs or climbing to depart overhead. However, the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 NM from the departure end of the runway, but may be less for aircraft with high climb performance. In all cases, the distance should be based on the pilot's awareness of traffic and the ability of the aircraft to climb above and clear of the circuit area.*

3.7. Rules of flight

3.7.1. Flight under Day Visual Flight Rules (VFR)

According to Aeronautical Information Publication (AIP) the meteorological conditions required for visual flight in the applicable (Class G) airspace at or below 3000 ft AMSL or 1000 ft AGL whichever is the higher are: 5000 m visibility, clear of clouds and in sight of ground or water.

Civil Aviation Regulation (1988) 157 (Low flying) prescribes the minimum height for flight. Generally speaking, aircraft are restricted to a minimum height of 500 ft AGL above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas, and 1000 ft AGL over built up areas.

These height restrictions do not apply if through stress of weather or any other unavoidable cause it is essential that a lower height be maintained.

Flight below these height restrictions is also permitted in certain other circumstances.

3.7.2. Night VFR

With respect to flight under the VFR at night, Civil Aviation Regulations (1988) 174B states as follows:

The pilot in command of an aircraft must not fly the aircraft at night under the V.F.R. at a height of less than 1000 feet above the highest obstacle located within 10 miles of the aircraft in flight if it is not necessary for take-off or landing.

3.7.3. Instrument Flight Rules (Day or night) (IFR)

According to CAR 178, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method. Obstacle lights on structures not within the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR.

3.8. Aircraft operator characteristics

Flying training may be conducted under either the instrument flying rules (IFR) or visual flying rules (VFR). Other general aviation operations under either IFR or VFR are also likely to be conducted at various aerodromes in the area.

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 600 m horizontal distance. In VMC, the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project once wind turbines are erected.

Flight under day VFR is conducted above 500 ft (152.4 m) above the highest point of the terrain within a 600 m radius (300 m for helicopters) unless the operation is approved to operate below 500 ft above the highest point of the terrain.

It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project to enable appropriate obstacle avoidance manoeuvring.

IFR and Night VFR (which are required to conform to IFR applicable altitude requirements) aircraft operations are addressed in Section 6.

3.9. Passenger transport operations

Regular public transport (RPT) and passenger carrying charter operations are generally operated under the IFR.

3.10. Private operations

Private operations are generally conducted under day or night VFR, with some IFR. Flight under day VFR is conducted above 500 ft AGL.

3.11. Military operations

There may be some high-speed low-level military jet aircraft and helicopter operations conducted in the area.

3.12. Aerial application operations

Aerial agricultural operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL; usually between 6.5 ft (2 m) and 100 ft (30.5 m) AGL.

Aerial application operations are conducted in the area.

Due to the nature of the operations conducted, aerial agriculture pilots are subject to rigorous training and assessment requirements to obtain and maintain their licence to operate under these conditions.

The Aerial Application Association of Australia (AAAA) has a formal risk management program which is recommended for use by its members.

The impact of the proposed turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the Project will be assessed during stakeholder consultation.

Landowner comments about potential impacts to their operations are provided in Section 5.

3.13. Aerial Application Association of Australia

In previous consultation with the AAAA, Aviation Projects has been directed to the AAAA Windfarm Policy (dated March 2011) which states in part:

> *As a result of the overwhelming safety and economic impact of wind farms and supporting infrastructure on the sector, AAAA opposes all wind farm developments in areas of agricultural production or elevated bushfire risk.*
>
> *In other areas, AAAA is also opposed to wind farm developments unless the developer is able to clearly demonstrate they have:*
>
> > *1. consulted honestly and in detail with local aerial application operators;*
> >
> > *2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development;*

> *3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;*
>
> *4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and*
>
> *5. adequately marked any wind farm infrastructure and advised pilots of its presence.*

AAAA had developed National Windfarm Operating Protocols (adopted May 2014). These protocols note the following comments:

> *At the development stage, AAAA remains strongly opposed to all windfarms that are proposed to be built on agricultural land or land that is likely to be affected by bushfire. These areas are of critical safety importance to legitimate and legal low-level operations, such as those encountered during crop protection, pasture fertilisation or firebombing operations.*
>
> *However, AAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAA has developed the following national operational protocols to support a consistent approach to aerial application where windfarms are in the operational vicinity.*

The protocols list considerations for developers during the design/build stage and the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included in the Protocols document as Appendix 1, and AAAA Aerial Application Pilots Manual – excerpts on planning are provided as Appendix II.

3.14. Local aerial application operators

Local aerial application operators consulted in previous studies undertaken by Aviation Projects have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, but that properties adjacent to the wind farm would have to be assessed on an individual basis.

Aerial application operators generally align their positions with the AAAA policies.

Based on previous studies undertaken by Aviation Projects, and subject to the results of consultation with AAAA and any further consultation with local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Project site and neighbouring the Project site, subject to final turbine locations and by implementing recommendations provided in this report.

The use of helicopters enables aerial application operations to be conducted in closer proximity to obstacles than would be possible with fixed wing aircraft due to their greater manoeuvrability.

To facilitate the flight planning of aerial application operators, details of the proposal, including location and height information of wind turbines, wind monitoring towers and overhead powerlines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Aerial application operator comments about potential impacts to their operations are provided in Section 5.

3.15. Aerial firefighting

Aerial firefighting operations (firebombing in particular) are conducted in Day VFR, sometimes below 500 ft AGL. Under certain conditions visibility may be reduced/limited by smoke/haze.

Most aerial firefighting organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained. For example, pilots require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

The Australasian Fire and Emergency Services Council (AFAC) developed a national position on wind turbines: *Wind Farms and Bush Fires Operations*, version 3.0, dated 25 October 2018.

Of specific interest in this document is the paragraph copied from the Response section, copied below:

> *The developer or operator should ensure that:*
>
> - *liaison with the relevant fire and land management agencies is ongoing and effective*
> - *access is available to the wind farm site by emergency services response for on-ground firefighting operations*
> - *wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.*
>
> *Aerial personnel should assess risks posed by aerial obstacles, wake turbulence and moving blades in accordance with routine procedures.*

3.16. Emergency services - Royal Flying Doctor Service

Royal Flying Doctor Service (RFDS) and other emergency services operations are generally conducted under the IFR, except when arriving/departing a destination that is not serviced by instrument approach aids or procedures.

Most emergency aviation services organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

For example, pilots and crew require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

4. INTERNAL CONTEXT

4.1. Wind farm site description

Land surrounding the wind farm site is characterised by rolling pastoral hills, open flat valleys and ridgelines with scattered vegetation. The hill slopes are generally gentle in gradient and predominantly cleared of vegetation, except for patches of denser remnant vegetation on steeper terrain, near rocky outcrops and between saddles.

The townships of Coolah and Leadville are the closest population centres to the proposed site. These townships are located on gently sloping to level land within valleys near creeks. Most built structures are of low to moderate scale. The main street of Coolah is the focus for local retail and community services in the local area.

Land uses within the locality include:

- Farming – predominantly grazing cattle and sheep, with small patches of cropping (cereal and fodder)
- Rural living – scattered rural dwellings and sheds present throughout the landscape, with a higher density of dwellings in the townships.

Images of the site taken from locations noted in the figure titles are provided at Figure 6 and Figure 7.

Figure 6 Image taken from Mt Hope cluster facing southwest

Figure 7 Aerial image over Girragulang cluster facing northeast

4.2. Wind turbine description and layout

The maximum turbine tip height of the proposed wind turbines will be up to 250 m AGL.

The maximum ground elevation for the proposed wind turbine MH25 is 773 m AHD, which results in a maximum overall height of 1028 m AHD (3373 ft AMSL) including a 5 m error budget.

Figure 8 shows the Project layout and site boundaries identifying the highest wind turbine MH25 (source: UPC\AC, Google Earth).

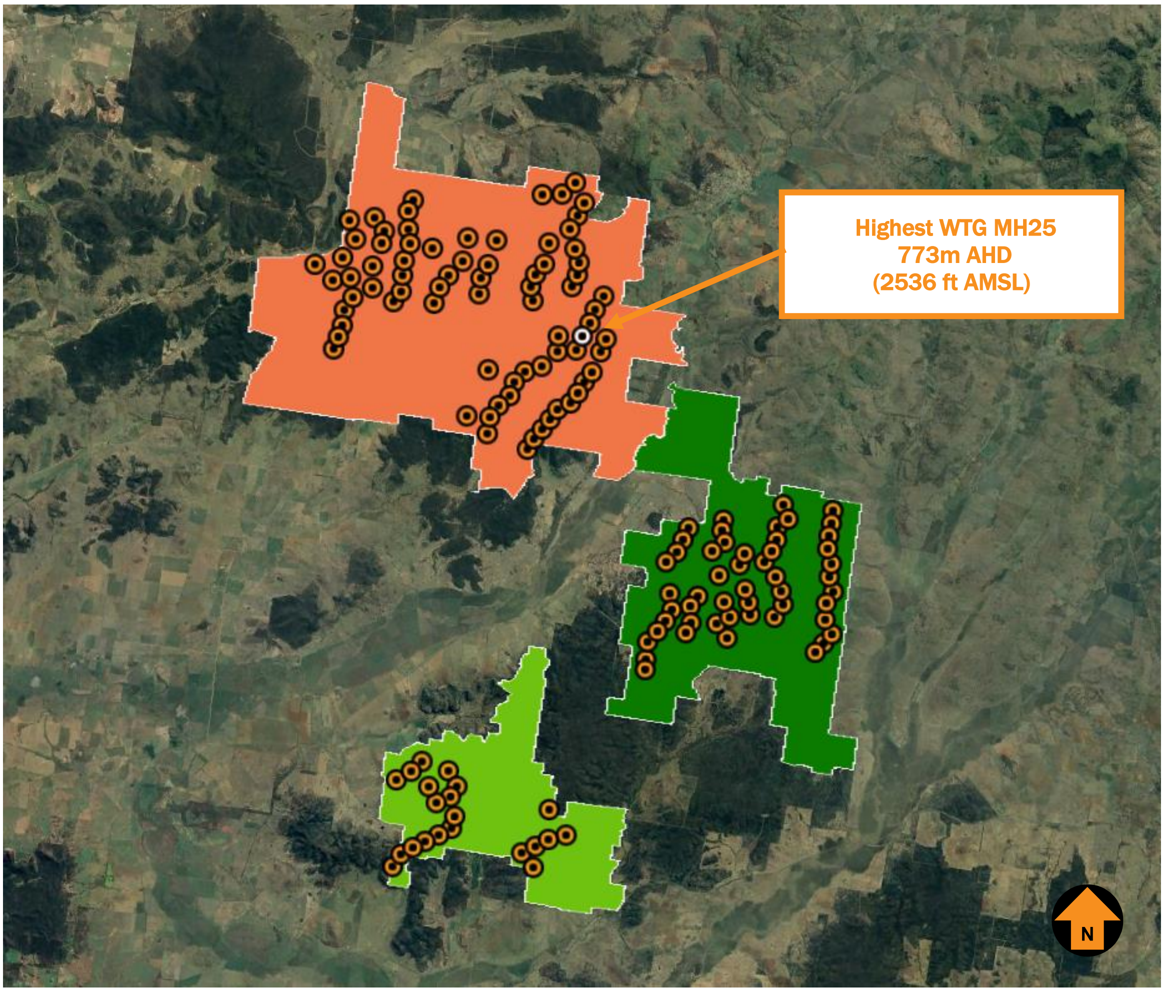

Figure 8 Project layout and highest wind turbine

The coordinates and ground elevations of the proposed wind turbines are listed in Annexure 3.

4.3. Wind monitoring tower description

There are 13 permanent WMT, and 15 temporary WMTs at 150m high. Locations are shown as yellow and green triangles in Figure 9 (source: UPC\AC, Google Earth).

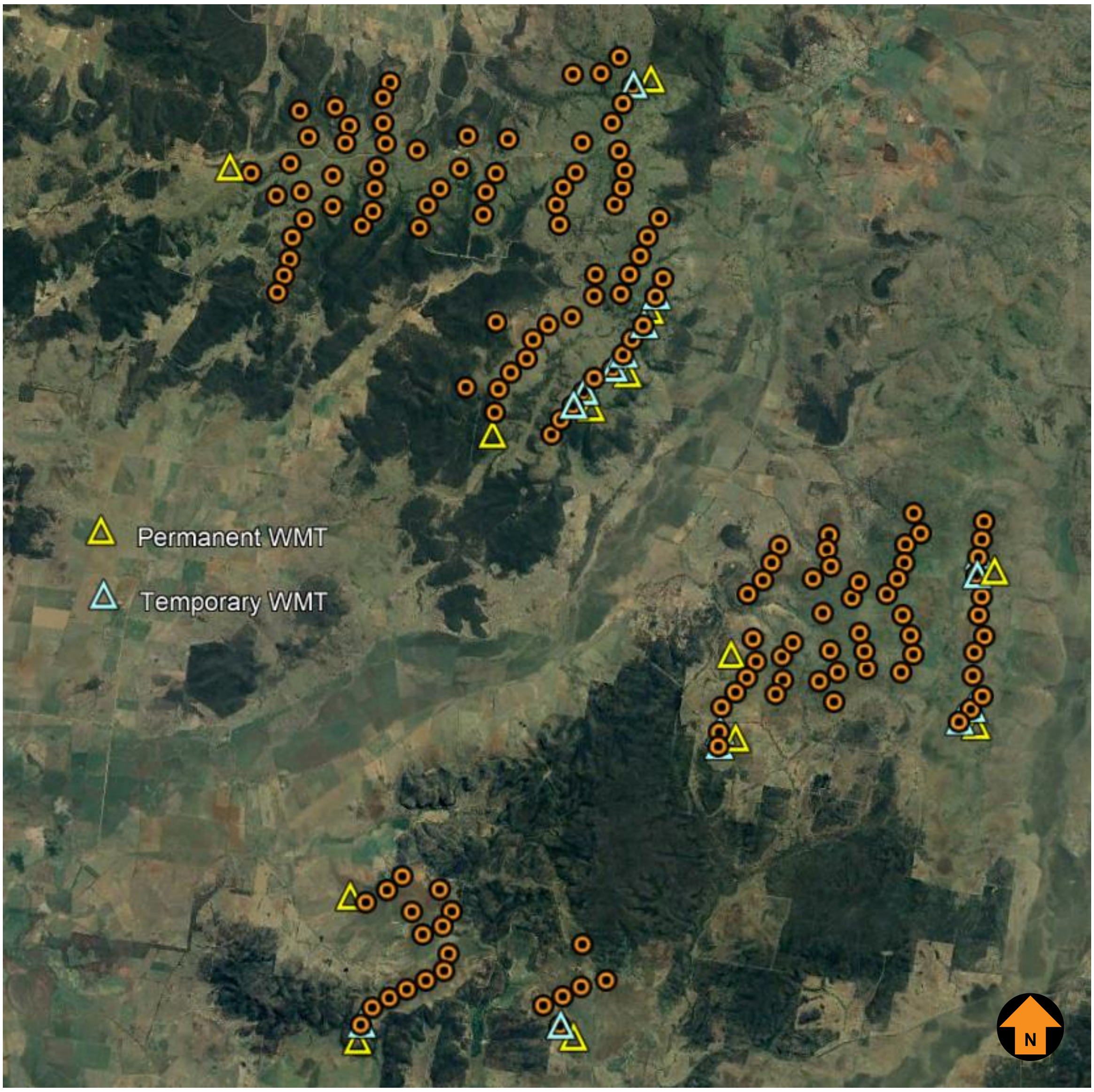

Figure 9 Temporary and Permanent WMT locations

4.4. Overhead transmission line

The proposed overhead transmission lines (up to 330Kv) will dispatch electricity from each cluster and connecting clusters (Mount Hope to Girragulang Road). Also potentially connecting the Leadville cluster to the Girragulang Road high voltage transmission line.

The proposed high voltage (up to 500Kv) overhead transmission line(s) will connect the wind farm to the Central-West Orana Transmission line

Figure 10 shows the alignment of the overhead transmission lines in white colour (source: UPC\AC, Google Earth).

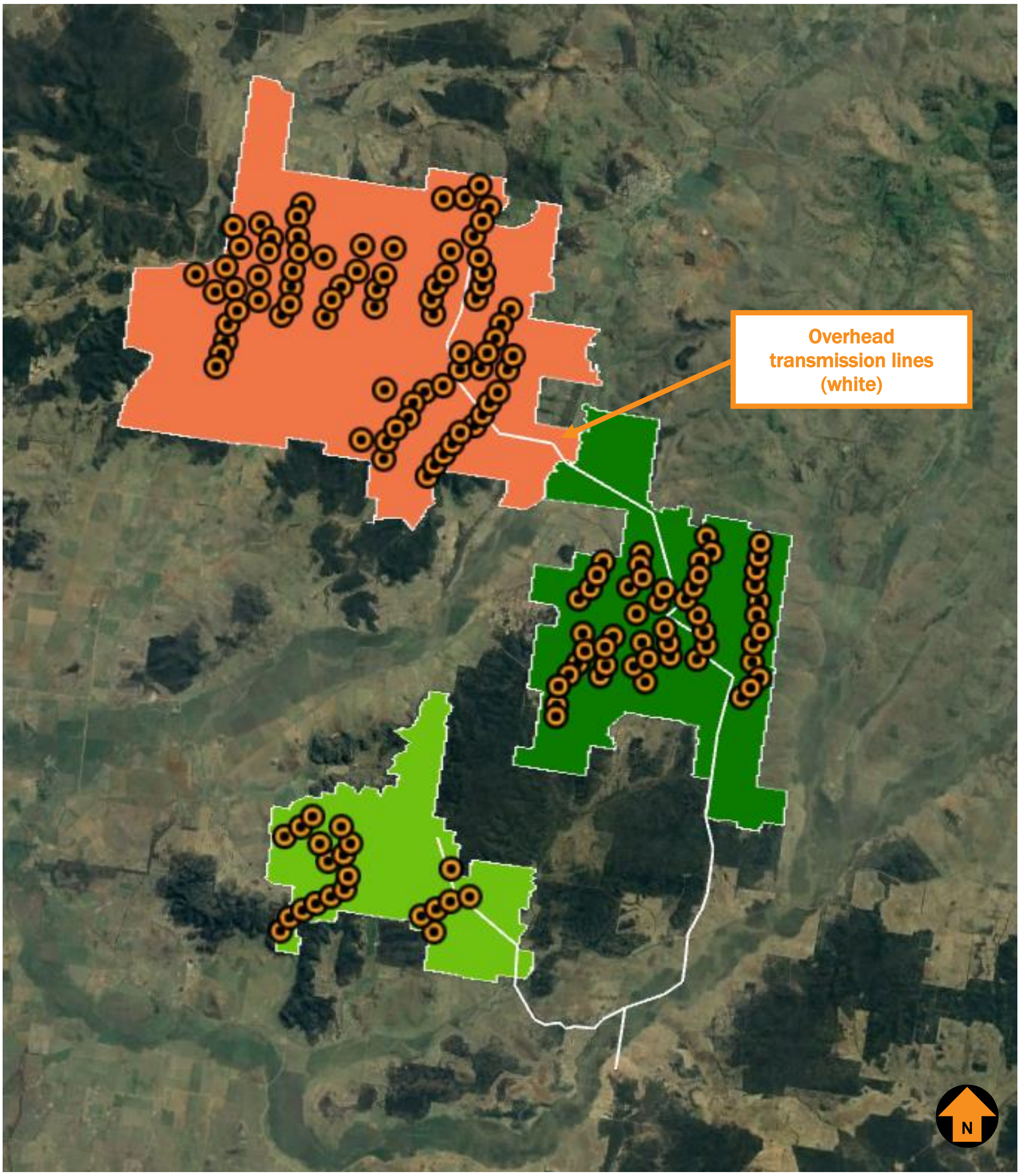

Figure 10 Overhead transmission lines

5. CONSULTATION

The stakeholders consulted include:

- Airservices Australia
- Civil Aviation Safety Authority
- Department of Defence
- NSW Rural Fire Service
- Coolah Airport (YCAH) (Warrumbungle Shire Council)
- Royal Flying Doctor Service
- Coolah ALA

Details and results of the consultation activities are provided in Table 1.

Table 1 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	Email sent 10 September 2021	15 October 2021 – William Zhao (Advisor Customer Engagement)	*…Summary* *Based on the above assessment, our view is that the proposed Valley of the Winds Wind Farm would have an* ***impact*** *on the Airservices designed air routes.* *If you wish to proceed with this proposal, we request that you consult with us further to arrange a commercial agreement to make the amendments to the air routes. Note that the changes to the Aeronautical Information Package (AIP) chart is dependent on the publication cycle, for this particular change, we will need at least a minimum of 7 month lead time.*	1. Commercial agreement required to amend air route LSALT. 2. Completes the Vertical Obstacle Notification Form and submit to VOD@airservicesaustralia.com
CASA	CASA has advised that it will only review assessments referred to it by a planning authority or agency.			No further action required
Department of Defence	Email sent 10 September 2021	Reminder email sent 08 November 2021	Nil response from Defence. Defence has previously responded to other wind farm projects noting the following around obstacle lighting compatibility - *…The proposed structures will meet the above definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com.* *Defence understands this assessment is yet to be considered by CASA. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons*	*If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres.*

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres. *Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.* *.... Defence has no objection to the proposed wind farm provided that the project complies with the above conditions.*	
NSW RFS	Email sent 10 September 2021	Reminder email sent 08 November 2021	Nil response	No further action required.
Coolah Airport (YCAH) Warrumbungle Shire Council	Email sent 10 September 2021	Reminder email sent 08 November 2021	Replied 11 January 2022 Kevin Tighe (Manager Special Projects and Infrastructure) replied – *...The impact of the Valley of the Winds development on the Coolah Aerodrome should take into consideration current and future operations at the aerodrome. There is no regular passenger transport service at Coolah aerodrome and no regular commercial flights. The aerodrome is predominantly used as a landing area by small privately owned aeroplanes and it is occasionally used for crop dusting operations. The Coolah*	No further action required.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			aerodrome is also used by air ambulance operators for collection or delivery of patients to the Coolah hospital.	
RFDS	Email sent 10 September 2021	13 September 2021	Positive phone discussion with RFDS Mark Woods (13 September 2021). Nil further response.	No further action required.

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The Project site is located close to the certified Coolah Airport (YCAH). YCAH is approximately 6 km (north) from the nearest WTG MH39.

The next closest certified airport is Mudgee Airport (YMDG). Mudgee Airport lies approximately 56 km to the south of the closest VotW WF boundary.

The next 4 closest certified airports are:

- Coonabarabran (YCBB) approximately 60 km to the north from the nearest boundary of VotW WF
- Quirindi (YQDI) approximately 89 km to the north-east from the nearest boundary of VotW WF
- Dubbo (YSDU) approximately 95 km to the west from the nearest boundary of VotW WF
- Scone (YSCO) approximately 100 km to the east from the nearest boundary of VotW WF.

The location of the Project location relative to Coolah, Mudgee, Coonabarabran, Quirindi, Dubbo and Scone certified airports are shown in Figure 11 (source: UPC\AC, Google Earth).

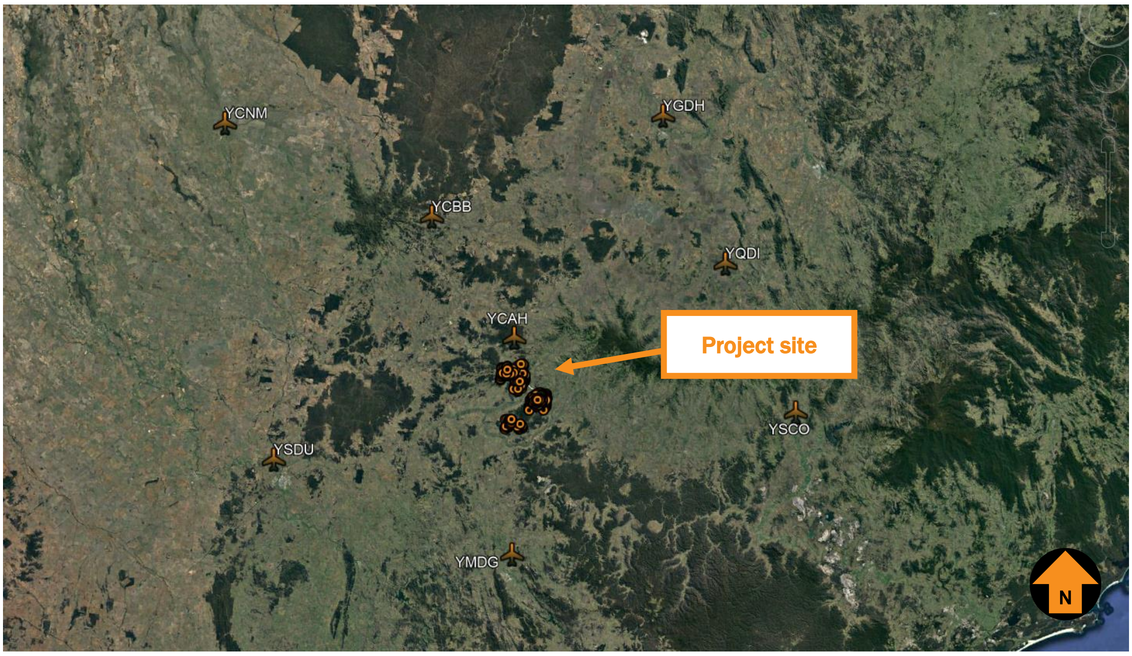

Figure 11 Project sites relative to nearby certified airports

Figure 12 shows buffer areas of 25 nm MSA (+5 nm buffer) of nearby certified airports (source: UPC\AC, Google Earth).

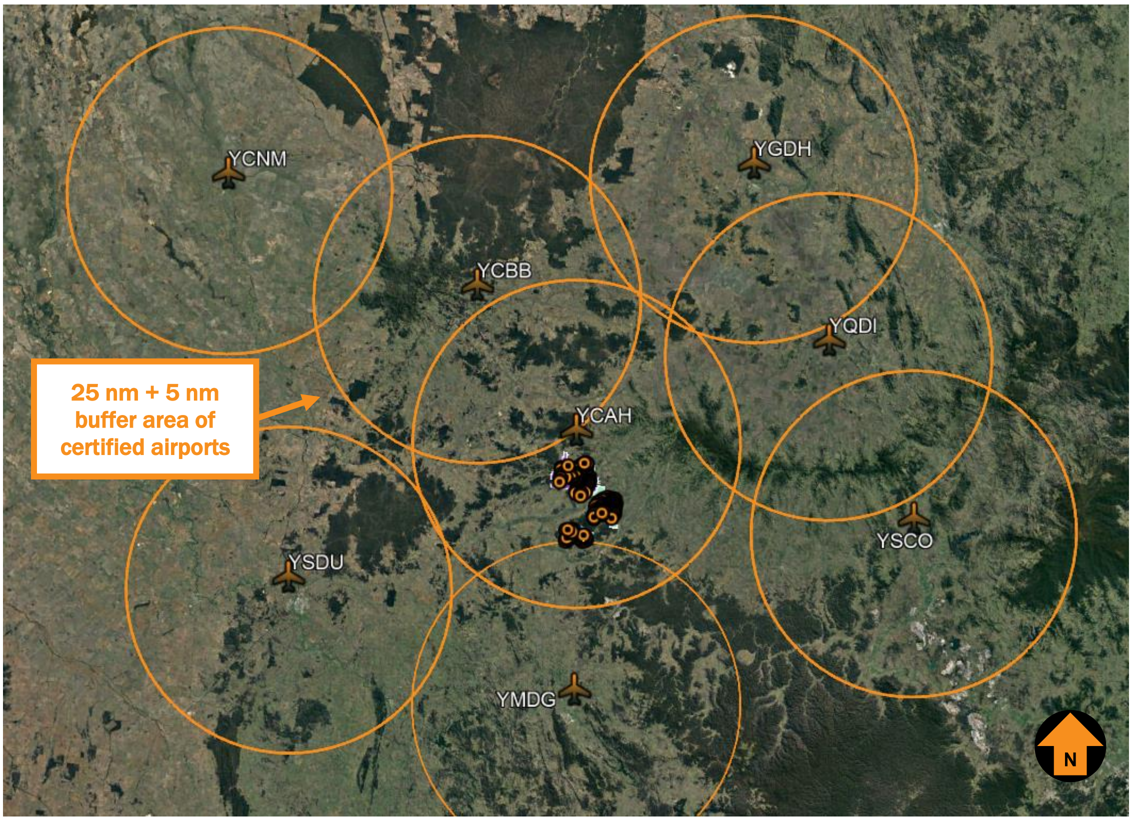

Figure 12 MSA buffer areas relative to the Project sites

Based on the distance between the nearest certified airports and the Project, it can be seen YCAH penetrates the 30 nm range circles. YMCG appears close however does not impinge on a WTG. Figure 13 refers.

Figure 13 – Mudgee Airport sits outside 30 nm from VofW WF nearest WTG.

Mudgee Airport is not impacted by the Project.

Coolah Airport (YCAH) is a certified Code 2 non-instrument airport, operated by Warrumbungle Shire Council, with a published aerodrome elevation of 1654 ft (source: Airservices Australia (AsA), FAC 17 June 2021).

Coolah Airport has one runway:

- runway 08/26 is a brown gravel grass runway 1074 m x 30 m and runway strip 90 m.

Figure 14Figure 14 shows the runway details of Coolah Airport (YCAH) (source: AsA, FAC 17 June 2021).

AIP Australia | 17 JUN 2021 | FAC YCAH - 1

COOLAH **ELEV 1654**

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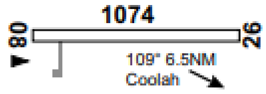

NSW | UTC +10 | YCAH
314624S | 1493634E | VAR 11 DEG E | CERT

AD OPR Warrumbungle Shire Council, PO Box 191, Coonabarabran, NSW, 2357. PH 02 6849 2000: AD Manager 0429 771 758. Fax 6842 1337.

PHYSICAL CHARACTERISTICS

08/26 079 35c 5700/450 (65PSI) Brown gravel grass. WID 30 RWS 90

ATS COMMUNICATIONS FACILITIES

FIA BRISBANE CENTRE 127.1 Circuit area

ADDITIONAL INFORMATION

Animal and bird hazard exists. Kangaroos are likely at dusk and at night.

CTAF 126.7

CHARTS RELATED TO THE AERODROME

WAC 3356, 3357.

Figure 14 Coolah Airport (YCAH) FAC page

Coolah Airport Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's Designated Airspace Handbook (DAH) are Latitude 31°46'24"S and Longitude 149°36'34"E.

6.2. Instrument procedures

Coolah Airport (YCAH) is not served by any instrument procedures.

The Project site is not impacted by minimum obstacle clearances associated with such procedures.

6.3. Circling areas

Not applicable to non-instrument runways, therefore the project will not impact Coolah Airport in this respect.

6.4. PANS-OPS surfaces – Coolah Airport

Coolah Airport is not served by instrument or non-precision approach procedures therefore there are no PANS-OPS surfaces.

6.5. Obstacle limitation surfaces

For a Code 2 non-instrument runway the inner horizontal and approach surfaces extend up to 2,500 m (MOS Part 139).

VotW WF closest WTG MH39 is 6 km to the south and will therefore have no impact on any airport obstacle limitation surfaces.

As Coolah Airport is non-instrument and satisfies the OLS, an area of interest within a 3 nm radius can be assessed for potential impacts of proposed developments on aircraft operations at or within the vicinity of the airport. Figure 15 refers.

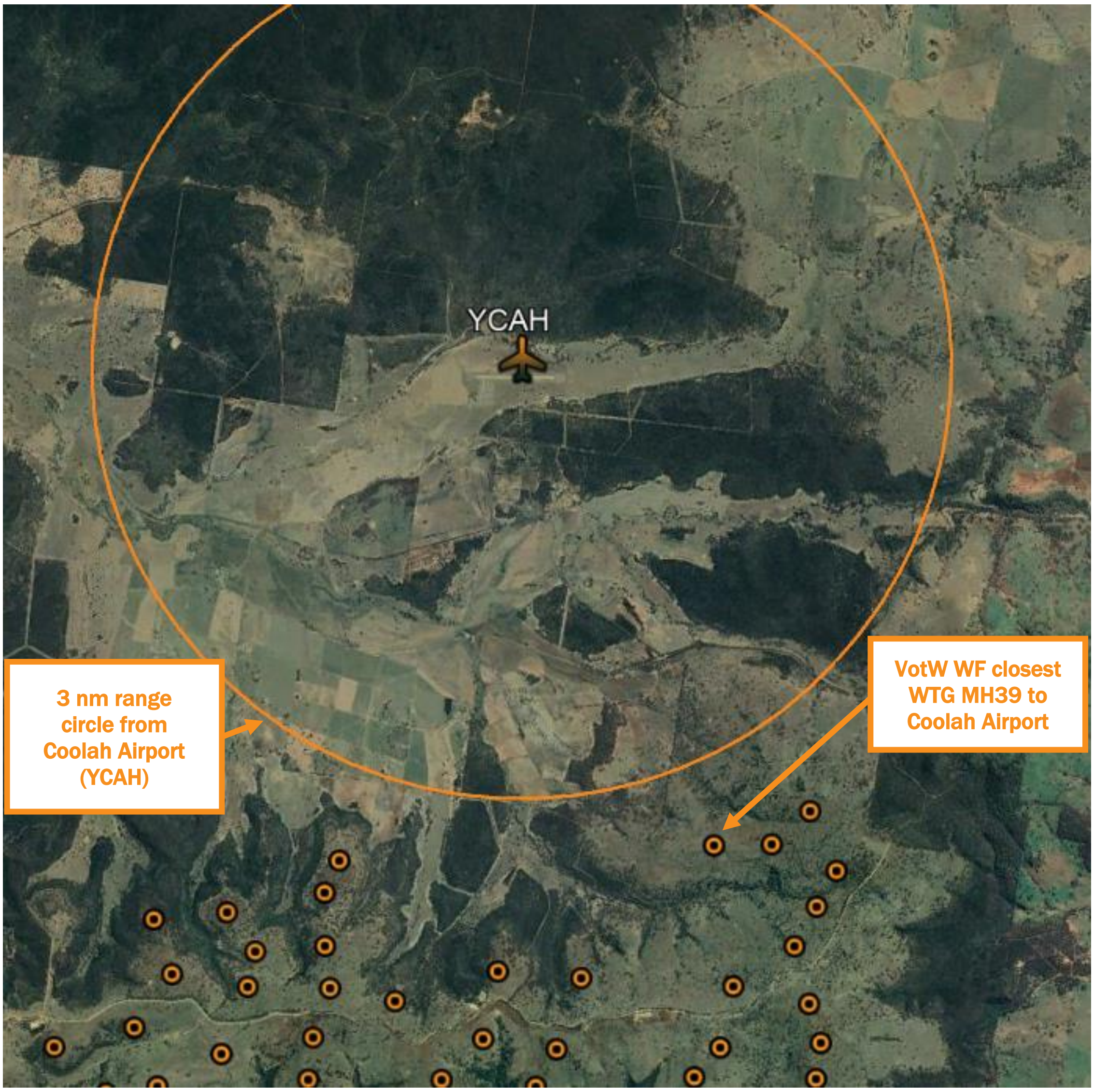

Figure 15 – Coolah Airport 3 nm range circle

None of the proposed WTGs are located inside the horizontal extent of the 3 nm range. Therefore, Coolah Airport (YCAH) will not be impacted by the Project.

6.6. Nearby aircraft landing areas

As a guide, an area of interest within a 3 nm radius of an aircraft landing area (ALA) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.

A search on OzRunways, which sources its data from Airservices Australia (AIP), returned with 10 nearby ALAs from the Project site. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

Figure 16 shows the location of nearby ALAs relative to the Project from identified ALAs (source: OzRunway, Google Earth).

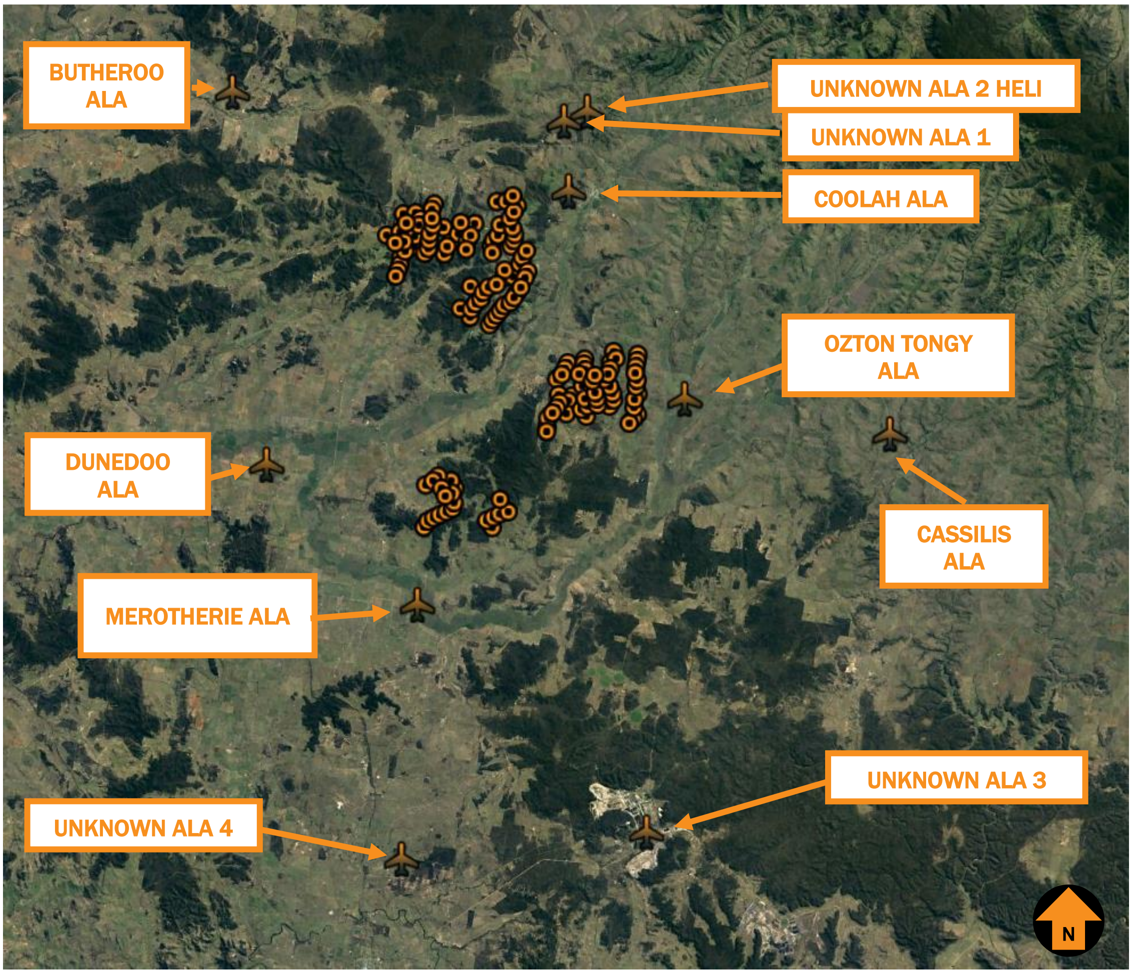

Figure 16 Project site relative to closest ALAs

Seven out of the 10 identified ALAs are more than 3 nm from any WTG and are assessed as not being impacted. Refer to Figure 17, showing the ALAs with a 3 nm ring (source: UPC\AC, Google Earth).

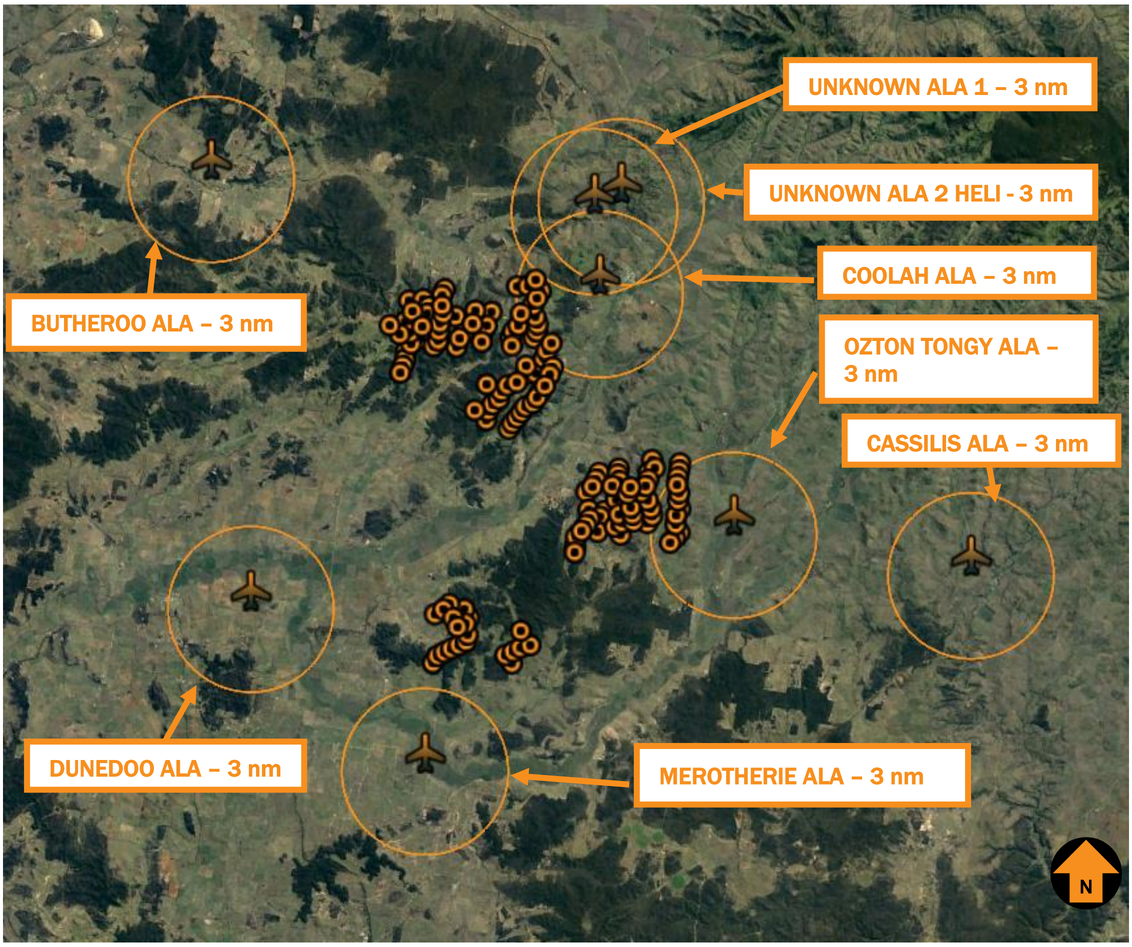

Figure 17 ALAs with 3 nm buffer

Proposed WTGs are located within a 3 nm radius of Coolah ALA, Unknown ALA 1 and Ozton Tongy ALA.

Note: Coolah ALA not to be confused with Coolah Airport (certified) which lies to the north of the Project site.

The wind turbines located in proximity to the runways and circuits of each affected ALA have been analysed to identify any potential impacts.

Approach and take off surfaces

The analysis of approach and take-off surfaces is based on the guidance published in the CASA CAAP 92-1(1) *Guidelines for aeroplane landing areas*.

The purpose of the CAAP 92-1(1) guidance is described as follows:

> *These guidelines set out factors that may be used to determine the suitability of a place for the landing and taking-off of aeroplanes. Experience has shown that, in most cases, application of these guidelines will enable a take-off or landing to be completed safely, provided that the pilot in command:*
>
> *a. has sound piloting skills; and*
>
> *b. displays sound airmanship.*

A copy of CAAP 92-1(1) Figure 2A – *Single engine and Centre-Line Thrust Aeroplanes not exceeding 2000 kg MTOW (day operations),* which shows the physical characteristics that may be applicable to the circumstances, is provided in Figure 18 (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

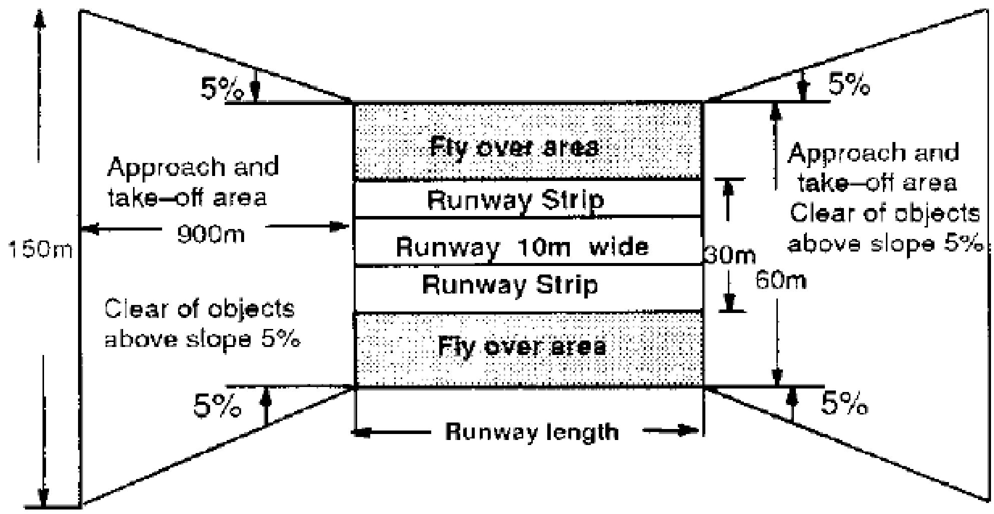

Figure 18 CAAP 92-1(1) Figure 2A

For these operations, the approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The surfaces increase in height at a rate of 5%, or 5 m in every 100 m.

For aerial application operations, the physical characteristics and obstacle limitation surfaces are considerably less restrictive.

A copy of CAAP 92-1(1) Figure 4 – *Dimensions – agricultural day,* which shows the physical characteristics applicable to aerial application operations, is provided in Figure 19 CAAP 92-1(1) Figure 4 (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

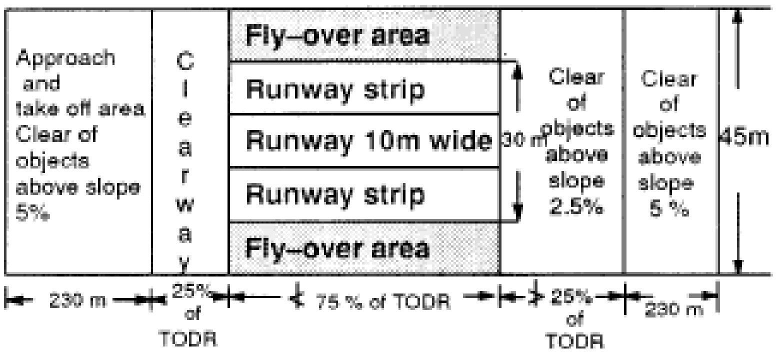

Figure 4 - Dimensions - agricultural day operations

Figure 19 CAAP 92-1(1) Figure 4

The proposed WTGs are located outside the horizontal extent of Figure 2A approach and take-off surfaces at Unknown ALA 1, Coolah ALA and Ozton Tongy ALA. Therefore, the Project will not impact Figure 2A approach and take-off surfaces of these ALAs.

<u>Aerodrome circuits</u>

For the purpose of this AIA the wind turbines located in proximity to Unknown ALA 1, Coolah ALA and Ozton Tongy ALA have been analysed to identify any potential impacts on the aerodrome's circuit operations.

The analysis of flight circuits is based on the recommendations provided in the CASA Advisory Publications (CAAP) 92 1(1) and (CAAP) 166-01 v4.2.

For the purposes of the flight circuit analysis, the following design parameters have been adopted:

- 1 nm upwind to achieve at least 500 ft AGL;
- 1 nm abeam the runway for downwind spacing;
- 45° relative position from the threshold for the turn from downwind onto the base leg; and
- Roll out at 1 nm final, not below 500 ft AGL.

Aerial application operators will most likely conduct smaller circuits than this nominal arrangement.

Figure 20 shows a close up of the nearest wind turbines relative to Unknown ALA 1, Coolah ALA and Ozton Tongy ALA showing the indicative flight circuits (in white colour) and 3 nm radii of these ALAs (source: UPC\AC, Google Earth).

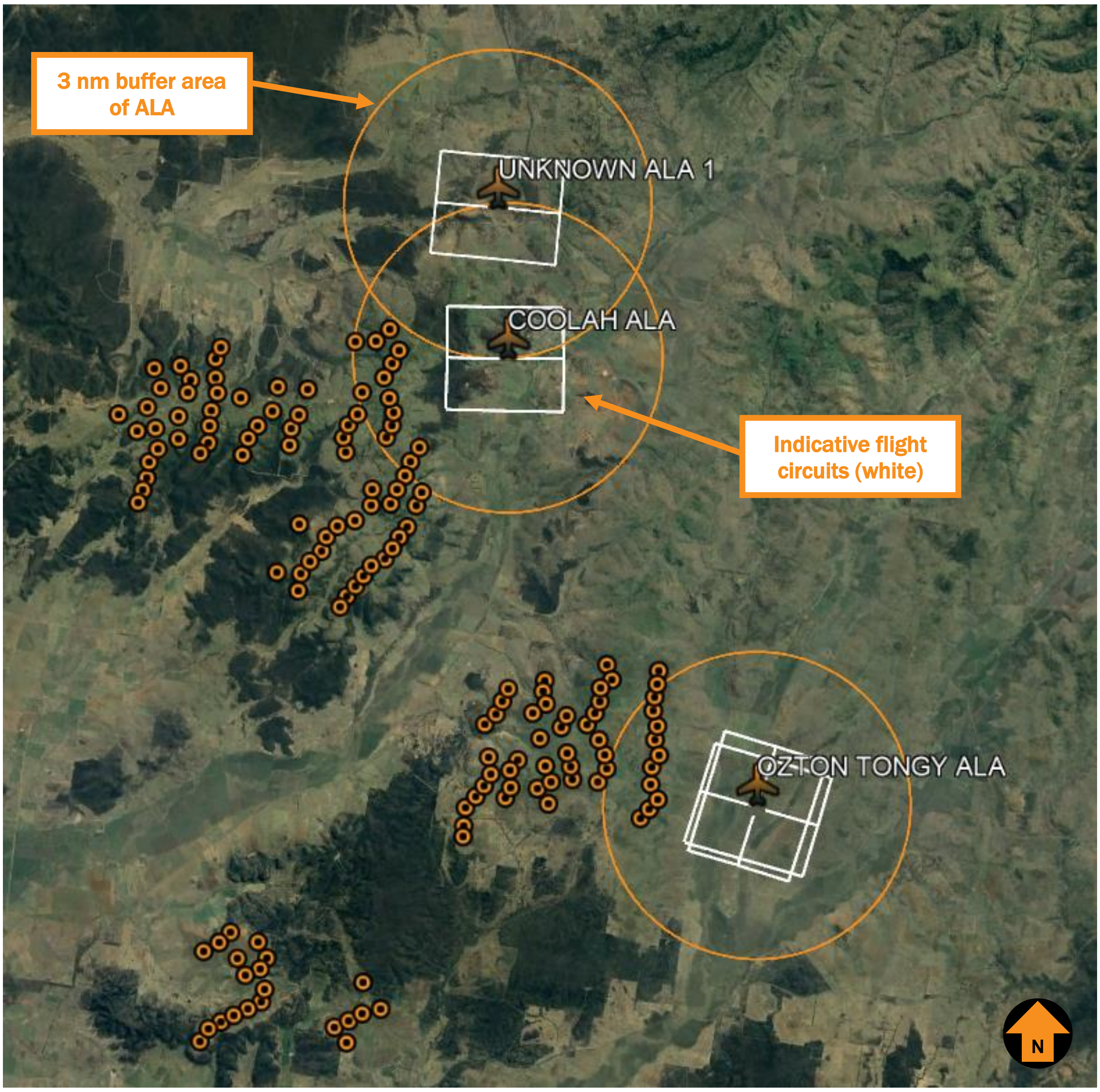

Figure 20 Proposed WTGs within 3 nm radii of likely impacted ALAs and indicative flight circuits

The proposed WTGs are located outside the horizontal extent of indicative flight circuits of Unknown ALA 1. It is unlikely aerodromes circuit operations of Unknown ALA 1 will be affected by the Project.

Given the circuit direction is toward the Project in Coolah ALA and Ozton Tongy ALA a more detailed analysis is warranted. to determine potential impact on aerial flight operations conducted to/from the ALAs.

<u>Coolah ALA - Circuit Operations</u>

As there is no published data available for Coolah ALA, a conservative approach of a runway length of 500 m, with a runway width of 10 m as per *CAAP 92-1(1) Figure 2A* was used as a basis for analysis.

A close-up of Coolah ALA highlighting the indicative flight circuit and a 3 nm radius of this ALA is shown in Figure 21.

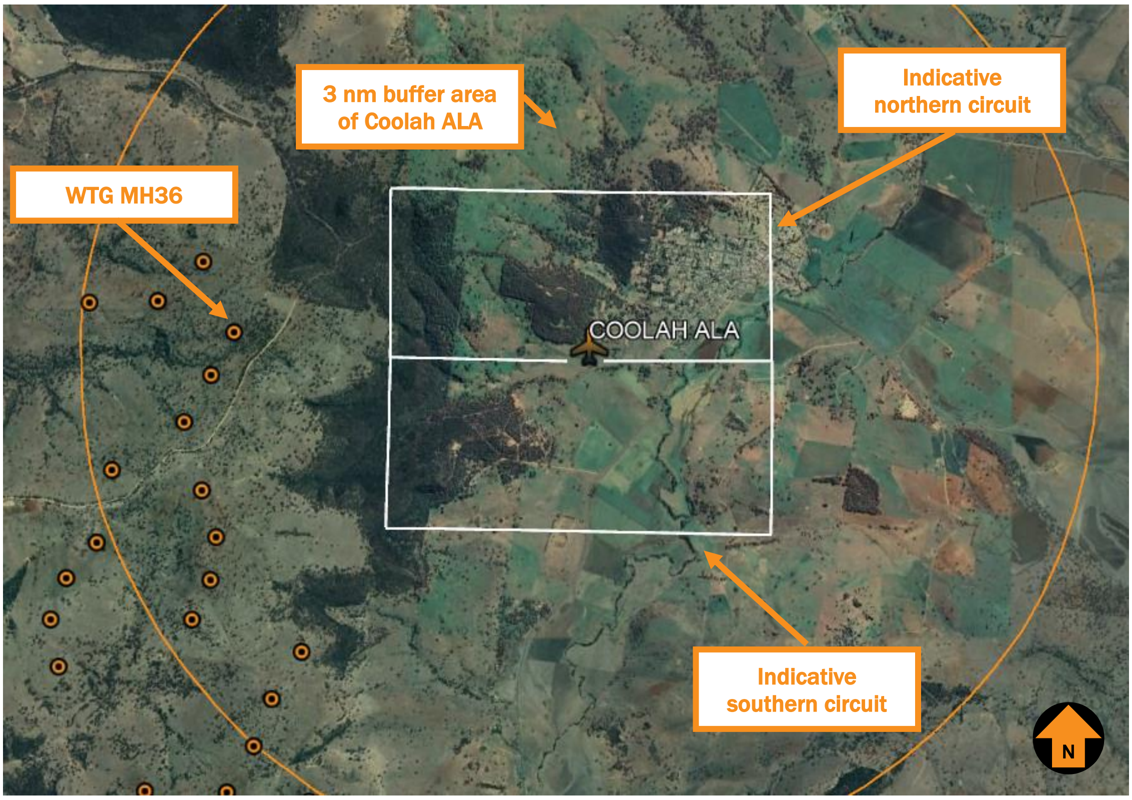

Figure 21 Proposed WTGs within a 3 nm radius of Coolah ALA and indicative flight circuits

Aerial image in proximity to Coolah ALA facing south (source: UPC\AC). Figure 22 refers.

Figure 22 Aerial image in proximity to Coolah ALA facing south (source: UPC\AC)

The approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The closest WTG to Coolah ALA is WTG MH36 and is located approximately 3.9 km (2.1 nm) from the end of the runway. Figure 21 refers.

Therefore, the approach and take-off surfaces will not be impacted.

Based on the analysis conducted above and the information gathered, it is unlikely that the Project will impact on circuit operations and approach and take-off surfaces at Coolah ALA.

Ozton Tongy ALA - Circuit Operations

Published data from ozrunways indicates Ozton Tongy ALA has 2 runways;

- 18/36, grass, 775m length
- 09/27, grass, 590m length

A close-up of Ozton Tongy ALA highlighting the indicative flight circuit(s) off both runways and a 3 nm radius of this ALA is shown in Figure 23Figure 23.

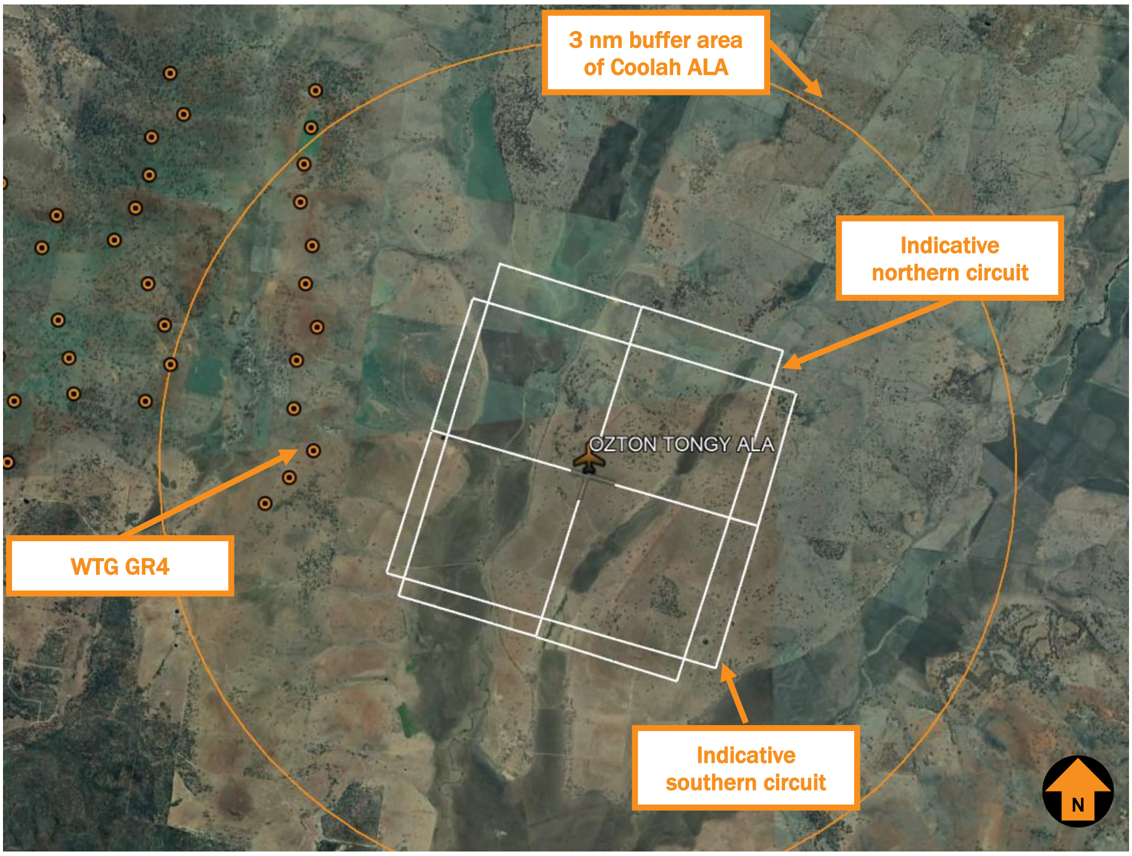

Figure 23 Proposed WTGs within a 3 nm radius of Ozton Tongy ALA and indicative flight circuits

Image taken in vicinity of Ozton Tongy ALA facing south (source: UPC\AC) is shown in Figure 24.

Figure 24 Image taken in vicinity of Ozton Tongy ALA facing south

Image taken in vicinity of Ozton Tongy ALA facing north (source: UPC\AC) is shown in Figure 25

Figure 25 Image taken in vicinity of Ozton Tongy ALA facing north

The approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The closest WTG to Ozton Tongy ALA is WTG GR4 and is located approximately 3.3 km (1.8 nm) from the end of the runway. Figure 23 refers.

Therefore, the approach and take-off surfaces will not be impacted.

Based on the analysis conducted above and the information gathered, it is unlikely that the Project will impact on circuit operations and approach and take-off surfaces at Ozton Tongy ALA.

6.7. Potential impacts from wake turbulence

Consideration should be given to recommendations outlined in the NASF Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers.

NASF Guideline D provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and wind monitoring towers.

Guidance regarding wind turbine wake turbulence states:

> *Wind farm operators should be aware that wind turbines may create turbulence which noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 200 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm…*

The effects of wake turbulence could be noticeable while performing circuits for Unknown ALA 1, Coolah ALA and Ozton Tongy ALA in west and southwest wind conditions.

For the purpose of the wake turbulence analysis, a logical conservative 180 m rotor diameter has been used.

Based on this scenario, the effects of wake turbulence could be noticeable at a distance of 2880 m (16 times rotor diameter) from the proposed wind turbines.

Coolah Airport (YCAH) and Unknown ALA 1 circuit areas remain outside the 2880 m hence no wake turbulence would be expected.

Coolah ALA and Ozton Tongy ALA circuit areas are within 2880 m from a proposed WTG and this may have a wake turbulence effect on aircraft in the circuit area. Figure 26 refers.

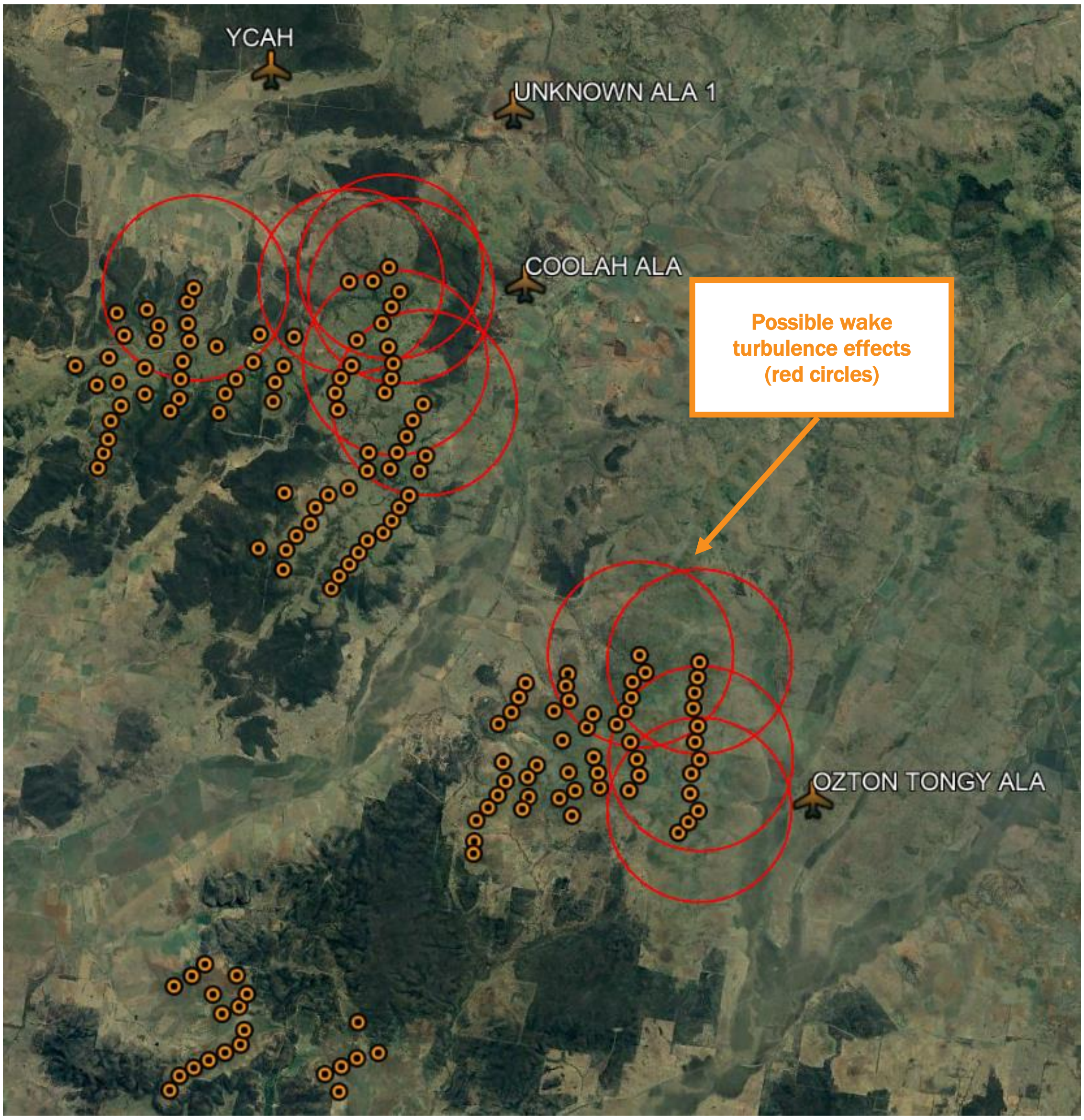

Figure 26 Wake turbulence effects (2880 m) to nearest ALAs

6.8. Summary of ALA analysis

Some of the identified ALAs will most likely be used by aerial application operators.

CAAP 166-01 v4.2 *Operations in the vicinity of non-controlled aerodromes* provides guidance on standard aerodrome traffic. According to paragraph 3.6.2, which is copied below, it is expected that aerial application operators may not conform the standard aerodrome circuit.

> *3.6.2 Aerial application operations frequently involve low-level manoeuvring after take-off and prior to landing. These low-level manoeuvres are not required to conform to the standard traffic circuit.*

As a courtesy, UPC\AC should try and contact the landowners and aerial operators for the identified airport and ALAs to inform them of potential impacts on the operation.

To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of wind turbines, wind monitoring towers and overhead powerlines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

The details of all identified ALAs are provided in Table 2.

Table 2 Nearby aircraft landing areas

ALA Name	*ICAO code*	*Registration status*	*Distance from the Project site*	*Location relative to the Project site*	*Nearest WTG*	*Impact on the OLS*	*Impact on flight circuit(s)*	*Potential wake turbulence from WTGs*
Coolah Airport	YCAH	certified	6.5 km (3.5 nm)	north	MH39	Nil	Nil	Nil
Coolah ALA	Nil	uncertified	3.9 km (2.1 nm)	east	MH36	Nil	Nil	YES
Ozton Tongy ALA	Nil	uncertified	3.5 km (1.9 nm)	east	GR4	Nil	Nil	YES
Unknown ALA 1	Nil	uncertified	5.9 km (3.2 nm)	northeast	MH37	Nil	Nil	Nil

6.9. Air routes and LSALT

MOS 173 requires that a minimum obstacle clearance of 1000 ft below the published lowest safe altitude (LSALT) is maintained along each air route.

The Project is split between 2 grids. The northern grid has a grid lowest safe altitude of 1646 m AHD (5400 ft AMSL) with a MOC surface of 1341 m AHD (4400 ft AMSL). The southern grid has a grid lowest safe altitude of 1524 m AHD (5000 ft AMSL) with a MOC surface of 1219 m AHD (4000 ft AMSL)

The highest WTG, which is MH25, with a maximum overall height of 1028 m AHD (3373 ft AMSL) will be below the LSALT MOC of 4000 ft AMSL by approximately 191 m (627 ft) (using most limiting MOC between the grids).

Figure 27 provides the grid LSALTs and air routes in proximity to the Project site (source: UPC\AC, OzRunways).

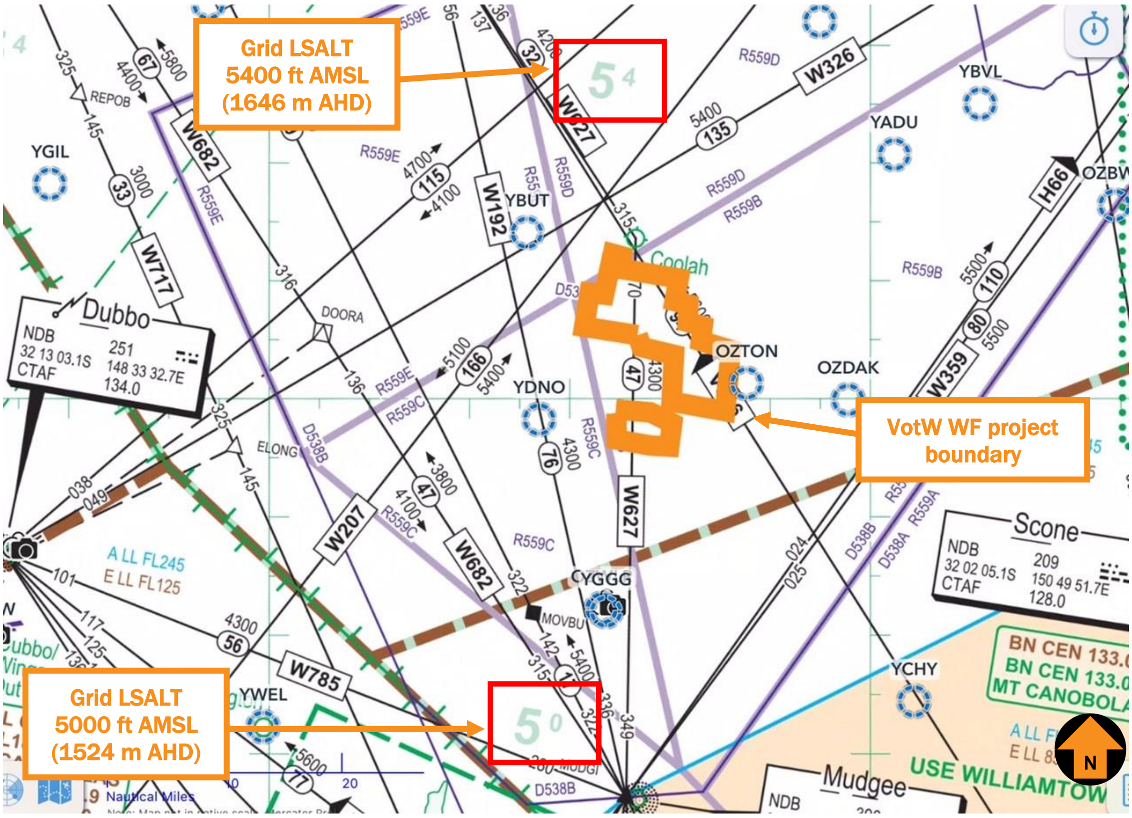

Figure 27 Air routes in proximity to the Project site

An impact analysis of the surrounding air routes is provided in Table 3.

Table 3 Air route impact analysis

Air Route	Way Point Pair	Route LSALT	MOC	Impact on airspace	Potential Solution	Impact on aircraft ops
V316	Coonabarabran - SKATZ	5600 ft AMSL 1707 m AHD	4600 ft AMSL 1402 m AHD	Nil	N/A	N/A
W627	MUDGI – (YCAH) Coolah	4300 ft AMSL 1311 m AHD	3300 ft AMSL 1006 m AHD	Yes	RAISE LSALT TO 4400 FT	Nil

Note: MOC is the height above which obstacles would impact on LSALTs or air routes.

Therefore, the Project WILL have an impact on nearby designated air routes, specifically the W627 air route.

6.10. Airspace

The Project is located outside of controlled airspace (wholly within Class G airspace).

The Project is located with a Danger Area D538B and a Restricted Area R559B. Figure 28 refers.

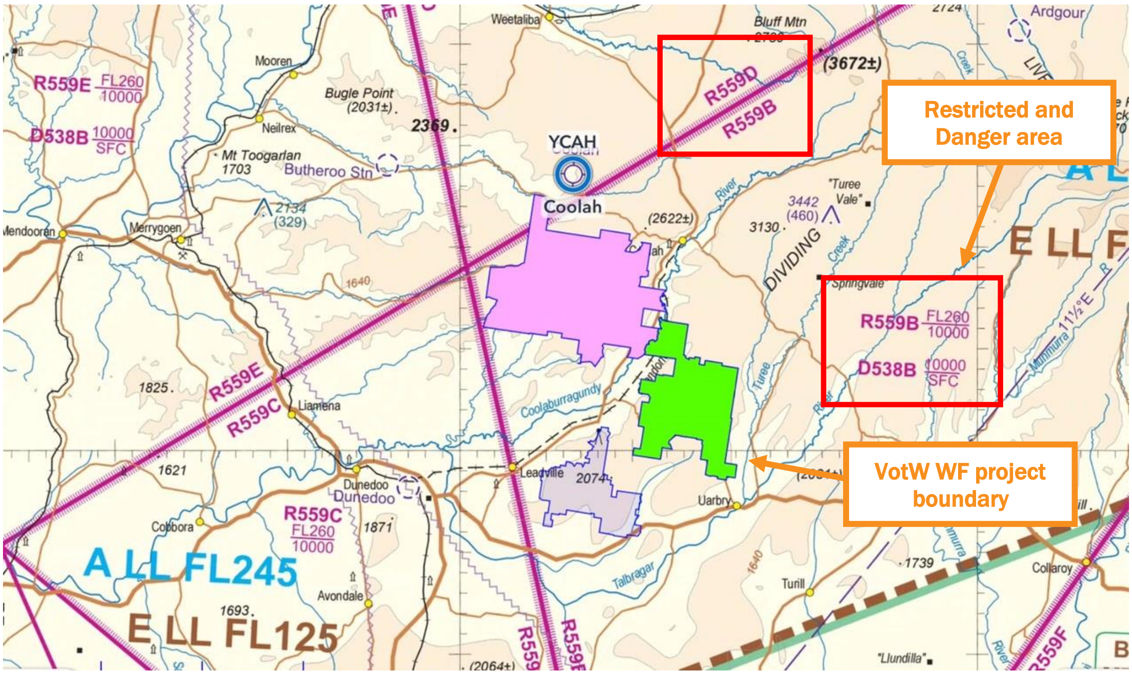

Figure 28 Project is located with a Danger Area D538B and a Restricted Area R559B

The restrictions of R559B on the airspace is detailed below:

- military flying area which is vertically restricted from 10,000 ft AMSL up to flight level 260;
- hours of activity as detailed by notice to airmen (NOTAM); and
- operated by No 453 Squadron at RAAF Base Williamtown.

The restrictions of D538B on the airspace is detailed below:

- military flying area which is vertically restricted from surface up to 10,000 ft AMSL;
- hours of activity as detailed by NOTAM; and
- operated by No 453 Squadron at RAAF Base Williamtown.

The Project is not located within a Prohibited Area.

The highest WTG MH25 has a maximum height of 1028 m AHD (3373 ft AMSL).

All turbines within Restricted Area R559B and adjacent to Restricted Area R559D will be below the applicable vertical restriction limits. However, the proposed WTGs are located within the Danger Area D538B, which is operated between surface and 10,000 ft AMSL. Therefore, the Project could potentially impact on flight operations within the Danger Area D538B (as vertical flight restrictions are between ground surface and 10,000 ft AMSL).

It is recommended to consult with the Department of Defence on any potential impacts of the proposed Project on military flying training within Danger Area D538B.

6.11. Aviation facilities

The following aviation facilities were identified in proximity to the Project:

- Radio Transmitter, NDB, located at Mudgee, approximately 56 km (30.1 nm) south from the Project.
- Radio Transmitter, NDB, located at Quirindi, approximately 91 km (49.0 nm) south from the Project.
- Radio Transmitter, NDB, located at Dubbo, approximately 97 km (52.0 nm) south from the Project.
- Radio Transmitter, located at Dubbo, approximately 97 km (52.0 nm) west from the project.

The Project will not impact on any protection areas associated with these aviation facilities.

6.12. Radar

Airservices Australia currently requires an assessment of the potential for wind turbines to affect radar line of sight.

The closest aviation radar facility is the Mount Sandon SSR, which is located approximately 170 km (92 nm) east of the Project. The second closest radar facility is Mount Boyce RSR, located approximately 179 km (54 97 nm) south of the Project.

The Project is located in Zone 4 and outside the radar line of sight of the SSR. The EUROCONTROL guidelines state:

> *When further than 16 km from an SSR the impact of a wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.*

Therefore, it is unlikely that the Project will impact either the Mount Sandon SSR or the Mount Boyce RSR radar facilities. Note: Route Surveillance Radar (RSR) and Secondary Surveillance Radar (SSR) is the same radar system.

6.13. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties, refer to Section 5 for details of the stakeholders and a summary of the consultation.

6.14. AIS summary

Based on the Project layout and overall turbine blade tip height limit of 250 m AGL, the blade tip elevation of the highest wind turbine, which is WTG MH25, will not exceed 1028 m AHD (3373 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate any PANS-OPS surfaces
- WILL have an impact on nearby designated air routes
- will not have an impact on the grid LSALTs of 5000 ft AMSL and 5400 ft AMSL
- will not have an impact on prescribed airspace
- lies within Danger Area D538B Surface to 10 000 ft. (Military Flying Training). Defence will need to be notified
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.
- Wake turbulence may affect aircraft operations in the circuit at Coolah ALA and Ozton Tongy ALA

6.15. Assessment recommendations

Based on the information contained within this section and the analysis conducted, the following recommendations are made:

- Consultation should be undertaken with Airservices Australia to assess potential impacts of the Project and to address the LSALT impact of air route W627 which will need to be raised.
- Consult Department of Defence regarding the impact of Danger Area D538B Surface to 10,000 ft.
- Advise/liaise with Coolah Airport (YCAH) (Wurrumbungle Shire Council)
- Advise/liaise with Oztong Tongy ALA
- Advise/liaise with Coolah ALA.

The list of wind turbines (obstacles), showing coordinates and elevation data that are applicable to this AIS, is provided in Annexure 3.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it has been concluded that aviation lighting is not required for WTGs and WMTs, but relevant lighting standards and guidelines are summarised in **Annexure 5.**

8. ACCIDENT STATISTICS

This section establishes the external context to ensure that stakeholders and their objectives are considered when developing risk management criteria, and that externally generated threats and opportunities are properly taken into account.

8.1. General aviation operations

The general aviation (GA) activity group is considered by the Australian Transport Safety Bureau (ATSB) to be all flying activities that do not involve commercial air transport (activity group), which includes scheduled (RPT) and non-scheduled (charter) passenger and freight type. It may involve Australian civil (VH–) registered aircraft, or aircraft registered outside of Australia. General aviation/recreational encompasses:

- Aerial work (activity type). Includes activity subtypes: agricultural mustering, agricultural spreading/spraying, other agricultural flying, photography, policing, firefighting, construction – sling loads, other construction, search and rescue, observation and patrol, power/pipeline surveying, other surveying, advertising, and other aerial work.
- Own business travel (activity type).
- Instructional flying (activity type). Includes activity subtypes: solo and dual flying training, and other instructional flying.
- Sport and pleasure flying (activity type). Includes activity subtypes: pleasure and personal transport, glider towing, aerobatics, community service flights, parachute dropping, and other sport and pleasure flying.
- Other general aviation flying (activity type). Includes activity subtypes: test flights, ferry flights and other flying.

8.2. ATSB occurrence taxonomy

The ATSB uses a taxonomy of occurrence sub-type. Of specific relevance to the subject assessment are terms associated with **terrain collision**. Definitions sourced from the ATSB website are provided below:

- **Collision with terrain**: Occurrences involving a collision between an airborne aircraft and the ground or water, where the flight crew were aware of the terrain prior to the collision.
- **Controlled flight into terrain (CFIT):** Occurrences where a serviceable aircraft, under flight crew control, is inadvertently flown into terrain, obstacles, or water without either sufficient or timely awareness by the flight crew to prevent the event.
- **Ground strike:** Occurrences where a part of the aircraft drags on, or strikes, the ground or water while the aircraft is in flight, or during take-off or landing.
- **Wirestrike:** Occurrences where an aircraft strikes a wire, such as a powerline, telephone wire, or guy wire, during normal operations.

8.3. National aviation occurrence statistics 2010-2019

The Australian Transport Safety Bureau recently published a summary of aviation occurrence statistics for the period 2010-2019 (AR-2020-014, Final - 29 April 2020).

According to the report, there were no fatalities in high or low capacity RPT operations during the period 2010-2019. In 2019, 220 aircraft were involved in accidents in Australia, with a further 148 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there was 35 fatalities from 22 fatal accidents. There have been no fatalities in scheduled commercial air transport in Australia since 2005.

Of the 326 fatalities recorded in the 10-year period, almost two thirds (175 or 53.68%) occurred in the general aviation segment. On average, there were 1.51 fatalities per aircraft associated with a fatality in this segment. The fatalities to aircraft ratio ranges from 1.09 to 177:1. Whilst it can be inferred from the data that the majority of fatal accidents are single person fatalities, it is reasonable to assert that the worst credible effect of an aircraft accident in the general aviation category will be multiple fatalities.

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 4 (source: ATSB).

Table 4 Number of fatalities by GA sub-category – 2010 to 2019

Sub-category	*Aircraft assoc. with fatality*	*Fatalities*	*Fatalities to aircraft ratio*
Aerial work	37	44	1.18:1
Instructional flying	11	19	1.72:1
Own business travel	3	5	1.6:1
Sport and pleasure flying	53	94	1.77:1
Other general aviation flying	11	12	1.09:1
Totals	115	174	1.51:1

Figure 29 refers to Fatal Accident Rate by operation type per million departures over the 6-year period (source: ATSB).

Note the rates presented are not the full year range of the study (2010–2019). This was due to the availability of exposure data (departures and hours flown) which was only available between these years. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period ranged between 6.6 in 2014 and 4.9 in 2019.

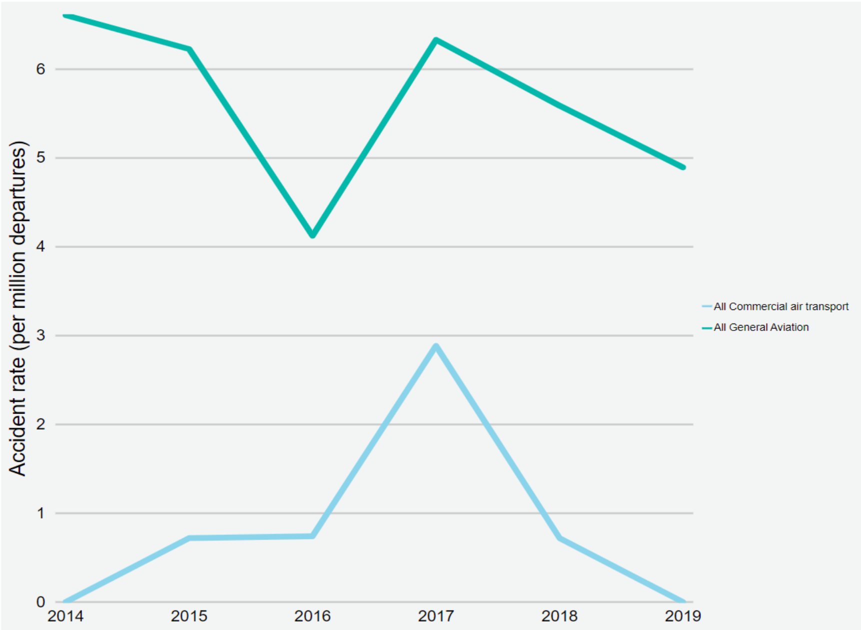

Figure 29 Fatal Accident Rate (per million departures) by Operation Type

In 2018, there were 9 fatal accidents and 9 fatalities involving GA aircraft, resulting in a rate of 5.6 fatal accidents per million departures and 7.7 fatal accidents per million hours flown.

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 5 (source: ATSB).

Table 5 Fatal accidents by GA sub-category – 2010 -2019

Sub-category	*Fatal accidents*	*Fatalities*
Agricultural spreading/spraying	13	13
Agricultural mustering	11	12
Other agricultural	1	1
Survey and photographic	5	10
Search and rescue	2	2
Firefighting	2	2
Other aerial work	3	4
Instructional flying	11	19

Sub-category	*Fatal accidents*	*Fatalities*
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	115	174

Over the 10-year period, no aircraft collided with a wind turbine or a wind monitoring tower.

Of the 20,529 incidents, serious incidents, and accidents in GA operations in the 10-year period, 1404 (6.83%) were terrain collisions.

The underlying fatality rate for GA operations discussed above is considered tolerable within Australia's regulatory and social context.

8.4. Worldwide accidents involving wind farms

To provide some perspective on the likelihood of a VFR aircraft colliding with a wind turbine, a summary of the four accidents that involved an aircraft colliding with a wind turbine, and the relevant factors applicable to this assessment, is incorporated in this section.

Based on the statistic of the Global Wind Energy Council (GWEC) report 2016, there were 341,320 wind turbines operating around the world at the end of 2016. Since 2016, approximately 1.8 million MW had been installed worldwide. It would represent around 594,229 WTGs (at an average of 3 MW per WTG).

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019.

Aviation Projects has researched public sources of information, accessible via the world wide web, regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

Of the four known accidents, one was caused by inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred overhead a wind farm, and the aircraft struck a wind turbine on its descent. This accident is not applicable to the circumstances under consideration.

There have been two accidents involving collision with a wind turbine during the day.

Only one of these (Melle, Germany 2017) resulted in a single fatality, as the result of a collision with a wind turbine steel lattice mast at a very low altitude during the day with good visibility and no cloud. If the mast was solid and painted white, then it more than likely would have been more visible than if it was equipped with an obstacle light.

In the other case (Plouguin, France, 2008), the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was in conditions of significantly reduced horizontal visibility in fog where the top of the turbine was obscured by cloud. The turbines became visible too late for avoidance manoeuvring and the aircraft made contact with two turbines. The aircraft was damaged but landed safely.

In both cases, it is difficult to conclude that obstacle lighting would have prevented the accident.

The other fatal accident occurred at night in instrument meteorological conditions (IMC) and is not applicable to the circumstances under consideration.

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group, which suggests a Cessna 182 collided with a wind turbine near Baraboo, Wisconsin, on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area, but suggests that the accident was caused by IFR flight into IMC encountered by the pilot and exceeding the design limits of the aircraft. A factor was flight to a destination alternate not performed by the pilot. No mention is made of wind turbines or a wind farm.

A summary of the four accidents is provided in Table 6.

Table 6 Summary of accidents involving collision with a wind turbine

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
1	Diamond DA320-A1 D-EJAR Collided with a wind turbine approximately 20 m above the ground, during the day in good visibility. The mast was grey steel lattice, rather than white, although the blades were painted in white and red bands.	02 Feb 2017	Melle, Germany	1	Day VFR No cloud and good visibility	Not specified	Not specified	Not specified	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
2	The Piper PA-32R-300, N8700E, was destroyed during an impact with the blades of a wind turbine tower, at night in IMC. The wind turbine farm was not marked on either sectional chart covering the accident location; however, the pilot was reportedly aware of the presence of the wind farm.	27 Apr 2014	10 miles south of Highmore, South Dakota	4	Night IMC Low cloud and rain	420 ft AGL overall	Fitted but reportedly not operational on the wind turbine that was struck	The NTSB determined the probable cause(s) of this accident to be the pilot's decision to continue the flight into known deteriorating weather conditions at a low altitude and his subsequent failure to remain clear of an unlit wind turbine. Contributing to the accident was the inoperative obstruction light on the wind turbine, which prevented the pilot from visually identifying the wind turbine.	An operational obstacle light may have prevented the accident

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
3	Beechcraft B55 The pilot was attempting to remain in VMC by descending the aircraft through a break in the clouds. The pilot, distracted by trying to visually locate the aerodrome, flew into an area of known wind turbines. After sighting the turbines, he was unable to avoid them. The tip of the left wing struck the first turbine blade, followed by the tip of the right wing striking the second turbine. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plougin, France	0	Day VFR The weather in the area of the wind turbines had deteriorated to an overcast of stratus cloud, with a base between 100 ft to 350 ft and tops of 500 ft.	328 ft AGL hub height, 393 ft AGL overall	Not specified	This pilot reported having been distracted by a troubling personal matter which he had learned of before departing for the flight. The wind farm was annotated on aeronautical charts.	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	VariEze N25063 The aircraft collided with a wind turbine following in-flight separation of the majority of the right canard and all of the right elevator	20 July 2001	Palm Springs, USA	2	Day VFR	N/A	N/A	The failure of the builder to balance the elevators per the kit manufacturer's instructions	Not applicable

9. RISK ASSESSMENT

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects and risk event description is provided in Annexure 4.

9.1. Risk Identification

The primary risk being assessed is that of aviation safety associated with the proposed Rangoon Wind Farm and WMTs.

Based on an extensive review of accident statistics data (see summary in Section 8 above) and input from stakeholders, five (5) identified risk events associated with wind turbines and WMTs relate to aviation safety, and are listed as follows:

1. potential for an aircraft to collide with a wind turbine, controlled flight into terrain (CFIT)
2. potential for an aircraft to collide with a wind monitoring tower (CFIT)
3. potential for a pilot to initiate manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in collision with terrain
4. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew
5. effect of obstacle lighting on neighbours.

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure and Regional Development, and in line with generally accepted practice, the risk to be assessed should primarily be associated with passenger transport services. The risk being assessed herein is primarily associated with smaller aircraft likely to be flying under the VFR, and so the maximum number of passengers exposed to the nominated consequences is likely to be limited.

A fifth identified risk event associated with WTGs and WMTs is the potential visual impact associated with obstacle lighting (if fitted) on surrounding residents.

The five risk events identified here are assessed in detail in the following section.

9.2. Risk Analysis, Evaluation and Treatment

For the purpose of considering applicable consequences, the concept of worst credible effect has been used. Untreated risk is first evaluated, then, if the resulting level of risk is unacceptable, further treatments are identified to reduce the level of risk to an acceptable level.

A summary of the level of risk associated with the proposed Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Tables 15 to 19.

Table 7 Aircraft collision with wind turbine

Risk ID:	1. Aircraft collision with wind turbine (CFIT)

Discussion

An aircraft collision with a wind turbine would result in harm to people and damage to property. Property could include the aircraft itself, as well as the wind turbine.

There have been four reported occurrences worldwide of aircraft collisions with a component of a wind turbine structure since the year 2000 as discussed in Section 8. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

In consideration of the circumstances that would lead to a collision with a wind turbine:

- GA VFR aircraft operators generally do not individually fly a significant number of hours in total, let alone in the area in question
- There is a very small chance that a pilot, suffering the stress of weather, will continue into poor weather conditions (contrary to the rules of flight) rather than divert away from it, is not aware of the wind farm, will not consider it or will not be able to accurately navigate around it
- If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a wind turbine.

Refer to the discussion of worldwide accidents at Section 8.1.

There are no known aerial agriculture operations conducted at night in the vicinity of the Project.

If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing:

(a) whether the object or structure will be a hazard to aircraft operations

(b) whether it requires an obstacle light that is essential for the safety of aircraft operations

The proposal is clear of the OLS of any aerodrome.

Consequence

If an aircraft collided with a wind turbine, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There have been four reports of aircraft collisions with wind turbines worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others. Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a wind turbine resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The proposal is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 250 m (820 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 97 m (318 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.
- If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The wind turbines are typically coloured white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Because the turbines are above 100 m AGL, there is a statutory requirement to report the towers to CASA.

Level of Risk

The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 - Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments

The following treatments which can be implemented at little cost will provide an acceptable level of safety:

• Details of the Project should be communicated to local and regional aircraft operators prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically: ○ Provide the details to the New South Wales Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm. ○ Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project. ○ Arrangements should be made to publish details of the wind farm in ERSA for surrounding aerodromes.
Residual Risk With the additional recommended treatments, the likelihood of an aircraft collision with a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **as low as reasonably practicable (ALARP)**. **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**

Residual Risk	7 - Tolerable

Table 8 Aircraft collision with wind monitoring tower

Risk ID:	2. Aircraft collision with a wind monitoring tower (CFIT)

Discussion

An aircraft collision with a WMT would result in harm to people and damage to property.

UPC\AC proposes to install 13 permanent WMT as part of the VotW WF.

The proposed permanent WMTs:

- will be constructed of steel lattice and will be at a maximum of 150 m (361 ft) AGL in height
- will be installed at different locations around the Project
- will have visibility aviation marker balls up on the top-level guy wires
- the top 1/3 of the masts will be painted in contrasting colours (red/white/red)
- will be reported to Airservices Australia.

There are only a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and no instance was in Australia.

There is a relatively low rate of aircraft activity in the vicinity of the wind farm.

There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm.

If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing:

a) whether the object or structure will be a hazard to aircraft operations

b) whether it requires an obstacle light that is essential for the safety of aircraft operations

Consequence

If an aircraft collided with a WMT, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few occurrences of an aircraft colliding with a WMT, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none were in Australia. It is assessed that collision with a wind monitoring tower without obstacle lighting that would be effective in alerting the pilot to its presence is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible
Current Treatments • The existing temporary WMT location has been reported to CASA and Airservices Australia. • The details of the proposed permanent WMT will be reported to CASA and Airservices Australia. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) AGL above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built-up areas. The WMT, at a maximum height of 150 m (492 ft) AGL, will be 2.4 m (8 ft) below the minimum height of 500 ft AGL for an aircraft flying at this height. • In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower. • Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The towers are constructed from grey steel. • Since the towers will be higher than 100 m AGL, there is a statutory requirement to report them to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 - Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the existing WMTs were reported to Airservices Australia when they were constructed. • Details of the proposed permanent WMT will be reported to CASA and Airservices Australia. • The proposed WMTs will have aviation marker balls and consideration will be made to MOS 139 Chapter 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically:	

8.110 (5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m. *8.110 (7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects. (8) The objects mentioned in subsection (7) must: be approximately equivalent in size to a cube with 600 mm sides; and be spaced 30 m apart along the length of the wire or cable.* • Details of the proposed and existing WMTs on the Project site will be communicated to local and regional aerodrome and aircraft operators before, during and following construction.	
Residual Risk With the additional recommended treatments, the likelihood of an aircraft colliding with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**. The consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision, given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. Only if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WMTs, without obstacle lighting on the WMTs of the Project.**	
Residual Risk	7 - Tolerable

Table 9 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	3. Harsh manoeuvring leads to controlled flight into terrain (CFIT)

Discussion

An aircraft colliding with terrain as a result of manoeuvring to avoid colliding with a wind turbine would result in harm to people and damage to property.

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day.

The proposal is clear of the OLS of any aerodrome.

Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas.

The proposed turbines will be a maximum of 250 m (820 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 97 m (320 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.

Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.

If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.

Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).

Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.

Assumed risk treatments

- The wind turbines are typically coloured white so they should be visible during the day
- The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts
- Since the turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Consequence

If an aircraft collided with terrain, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day. It is assessed that a ground collision accident following manoeuvring to avoid a wind turbine is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The proposal is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas.
- Wind turbines will be a maximum of 250 m (820 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 97 m (320 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.
- If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The wind turbines are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Level of Risk

The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 – Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, UPC\AC may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project.
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable.** It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project.**

Residual Risk	7 - Tolerable

Table 10 Effect of Project on operating crew

Risk ID:	4. Effect of the Project on operating crew
Discussion Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew. There are no known aerial agriculture operations conducted at night in the vicinity of the Project.	
Consequence The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.	
Consequence	Minor
Untreated Likelihood The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible
Current Treatments (without lighting) • The proposal is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. • Wind turbines will be a maximum of 250 m (820 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 97 m (320 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL. • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines. • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines. • If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective. • Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).	

• Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The wind turbines are typically coloured white so they should be visible during the day. • The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct cost benefit analysis
Proposed Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. However, the following treatments, which can be implemented at little cost, will provide an additional margin of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, UPC\AC may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable**, the additional recommended treatments will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the WTGs and WMTs of the Project.**	
Residual Risk	5 - Tolerable

Table 11 Effect of obstacle lighting on neighbours

Risk ID:	5. Effect of obstacle lighting on neighbours
Discussion This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm. Installation and operation of obstacle lighting on wind turbines or WMT can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions. If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: a) whether the object or structure will be a hazard to aircraft operations; and b) whether it requires an obstacle light that is essential for the safety of aircraft operations In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Consequence The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be: • Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences. This would be a Moderate consequence.	
Consequence	Moderate
Untreated Likelihood The likelihood of moderate site impact, minimal local impact is Almost certain - the event is likely to occur many times (has occurred frequently).	
Untreated Likelihood	Almost certain
Current Treatments If the wind turbines or WMTs are higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Level of Risk The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.	
Current Level of Risk	8 - Unacceptable

Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments Not installing obstacle lighting would completely remove the source of the impact. If lighting is required, there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including: • reducing the number of wind turbines with obstacle lights; • specifying an obstacle light that minimises light intensity at ground level; • specifying an obstacle light that matches light intensity to meteorological visibility; and • mitigating light glare from obstacle lighting through measures such as baffling. There are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground. Consideration may be given to activating the obstacle lighting via a pilot activated lighting system. An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.	
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact. If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is our assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.	
Residual Risk	7 - Tolerable

10. CONCLUSIONS

The results of this study are summarised as follows:

10.1. Project description

The proposed Project will comprise the following:

- up to 148 wind turbines
- maximum overall height (tip height) of the wind turbines is up to 250 m AGL
- highest wind turbine is MH25 with ground elevation of 773 m AHD and overall height of 1028 m (3373 ft AMSL) (including a 5 m error budget)
- Thirteen proposed permanent WMT with a maximum height of up to 150 m (492 ft) AGL, which will be reported to Airservices Australia.

10.2. Regulatory requirements

The following regulatory requirements apply:

- With respect to MOS 139 Chapter 8 Division 10 8.109, the proposed wind turbines and wind monitoring towers must be reported to CASA if they are considered a hazardous obstacle.
- Wind turbines and wind monitoring towers must be marked in accordance with respect to MOS 139 Chapter 8 Division 10 8.110.
- Wind turbines must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.

10.3. Planning considerations

The *Warrumbungle Shire Council Local Environmental* Plan does not incorporate any reference to the development of wind farms or the protection of aeronautical infrastructure.

10.4. Consultation

An appropriate and justified level of consultation will be undertaken with relevant parties. Refer to Section 5.

10.5. Aviation Impact Statement

Based on the Project layout and overall WTG tip height limit of 250 m AGL, the blade tip elevation of the highest wind turbine, which is WTG MH25, will not exceed 1028 m AHD (3373 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate any PANS-OPS surfaces
- WILL have an impact on nearby designated air routes (W627)

- will not have an impact on the grid LSALT of 5000 ft AMSL and 5400 ft AMSL
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- The Project lies within Danger Area D538B Surface to 10 000 ft. (Military Flying Training)
- is outside the clearance zones associated with aviation navigation aids and communication facilities.
- Wake turbulence may affect aircraft operations in the circuit at Coolah ALA and Ozton Tongy ALA

10.6. Aircraft operator characteristics

Aircraft will be required to navigate around the Project site in low cloud conditions where aircraft need to fly at 500 ft AGL.

UPC\AC may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the wind turbine rotor blades prior to the commencement of the subject aircraft operations within the Project.

Wind turbines are generally not a safety concern to aerial agricultural operators. WMTs remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.

10.7. Hazard lighting and marking

The following conclusions apply to hazard marking and lighting:

- With respect to MOS 139 Chapter 8 Division 10 8.109, the proposed wind turbines and wind monitoring towers must be reported to CASA if they are considered a hazardous obstacle. Wind turbines and wind monitoring towers must be marked in accordance with respect to MOS 139 Chapter 8 Division 10 8.110.
- Wind turbines must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- Aviation Projects has assessed that the proposed Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- With respect to marking of turbines, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:
    - marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires

- paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast
- ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation or
- a flashing strobe light during daylight hours.

10.8. Summary of risks

A summary of the level of residual risk associated with the proposed Project with the Recommended Treatments implemented, is provided in Table 12.

Table 12 Summary of Risks

Risk Element	Consequence	Likelihood	Risk	Actions Required
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with wind monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Although there is no obligation to do so, consideration has been made for marking the wind monitoring towers according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Details of wind monitoring towers have been communicated to local and regional operators and to CASA and Airservices Australia following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

11. RECOMMENDATIONS

Recommended actions resulting from the conduct of this assessment are provided below.

Notification and reporting

1. 'As constructed' details of wind turbine and WMT coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development, using the following email address: land.planning@defence.gov.au;
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the Project should be provided to local and regional aircraft operators prior to construction for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of wind turbines, wind monitoring towers and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

6. While not a statutory requirement, UPC\AC should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of turbines

7. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, typical of most wind turbines operational in Australia. No additional marking measures are required for WTGs.

Lighting of turbines

8. Aviation Projects has assessed that the proposed Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.

Marking of wind monitoring towers

9. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:

    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires

    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

    c. ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation or

    d. a flashing strobe light during daylight hours.

Triggers for review

10. Triggers for review of this risk assessment are provided for consideration:

    a. prior to construction to ensure the regulatory framework has not changed

    b. following any significant changes to the context in which the assessment was prepared, including the regulatory framework

    c. following any near miss, incident or accident associated with operations considered in this risk assessment.

12. ANNEXURES

1. References
2. Definitions
3. Turbine coordinates and heights
4. Risk Assessment Framework
5. CASA Regulatory Requirements – Lighting and Marking

ANNEXURE 1 – REFERENCES

References used or consulted in the preparation of this report include:

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 17 June 2021
- Airservices Australia, Designated Airspace Handbook, effective 17 June 2021
- Civil Aviation Safety Authority, Civil Aviation Regulations 1998 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 166-01 (v4.2): Operations in the vicinity of non-controlled aerodromes, dated February 2019
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019*, dated 5 September 2019
- Civil Aviation Safety Authority, Advisory Circular (AC) 139-08 v2.0: *Reporting of Tall Structures*, dated March 2018
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013
- Department of Planning and Environment, NSW Government, *NSW Wind Farm Guideline for State significant wind energy development*, December 2016
- Department of Planning and Environment, NSW State Government, Wind Energy: Visual Assessment Bulletin – For State significant wind energy development, December 2016
- Geoscience Australia, Electricity transmission lines in NSW, *ElectricityTransmissionLines_v2.kmz*, created 01 January 2015
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- Mid-Western Regional Local Environment Plan 2012, dated 14 July 2021
- New South Wales Government, *State Environmental Planning Policy (Infrastructure) 2007* (current version dated 22 January 2021)
- OzRunways, aeronautical navigation charts extracts, dated 17 June 2021
- Standards Australia, ISO 31000:2018 Risk management – Guidelines

- Upper Hunter Local Environmental Plan 2013, dated 14 July 2021
- Warrumbungle Local Environmental Plan 2013, dated 14 July 2021

ANNEXURE 2 – DEFINITIONS

Term	*Definition*
Aerial Agricultural Operator	Specialist pilot and/or company who are required to have a commercial pilot's licence, an agricultural rating and a chemical distributor's licence
Aerodrome	A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft.
Aerodrome facilities	Physical things at an aerodrome which could include: a. the physical characteristics of any movement area including runways, taxiways, taxilanes, shoulders, aprons, primary and secondary parking positions, runway strips and taxiway strips b. infrastructure, structures, equipment, earthing points, cables, lighting, signage, markings, visual approach slope indicators.
Aerodrome reference point (ARP)	The designated geographical location of an aerodrome.
Aeronautical Information Publication (AIP)	Details of regulations, procedures, and other information pertinent to the operation of aircraft
Aeronautical Information Publication En-route Supplement Australia (AIP ERSA)	Contains information vital for planning a flight and for the pilot in flight as well as pictorial presentations of all licensed aerodromes
Ancillary infrastructure	Supporting infrastructure for: • construction (temporary) e.g. compounds, batching plants etc. • operational (permanent) e.g. operations and maintenance facilities, access tracks etc.
Associated dwellings / associated properties	Dwellings or properties on which the wind turbines, or the transmission line, are located.
Central-West Orana Transmission line	TransGrid's proposed East-West transmission line for the overall renewable energy zone located to the south of the Girragulang Road and Leadville clusters (the project's proposed dispatch to the NEM)
Civil Aviation Safety Regulations 1998 (CASR)	Contain the mandatory requirements in relation to airworthiness, operational, licensing, enforcement.

Term	*Definition*
Construction access tracks	Vehicle access tracks for construction and delivery of plant and equipment on private property.
Development footprint	The area containing all the permanent and temporary project components associated with construction and operation – effectively the disturbance area for the project. Includes the transmission line connecting the wind farm to the Central-West Orana Transmission line and the access tracks to the wind farm clusters. Often referred to as the 'survey area' or 'survey boundary' in specialist reports.
Electrical reticulation	Underground and overhead electrical services that connect the turbines and connect to the substations in each cluster
Girragulang Road Cluster	Cluster east of Black Stump Way and Girragulang Road, south of Coolah
Instrument meteorological conditions (IMC)	Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minimum specified for visual meteorological conditions.
Leadville Cluster	Cluster north of Golden Highway and east of Leadville township
Manual of Standards (MOS)	The means CASA uses in meeting its responsibilities under the Act for promulgating aviation safety standards
Mt Hope Cluster	Cluster west of Black Stump Way, south west of Coolah
National Airports Safeguarding Framework (NASF)	Framework has the objective of developing a consistent and effective national framework to safeguard both airports and communities from inappropriate on and off airport developments.
Non-associated dwellings / non-associated properties	Dwellings or properties that are potentially impacted by the proposed wind farm, but on which wind turbines or transmission line are not located i.e. indirectly affected by the proposed development.
Obstacles	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.
Overhead transmission line	The proposed overhead transmission lines (up to 330Kv) dispatching electricity from each cluster and connecting clusters (Mount Hope to Girragulang Road). Also potentially connecting the Leadville cluster to the Girragulang Road high voltage transmission line.

Term	Definition
Project	Refers holistically to the proposed Valley of the Winds Wind Farm, including the wind farm and the transmission line(s).
Proponent	UPC\AC Renewables Australia Pty Ltd (abbreviated to 'UPC\AC')
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Runway strip	A defined area including the runway and stopway, if provided, intended: a. to reduce the risk of damage to aircraft running off a runway b. to protect aircraft flying over it during take-off or landing operations.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.
Transport routes	Public roads that are to be used for delivery of plant and equipment (e.g. rotor blades)
TxL or transmission line	The proposed high voltage (up to 500Kv) overhead transmission line(s) that will connect the wind farm to the Central-West Orana Transmission line
Wind farm site	The wind farm site boundary corresponds with the outer boundary of properties upon which the proposed Valley of the Winds wind farm is located. Includes the three clusters but excludes the transmission line connecting to the Central-West Orana REZ Transmission line.

ANNEXURE 3 – TURBINE AND WMT COORDINATES AND HEIGHTS

Source: UPC\AC, VotW Wind Farm turbine co-ordinates, *received via email VoW_18019_MGA2055_Elevations[32].xls*

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
MH03	749310	6466082	642	897
MH04	750188	6467172	695	950
MH05	749563	6466461	663	918
MH06	749886	6466815	674	929
MH07	750476	6467537	706	961
MH08	750973	6467766	690	945
MH09	751254	6468130	692	947
MH10	751504	6468529	716	971
MH11	751806	6468890	737	992
MH12	752151	6469642	739	994
MH13	752361	6470113	763	1018
MH14	747817	6466698	652	907
MH15	747065	6467378	684	939
MH16	747931	6467309	681	936

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
MH17	748267	6467739	687	942
MH18	748696	6468097	667	922
MH19	748878	6468598	657	912
MH20	749287	6468979	652	907
MH21	747908	6469081	647	902
MH22	749924	6469164	680	935
MH23	750527	6469695	716	971
MH24	751233	6469728	752	1007
MH25	751472	6470237	772	1027
MH26	750576	6470263	728	983
MH27	751772	6470723	734	989
MH28	751977	6471225	708	963
MH29	752311	6471722	673	928
MH30	751131	6472105	718	973
MH31	751344	6472531	721	976
MH32	751417	6472993	729	984

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
MH33	751276	6473502	734	989
MH34	751106	6474247	741	996
MH35	751406	6474747	721	976
MH36	751671	6475203	753	1008
MH37	751352	6475975	732	987
MH38	750845	6475562	716	971
MH39	750101	6475563	726	981
MH41	749651	6471622	648	903
MH42	749585	6472140	690	945
MH43	749773	6472587	722	977
MH44	750116	6472965	725	980
MH45	750306	6473747	736	991
MH46	747638	6471923	681	936
MH47	747721	6472511	708	963
MH48	748002	6472993	743	998
MH49	748343	6473899	705	960

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
MH50	745939	6471612	716	971
MH51	746166	6472195	724	979
MH52	746507	6472634	725	980
MH53	747056	6473147	716	971
MH54	747268	6474011	722	977
MH55	744419	6471709	699	954
MH56	744718	6472071	726	981
MH57	744783	6472678	733	988
MH58	744861	6473223	733	988
MH59	745929	6473660	721	976
MH60	745097	6473851	724	979
MH61	745041	6474392	717	972
MH62	745051	6475077	698	953
MH63	745247	6475482	680	935
MH64	742133	6469995	733	988
MH65	742319	6470442	721	976

WTG IDENTIFIER	EASTING	NORTHING	BASE ELEVATION (m)	TOTAL ELEVATION incl 5 m buffer
MH66	742474	6470870	667	922
MH67	742564	6471442	710	965
MH68	742903	6471899	724	979
MH69	743646	6472241	700	955
MH70	743673	6473041	724	979
MH71	744029	6473892	716	971
MH72	744138	6474344	713	968
MH73	743784	6474856	721	976
MH74	742160	6472561	678	933
MH75	742831	6472640	735	990
MH76	741505	6473174	692	947
MH77	742548	6473402	691	946
MH78	743053	6474077	705	960
MH79	742833	6474787	699	954
GR02	759945	6458232	605	860
GR03	760267	6458557	611	866

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
GR04	760587	6458894	612	867
GR05	760345	6459441	600	855
GR06	760398	6460059	611	866
GR07	760673	6460478	627	882
GR08	760633	6461526	615	870
GR09	760499	6462088	619	874
GR10	760559	6462572	621	876
GR11	760663	6463035	634	889
GR12	760733	6463509	633	888
GR13	758438	6459581	622	877
GR14	758775	6460045	625	880
GR15	758711	6460550	629	884
GR16	758513	6461087	623	878
GR17	758101	6461652	663	918
GR18	758392	6462051	683	938
GR19	758581	6462466	693	948

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
GR20	758622	6462951	696	951
GR21	759036	6463236	673	928
GR22	758870	6463773	645	900
GR23	757524	6459697	638	893
GR24	757475	6460158	639	894
GR25	757356	6460645	667	922
GR26	757170	6461574	679	934
GR27	757371	6461984	675	930
GR28	756639	6458842	617	872
GR29	756257	6459395	629	884
GR30	756756	6459623	645	900
GR31	756561	6460198	648	903
GR32	756394	6461194	631	886
GR33	756157	6462109	614	869
GR34	756642	6462426	619	874
GR35	755094	6459083	615	870

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
GR36	755296	6459452	619	874
GR37	755282	6460073	642	897
GR38	755578	6460433	643	898
GR40	753535	6457743	623	878
GR41	753568	6458121	624	879
GR42	753648	6458775	631	886
GR43	754027	6459161	626	881
GR44	754338	6459538	625	880
GR45	754591	6459956	638	893
GR46	754528	6460559	613	868
GR47	754418	6461745	607	862
GR48	754829	6462101	609	864
GR49	755071	6462557	614	869
GR50	755294	6462994	600	855
GR51	756547	6462873	593	848
GR52	756616	6463255	597	852

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
GR53	760537	6461040	601	856
LV03	750413	6451624	582	837
LV04	749149	6450441	562	817
LV05	748725	6450997	574	829
LV06	749248	6451227	592	847
LV07	749743	6451476	610	865
LV08	749804	6452596	599	854
LV09	743857	6450601	561	816
LV10	744180	6451055	591	846
LV11	744639	6451296	586	841
LV12	745108	6451518	601	856
LV13	745623	6451741	593	848
LV14	746242	6452428	597	852
LV15	746104	6453165	607	862
LV16	746353	6453549	593	848
LV17	746047	6454131	570	825

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION **(m)***	***TOTAL ELEVATION incl 5 m buffer***
LV18	745568	6452958	613	868
LV19	745296	6453566	614	869
LV20	744079	6453843	607	862
LV21	744651	6454155	623	878
LV22	745062	6454505	576	831
LV23	746111	6451980	580	835
WIND MONITORING TOWERS – PERMANENT AND TEMPORARY				
MH_ECG1	740922	6473313	687	842
MH_ECG2	747715	6466100	639	794
MH_PMM1	751972	6469259	717	872
MH_TMM1	752150	6469643	738	893
MH_TMM2	751806	6468890	737	892
MH_PMM2	752140	6475354	754	909
MH_TMM3	751675	6475216	753	908
MH_PMM3	750349	6466735	661	816
MH_TMM4	750188	6467172	695	850

WTG IDENTIFIER	EASTING	NORTHING	BASE ELEVATION (m)	TOTAL ELEVATION incl 5 m buffer
MH_TMM5	749886	6466815	674	829
MH_PMM4	751343	6467611	661	816
MH_TMM6	750974	6467765	690	845
MH_TMM7	751254	6468129	692	847
GR_ECG1	753911	6460134	606	761
GR_PMM1	760958	6462168	628	783
GR_TMM1	760559	6462571	621	776
GR_TMM2	760498	6462087	619	774
GR_PMM2	760386	6458097	556	711
GR_TMM3	760266	6458557	611	766
GR_TMM4	759944	6458232	605	760
GR_PMM3	753978	6457924	608	763
GR_TMM5	753569	6458121	624	779
GR_TMM6	753535	6457743	623	778
LV_ECG1	743634	6453982	565	720
LV_PMM1	743734	6450156	553	708

WTG IDENTIFIER	*EASTING*	*NORTHING*	*BASE ELEVATION* ***(m)***	***TOTAL ELEVATION incl 5 m buffer***
LV_TMM1	743857	6450601	561	716
LV_PMM2	749480	6450112	545	700
LV_TMM2	749148	6450440	562	717

ANNEXURE 4 – RISK ASSESSMENT FRAMEWORK

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects has been developed in consideration of ISO 31000:2018 *Risk management—Guidelines* and the guidance provided by CASA in its Safety Management System (SMS) for Aviation guidance material, which is aligned with the guidance provided by the International Civil Aviation Organization (ICAO) in Doc 9589 *Safety Management Manual*, Third Edition, 2013. Doc 9589 is intended to provide States (including Australia) with guidance on the development and implementation of a State Safety Programme (SSP), in accordance with the International SARPs, and is therefore adopted as the primary reference for aviation safety risk management in the context of the subject assessment.

Section 2.1 of the ICAO Doc 9589 *The concept of safety* defines safety as follows [author's underlining]:

> *2.1.1 Within the context of aviation, safety is "the state in which the possibility of harm to persons or of property damage is reduced to, and maintained* at or below, an acceptable level *through a continuing process of hazard identification and safety risk management."*

Likelihood

Likelihood is defined in ISO 31000:2018 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 1.

Table 1 Likelihood Descriptors

No	Descriptor	Description
1	Rare	It is almost inconceivable that this event will occur
2	Unlikely	The event is very unlikely to occur (not known to have occurred)
3	Possible	The event is unlikely to occur, but possible (has occurred rarely)
4	Likely	The event is likely to occur sometimes (has occurred infrequently)
5	Almost certain	The event is likely to occur many times (has occurred frequently)

Consequence

Consequence is defined as the outcome of an event affecting objectives, which in this case is the safe and efficient operation of aircraft, and the visual amenity and enjoyment of local residents.

Consequence descriptors used in this report are as indicated in Table 2.

Table 2 Consequence Descriptors

No	Descriptor	People Safety	Property/Equipment	Effect on Crew	Environment
1	Insignificant	Minor injury – first aid treatment	Superficial damage	Nuisance	No effects or effects below level of perception
2	Minor	Significant injury – outpatient treatment	Moderate repairable damage – property still performs intended functions	Operations limitation imposed. Emergency procedures used.	Minimal site impact – easily controlled. Effects raised as local issues, unlikely to influence decision making. May enhance design and mitigation measures.
3	Moderate	Serious injury - hospitalisation	Major repairable damage – property performs intended functions with some short-term rectifications	Significant reduction in safety margins. Reduced capability of aircraft/crew to cope with conditions. High workload/stress on crew. Critical incident stress on crew.	Moderate site impact, minimal local impact, and important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences.
4	Major	Permanent injury	Major damage rendering property ineffective in achieving design functions without major repairs	Large reduction in safety margins. Crew workload increased to point of performance decrement. Serious injury to small number of occupants. Intense critical incident stress.	High site impact, moderate local impact, important consideration at state level. Minor long-term cumulative effect. Design and mitigation measures unlikely to remove all effects.
5	Catastrophic	Multiple Fatalities	Damaged beyond repair	Conditions preventing continued safe flight and landing. Multiple deaths with loss of aircraft	Catastrophic site impact, high local impact, national importance. Serious long-term cumulative effect. Mitigation measures unlikely to remove effects.

Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 3.

Table 3 Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC
LIKELIHOOD	ALMOST CERTAIN 5	6	7	8	9	10
	LIKELY 4	5	6	7	8	9
	POSSIBLE 3	4	5	6	7	8
	UNLIKELY 2	3	4	5	6	7
	RARE 1	2	3	4	5	6

Actions required

Actions required according to the derived level of risk are shown in Table 4.

Table 4 Actions Required

8-10	**Unacceptable Risk**	Immediate action required by either treating or avoiding risk. Refer to executive management.
5-7	**Tolerable Risk**	Treatment action possibly required to achieve As Low As Reasonably Practicable (ALARP) - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.
0-4/5	**Broadly Acceptable Risk**	Managed by routine procedures, and can be accepted with no action.

ANNEXURE 5 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

In considering the need for aviation hazard lighting and marking, the applicable regulatory context was determined.

The Civil Aviation Safety Authority (CASA) regulates aviation activities in Australia. Applicable requirements include the Civil Aviation Regulations 1988 (CAR), Civil Aviation Safety Regulations 1998 (CASR) and associated Manual of Standards (MOS) and other guidance material. Relevant provisions are outlined in further detail in the following section.

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

In areas remote from an aerodrome, CASR 139.365 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether or not the structure will be hazardous to aircraft operations.

Manual of Standards Part 139—Aerodromes

Chapter 9 sets out the standards applicable to Visual Aids Provided by Aerodrome Lighting.

Section 9.30 provides guidance on Types of Obstacle Lighting and Their Use:

1. *The following types of obstacle lights must be used, in accordance with this MOS, to light hazardous obstacles:*
    a. *low-intensity;*
    b. *medium-intensity;*
    c. *high-intensity;*
    d. *a combination of low, medium or high-intensity.*
2. *Low-intensity obstacle lights:*
    a. *are steady red lights; and*
    b. *must be used on non-extensive objects or structures whose height above the surrounding ground is less than 45 m.*
3. *Medium-intensity obstacle lights must be:*
    a. *flashing white lights; or*
    b. *flashing red lights; or*
    c. *steady red lights.*

    Note CASA recommends the use of flashing red medium-intensity obstacle lights.
4. *Medium-intensity obstacle lights must be used if:*

a. *the object or structure is an extensive one; or*

b. *the top of the object or structure is at least 45 m but not more than 150 m above the surrounding ground; or*

c. *CASA determines in writing that early warning to pilots of the presence of the object or structure is desirable in the interests of aviation safety.*

Note For example, a group of trees or buildings is regarded as an extensive object.

5. *For subsection (4), low-intensity and medium-intensity obstacle lights may be used in combination.*

6. *High-intensity obstacle lights:*

    a. *must be used on objects or structures whose height exceeds 150 m; and*

    b. *must be flashing white lights.*

7. *Despite paragraph (6) (b), a medium-intensity flashing red light may be used if necessary, to avoid an adverse environmental impact on the local community.*

Sections 9.31 (8) and (9) provide guidance on obstacle lighting specific to wind farms:

8. *Subject to subsection (9), for wind turbines in a wind farm, medium-intensity obstacle lights must:*

    a. *mark the highest point reached by the rotating blades; and*

    b. *be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, but such that intervals between lit turbines do not exceed 900 m; and*

    c. *all be synchronised to flash simultaneously; and*

    d. *be seen from every angle in azimuth.*

    Note: This is to prevent obstacle light shielding by the rotating blades of a wind turbine and may require more than 1 obstacle light to be fitted.

9. *If it is physically impossible to light the rotating blades of a wind turbine:*

    a. *the obstacle lights must be placed on top of the generator housing; and*

    b. *a note must be published in the AIP-ERSA indicating that the obstacle lights are not at the highest position on the wind turbines.*

10. *If the top of an object or structure is more than 45 m above:*

    a. *the surrounding ground (ground level); or*

    b. *the top of the tallest nearby building (building level); then the top lights must be medium-intensity lights, and additional low-intensity lights must be:*

    c. *provided at lower levels to indicate the full height of the structure; and* *d. spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.*

Advisory Circular 139-08 v2—Reporting of Tall Structures

In Advisory Circular (AC) 139-08 v2—*Reporting of Tall Structures*, CASA provides guidance to those authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

Airservices Australia has been assigned the task of maintaining a database of tall structures, the top measurement of which is:

a) 30 metres or more above ground level—within 30 kilometres of an aerodrome; or

b) 45 metres or more above ground level elsewhere.

The purpose of notifying Airservices Australia of these structures is to enable their details to be provided in aeronautical information databases and maps/charts etc used by pilots, so that the obstacles can be avoided.

The proposed wind turbines must be reported to Airservices Australia. This action should occur once the final layout after micrositing is confirmed and prior to construction.

International Civil Aviation Organisation

Australia, as a contracting State to the International Civil Aviation Organisation (ICAO) and signatory to the Chicago Convention on International Civil Aviation (the Convention), has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention.

Annex 14 to the Convention – *Aerodromes, Volume 1,* Section 6.2.4 provides SARPs for the obstacle lighting and marking of wind turbines, which is copied below:

6.2.4 Wind turbines

6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note 1. – Additional lighting or markings may be provided where in the opinion of the State such lighting or markings are deemed necessary.

Note 2. – See 4.3.1 and 4.3.2

Markings

6.2.4.2 Recommendation. – The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.

Lighting

6.2.4.3 Recommendation. – When lighting is deemed necessary, in the case of a wind farm, i.e. a group of two or more wind turbines, the wind farm should be regarded as an extensive object and the lights should be installed:

a) to identify the perimeter of the wind farm;

b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm;

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and

e) at locations prescribed in a), b) and d), respecting the following criteria:

i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle should be provided;

ii) for wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other; and

iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, as specified in 6.2.1.3, should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights may be used.

Note. — The above 6.2.4.3 e) does not address wind turbines of more than 315 m of overall height. For such wind turbines, additional marking and lighting may be required as determined by an aeronautical study.

6.2.4.4 Recommendation. — The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

6.2.4.5 Recommendation. — Where lighting is deemed necessary for a single wind turbine or short line of wind turbines, the installation should be in accordance with 6.2.4.3 e) or as determined by an aeronautical study.

As referenced in Section 6.2.4.3(e)(iii), Section 6.2.1.3 is copied below:

6.2.1.3 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that adjacent object or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

As referenced in Section 6.2.4.3(b), Section 6.2.3.15 is copied below:

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and *a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and*

b) medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

Section 4.3 Objects outside the OLS states the following:

4.3.1 Recommendation.— Arrangements should be made to enable the appropriate authority to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by that authority, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.

4.3.2 Recommendation. — In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.

Note. — This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

ICAO Doc 9774 Manual on Certification *of Airports* defines an aeronautical study as:

An aeronautical study is a study of an aeronautical problem to identify potential solutions and select a solution that is acceptable without degrading safety.

Light characteristics

If obstacle lighting is required, installed lights should be designed according to the criteria set out in the applicable regulatory material and taking CASA's recommendations into consideration in the case that CASA has reviewed this risk assessment and provided recommendations.

The characteristics of the obstacle lights should be in accordance with the applicable standards in MOS 139.

The characteristics of low and medium intensity obstacle lights specified in MOS 139, Chapter 9, are provided below.

MOS 139 Chapter 9 Division 4 – Obstacle Lighting section 9.32 outlines Characteristics of Low Intensity Obstacle Lights.

1. *Low-intensity obstacle lights must have the following:*
    a. *fixed lights showing red;*
    b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*
    c. *a minimum intensity of 100 candela (cd);*
    d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*
    e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*

f. not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.

Note: The intensity requirement in paragraph (c) may be met using a double-bodied light fitting. CASA recommends that double-bodied light fittings, if used, should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

2. To indicate the following:

a. taxiway obstacles;

b. unserviceable areas of the movement area; low-intensity obstacle lights must have a peak intensity of at least 10 cd.

MOS 139 Chapter 9 Division 4 – Obstacle Lighting section 9.33 outlines Characteristics of Medium Intensity Obstacle Lights.

1. Medium-intensity obstacle lights must:

a. be visible in all directions in azimuth; and

b. if flashing — have a flash frequency of between 20 and 60 flashes per minute.

2. The peak effective intensity of medium-intensity obstacle lights must be 2 000 ☐ 25% cd with a vertical distribution as follows:

a. for vertical beam spread — a minimum of 3 degrees;

b. at -1-degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;

c. at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.

3. For subsection (2), vertical beam spread means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.

4. If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.

Visual impact of night lighting

Annex 14 Section 6.2.4 and MOS 139 Chapter 9 are specifically intended for wind turbines and recommends that medium intensity lighting is installed.

Generally accepted considerations regarding minimisation of visual impact are provided below for consideration in this aeronautical study:

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness

- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
    - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal
    - such that no light is emitted at or below 10 degrees below horizontal
- If a light would be shielded in any direction by an adjacent object or structure, the light so shielded may be omitted, provided that such additional lights are used as are necessary to retain the general definition of the object or structure
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall turbine.

Marking of turbines

ICAO Annex 14 Vol 1 Section 6.2.4.2 recommends that the rotor blades, nacelle and upper 2/3 of the supporting mast of the wind turbines should be painted a shade of white, unless otherwise indicated by an aeronautical study.

It is generally accepted that a shade of white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.

Wind monitoring towers

Consideration could be given to marking any WMTs according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings; specifically:

> *8.110 (5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m.*
>
> *8.110 (7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects. (8) The objects mentioned in subsection (7) must: be approximately equivalent*

NASF Guideline D suggests consideration of the following measures specific to the marking and lighting of WMTs:

- the top 1/3 of wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers

- marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires
- ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation or
- a flashing strobe light during daylight hours.

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