APPENDIX H AVIATION IMPACT ASSESSMENT

October 2020

HILLS OF GOLD WIND FARM

AVIATION IMPACT ASSESSMENT

Prepared for ERM Australia Pty Ltd

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
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
GNSS	global navigation satellite system
HOGWF	Hills of Gold Wind Farm
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 budget error has been applied for an assessment of the wind turbine generators (WTGs) and proposed permanent wind monitoring towers (WMTs) maximum height.

Additional permanent WMTs height structure is 150 m above ground level (AGL).

EXECUTIVE SUMMARY

Introduction

ERM Australia Pty Ltd (ERM) is preparing a development application (DA) for a State Significant Development (SSD) application for the proposed Hills of Gold Wind Farm (the Project).

Wind Energy Partners Pty Ltd (WEP) is the Proponent of the Project.

The Project consists of up to 70 wind turbines and associated infrastructure to be developed over the Project Area. The Project Area is located south of Tamworth, south of Nundle, south of Hanging Rock and east of Wallabadah, within the boundaries of Tamworth Regional Council (TRC) ,Upper Hunter Shire Council (UHSC) and Liverpool Plains Shire Council (LPSC) local government area (LGAs) in New South Wales, and approximately 53 km (28 nm) east from Quirindi Airport (YQDI).

The maximum tip height of the wind turbine generator (WTG) will be up to 230 m above ground level (AGL).

ERM has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) to assess the potential aviation safety impacts associated with the Project to support the proposed SSD application and formally consult with aviation agencies. The SSD application will be submitted to the Department of Planning, Industry and Environment (DPIE) for approval.

This AIA assesses the potential aviation impacts, provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies.

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators.

Project description

The proposed Project will comprise the following:

- up to 70 wind turbines
- maximum overall height (tip height) of the wind turbines is up to 230 m AGL
- highest wind turbine is WP20 with ground elevation of 1410 m Australian Height Datum (AHD) and overall height of 1646 m AHD (5400 ft above mean sea level (AMSL))
- 3 existing temporary wind monitoring towers (WMTs) with a maximum height of up to 110 m (361 ft) AGL, which have been reported to Airservices Australia. Additionally, the Project includes decommissioning of three current monitoring masts and installation of up to five additional monitoring masts for power testing
- 5 proposed permanent WMTs with a maximum height of up to 155 m (509 ft) AGL, which will be reported to Airservices Australia

- 330 kV single circuit twin conductor overhead transmission line (transmission line) to connect the onsite substation to the existing 330 kV TransGrid Liddell to Tamworth overhead transmission line network.

Conclusions

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

Planning considerations

The Project as proposed does not satisfy the following Local Environmental Plan in relation to impacts to 'Operations Surfaces', noting however, that Procedures for Air Navigation Services Operations Surface Maps are not published in any of the Plans:

- Upper Hunter LEP 2013, dated 17 April 2020

Under the planning provisions, the impacts would be acceptable if the relevant Commonwealth body (assumed to be Airservices Australia or CASA) advises that the development will penetrate Operations Surfaces but it has no objection to its construction.

The Project as proposed satisfies the following planning documents:

- Tamworth Regional Development Control Plan 2010, Amendment No 13. Adopted 26 October 2010
- Tamworth Regional LEP 2010, dated 17 April 2020
- Liverpool Plains Shire Council Development Control Plan 2012, Amendment No 4, 26 February 2020
- Liverpool Plains LEP 2011, dated 17 April 2020.

Certified airports

1. The Project site is located beyond 30 nautical miles (nm) (55.56 km) (area used to identify possible constraints) from Tamworth Airport (YSTW), however is located within 30 nm of Scone Airport (YSCO) and Quirindi Airport (YQDI).
2. The Project is located outside the 10 nm minimum safe altitude (MSA) of Scone Airport but within the 25 nm MSA of Scone Airport with an MSA of 6300 ft AMSL.
3. The Project will impact the 25 nm MSA at Scone Airport in the sector bounded by bearings 070º and 290º.
4. The initial approach altitude for RNAV GNSS approach procedures for runway 29 at Scone Airport will be impacted by the Project.
5. The Project site is located outside the 10 nm MSA of Quirindi Airport but within the 25 nm MSA of Quirindi Airport in the sectors bounded by bearings of 245º and 065º. The 25 nm MSA of Quirindi Airport will not be impacted.
6. The Project is located beyond the horizontal extent of aerodrome circling areas at Quirindi Airport and Scone Airport.

Aircraft Landing Areas (ALAs)

7. 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.
8. There are three ALAs located within proximity to the Project Area and associated infrastructure. ALA 1 which is located approximately 1.8 km (1 nm) west of the Project, ALA 2, which is located approximately 2.79 km (1.5 nm) east of the Project and ALA 5 which is located approximately 300 m east of the proposed infrastructure (switching yard and powerline) of the Project.
9. Dependent on the wind direction and wind speed at the time, if wind turbines are operating when ALA 1 and ALA 2 are used, the potential extent of downstream wake turbulence could be noticeable from some of the proposed wind turbines at these ALAs.
10. Consultation should be completed with aerial operators who operate at ALA 1 and ALA 2 to address potential impacts on the aircraft operations.

Obstacle Limitation Surfaces

11. The obstacle limitation surfaces of Quirindi and Scone Airports will not be impacted.

Air Routes and Lowest Safe Altitude

12. The Project boundary is solely located in the area with a grid lowest safe altitude of 2011 m AHD (6600 ft AMSL) with a minimum obstacle clearance (MOC) surface of 1707 m AHD (5600 ft AMSL). The highest wind turbine, which is WP20, is below the Lowest safe altitude (LSALT) MOC of 5600 ft AMSL by approximately 61 m (200 ft). Therefore, the Project will not affect the grid LSALT MOC of 5600 ft AMSL.
13. The Project will impact air route H99 LSALT.

Airspace

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

Aviation Facilities

15. The wind turbines of the Project will not penetrate any protection areas associated with aviation facilities.

Radar

16. The Project site is located in Zone 4 (accepted zone) and outside the radar line of sight of Round Mountain Route Surveillance Radar (RSR) and will not interfere with the serviceability of this aviation facility.
17. It is unlikely that the Project will impact Namoi Black Jack Mountain DWSR 8502S 2° S-band Doppler radar located at Black Jack Mountain near Gunnedah, as the project is located beyond 104 km from this meteorological radar.

Aviation Impact Statement

18. Based on the proposed Project layout and overall turbine overall blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is WP20, will not exceed 1646 m AHD (5400 ft AMSL).

19. This AIS concludes that the proposed Project:

    a. will not penetrate any OLS surfaces

    b. will penetrate PAN-OPS surfaces of Scone Airport

    c. will have an impact on nearby designated air route H99

    d. will not have an impact on the grid LSALT

    e. will not have an impact on prescribed airspace

    f. is wholly contained within Class G airspace

    g. is outside the clearance zones associated with aviation navigation aids and communication facilities.

Obstacle lighting risk assessment

20. 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, once the proposed mitigation solutions outlined in Section 6.24 are implemented.

Consultation

21. Refer to Section 5 for detailed responses from relevant aviation stakeholders.

Summary of key recommendations

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

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

1. 25 nm MSA at Scone Airport in the sector bounded by bearings 070° and 290° should be increased by 100 ft to 6400 ft AMSL.

2. The initial approach altitude for RNAV GNSS approach procedures for runway 29 at Scone Airport should be amended to 6400 ft AMSL to safeguard the approach procedure.

3. Air route H99 LSALT should be increased by 300 ft from 6100 ft to 6400 ft AMSL.

4. WEP should consult with the operator of the ALA 1 and ALA 2 to agree on a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that the ALAs are in use for take-off and landing.

5. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

6. Department of Defence should be consulted for the proposed Project development.

7. To facilitate the flight planning of aerial application operators, the location and height of wind turbines and wind monitoring towers 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.

8. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.

9. WEP 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.

10. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction in order for them to consider the wind farm for their operations. Specifically, details should be provided to the New South Wales Regional Airspace and Procedures Advisory Committee (rapac@casa.gov.au) for consideration by its members in relation to visual flight rules (VFR) transit routes in the vicinity of the wind farm.

11. The rotor blades, nacelles and towers of the wind turbines should be painted in white, typical of most wind turbines operational in Australia.

12. Consideration has been made to marking the temporary and permanent wind monitoring towers according to the requirements set out in Manual of Standards (MOS) 139 Chapter 8 Division 10 (as modified by the guidance in NASF Guideline D).

1. INTRODUCTION

1.1. Situation

ERM is preparing an Environmental Impact Statement (EIS) for a State Significant Development (SSD) application for the Project.

The Project consists of up to 70 wind turbines and associated infrastructure to be developed over the Project Area. The Project Area is located south of Tamworth, south of Nundle, south of Hanging Rock and east of Wallabadah, within the boundaries of Tamworth Regional Council (TRC) ,Upper Hunter Shire Council (UHSC) and Liverpool Plains Shire Council (LPSC) local government area (LGAs) in New South Wales, and approximately 53 km (28 nm) east from Quirindi Airport (YQDI).

The maximum tip height of the WTG will be up to 230 m AGL.

ERM has engaged Aviation Projects to prepare an AIA to assess the potential aviation safety impacts associated with the Project to support the proposed SSD application and formally consult with aviation agencies. The SSD application will be submitted to the DPIE for approval.

This AIA assesses the potential aviation impacts, provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies.

The AIA and supporting technical data will provide evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified.

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*
- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Secretary’s Environmental Assessment Requirements (SEARs) SSD 9679.

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:

- confirmed the scope and deliverables with ERM
- reviewed client material

- conducted a site visit on 10 June 2020 to properly investigate aviation safety aspects of the proposed Project
- reviewed relevant regulatory requirements and information sources
- prepared 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
- identified 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*
- consulted with LPSC, UHSC and TRC, Part 173 procedure designers (Airservices Australia) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
- consulted/engaged with stakeholders to negotiate acceptable outcomes (if required)
- finalised 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 Area
- 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 Area 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 Area is located

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by ERM for preparation of this assessment included:

- ERM, ALA layout, *ALA Golland.kmz*, received 17 August 2020
- ERM, Hills of Gold Wind Farm Layout, *70 WTG Coordinates V2_02July2020_FINAL.kmz*, dated 2 July 2020
- ERM, Hills of Gold Wind Farm Transmission layout, *TransmissionLine_V6_10Sep2020.shp,* dated 10 September 2020
- ERM, Hills of Gold Wind Farm Transmission Line Structures, TransmissionLineStructures_V6_10Sep2020.*shp,* dated 10 September 2020
- ERM, Hills of Gold Wind Farm Turbine Co-ordinates, *Turbine Co-ordinates.xlsx*, received 20 October 2020
- ERM, Hills of Gold Wind Farm Site Boundary, *WFSiteBoundary_V7_17Sep2020.shp*, dated 17 September 2020
- ERM, Hills of Gold Wind Farm WMT coordinates and details, *Multiple-structure-reporting-csv-format-template-Hills of Gold.xlsx,* received 27 May 2020.

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2. BACKGROUND

2.1. Site overview

An overview of the Project Area and transmission corridor (in yellow colour) relative to localities of Nundle, Hanging Rock and Wallabadah is provided in Figure 1 (source: Someva, Google Earth).

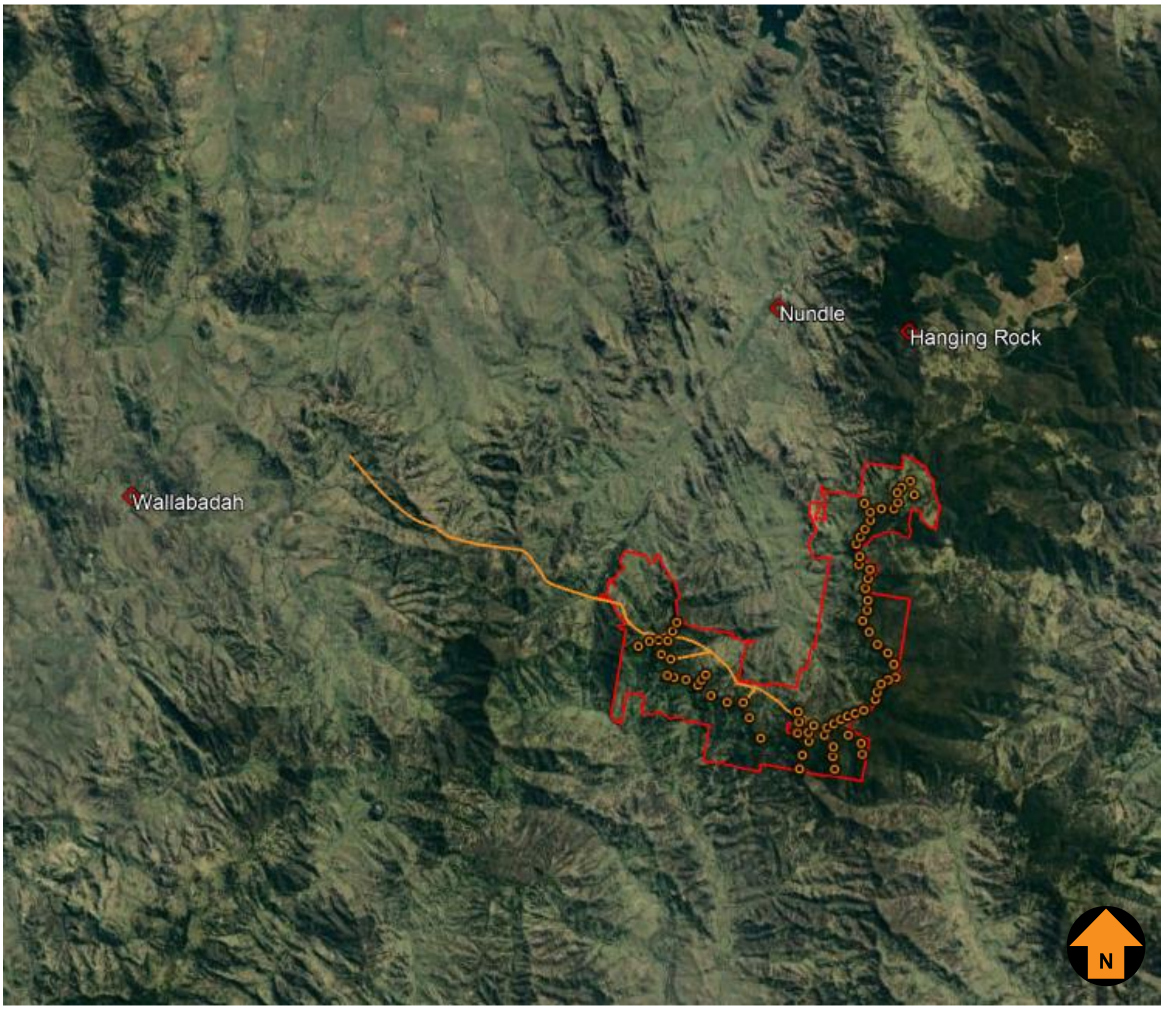

Figure 1 Project site overview

2.2. Project description

The Project involves the construction, operation and commissioning of a wind farm with up to 70 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project consists of the following key components:

- up to 70 WTGs, each with:
    - a generating capacity of approximately 6 MW
    - three blades mounted to a rotor hub on a tubular steel tower, with a combined height of blade and tower limited to a maximum tip height of 230 m AGL
    - a gearbox and generator assembly housed in a nacelle
    - adjacent hardstands for use as crane pads and assembly and laydown areas.
- decommissioning of three current monitoring masts and installation of up to five additional monitoring masts for power testing. The new monitoring masts will be located close to a WTG location with a maximum height of approximately 150 m AGL, equivalent to the hub height of the installed WTGs. The exact number and location will be defined at the detailed design stage
- a centrally located 330 kV electrical substation, including transformers, insulators, switchyard and other ancillary equipment
- an operations and maintenance facility
- a battery energy storage system (BESS) of 100 MW/400 MWh (4 hours of storage of 100MW of power)
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where practicable) (connection lines)
- a 330 kV single circuit twin conductor overhead transmission line (transmission line) to connect the onsite substation to the existing 330 kV TransGrid Liddell to Tamworth overhead transmission line network, located approximately 18.8 km west of the substation
- a switching station to connect the Project to the 330 kV TransGrid Liddell to Tamworth line and enable the Project to connect to the gird. The switching station will also be located approximately 18.8 km west of the substation, or approximately 13.5 km from the WTG Project Area
- an internal private access road network (combined total length of approximately 48 km) connecting the WTGs and other Project infrastructure to the public road network
- upgrades to local roads and crossings required for the delivery, installation and maintenance of WTG components and associated materials and structures.

The following temporary elements will be required during construction of the Project:

- temporary site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce
- two temporary concrete batching plants to supply concrete for WTG footings and substation construction works

- earthworks for access roads, WTG platforms and foundations
- potentially rock crushing facilities for the generation of suitable aggregates for concrete batching or sized rock for access road and hardstand construction
- up to seven hardstand laydown areas for the temporary storage of construction materials, plant, and equipment construction
- external water supply and aggregates / materials for concrete batching and construction activities
- the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure.

The Project Area is located east of Crawney Road within the boundaries of TRC, UHSC and LPSC LGAs in New South Wales, and approximately 53 km (28.5 nm) east from Quirindi Airport.

Refer to Figure 2 for the Project boundary within the boundaries of Tamworth Regional Council and Upper Hunter Shire Council (source: Someva, NSW Globe).

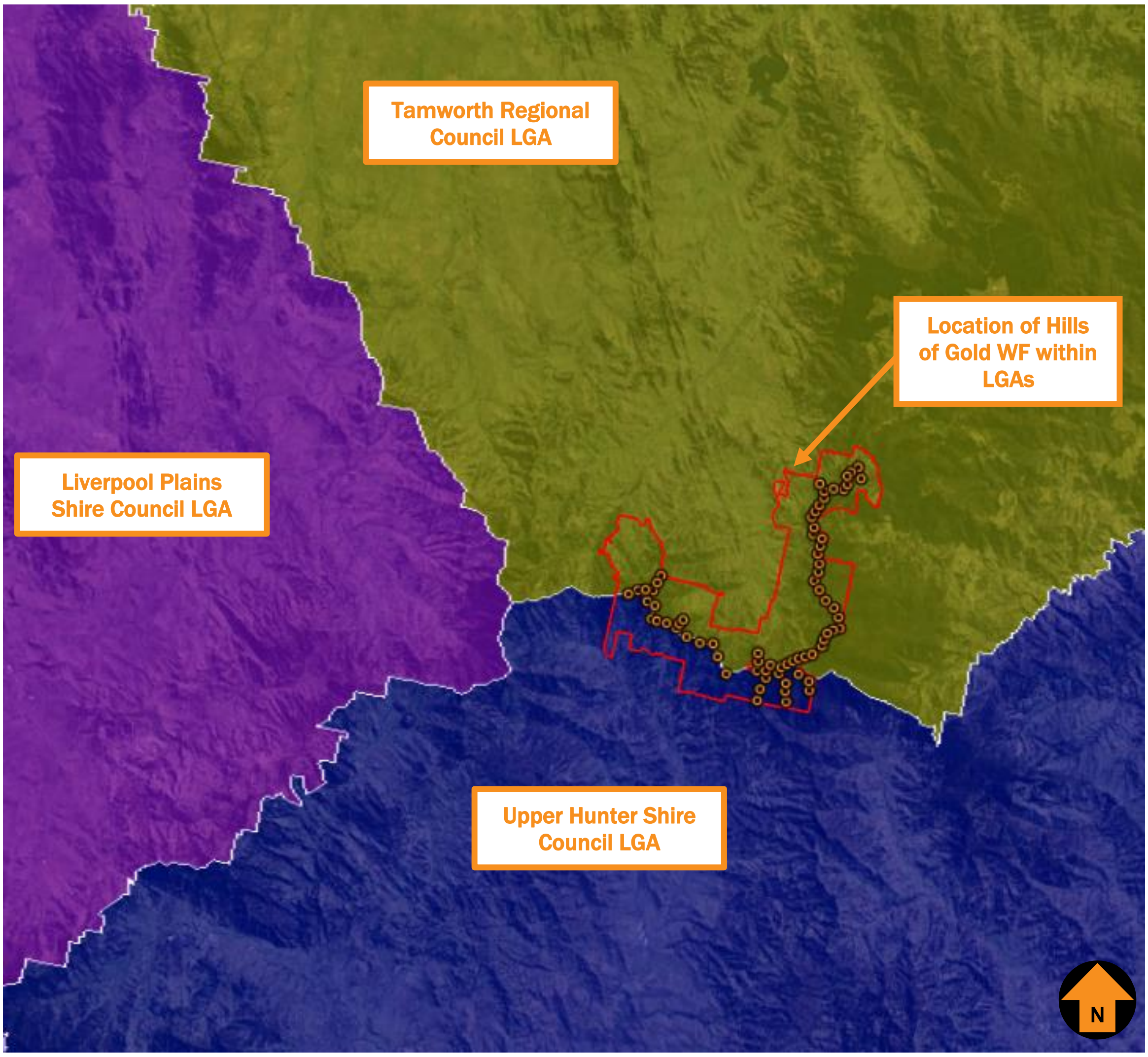

Figure 2 Project boundary relative to LGAs

3. EXTERNAL CONTEXT

3.1. Planning context

The Proponent, Wind Energy Partners Pty Ltd, 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.

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. Tamworth Regional Council

The Tamworth Regional Development Control Plan 2010 Step 4: Site Specific Tamworth Business Park, (amendment No 13. Adopted 26 October 2010) includes the following provisions for Tamworth Airport:

> *Airport*
>
> *A condition will be imposed of any development consent to require that notification be provided to the Airport Manager a minimum of 21 days before the operation of a crane for building work.*
>
> *The Tamworth Regional Local Environmental Plan 2010 contains controls relating to the construction of buildings within the vicinity of the Tamworth Airport which may impact on the height and construction standards.*

The Tamworth Regional Local Environmental Plan 2010 (dated 17 April 2020) includes provisions for airspace operations at Tamworth Airport. Section 7.6 Development in flight path details the following:

> *7.6 Development in flight path*
>
> *(1) The objectives of this clause are—*
>
> > *(a) to provide for the effective and on-going operation of the Tamworth Airport, and*
> >
> > *(b) to ensure that any such operation is not compromised by proposed development in the flight path of that airport.*
>
> *(2) Development consent must not be granted to erect a building on land in the flight path of the Tamworth Airport if the proposed height of the building would exceed the obstacle height limit determined by the relevant Commonwealth body.*
>
> *(3) Before granting development consent to the erection of a building in the flight path of the Tamworth Airport, the consent authority must—*
>
> > *(a) give notice of the proposed development to the relevant Commonwealth body, and*
> >
> > *(b) consider any comment made by the relevant Commonwealth body within 28 days of the body having been given notice of the proposed development, and*
> >
> > *(c) consider whether the proposed use of the building will be adversely affected by the exposure to aircraft noise.*
>
> *(4) For the purposes of this clause, land is in the flight path of the Tamworth Airport if the relevant Commonwealth body has notified the consent authority that the land is in such a flight path.*

Refer to Figure 3 for a map depicting the obstacle limitation surface for Tamworth Airport (source: Tamworth Regional LEP 2010, Sheet OLS_004C).

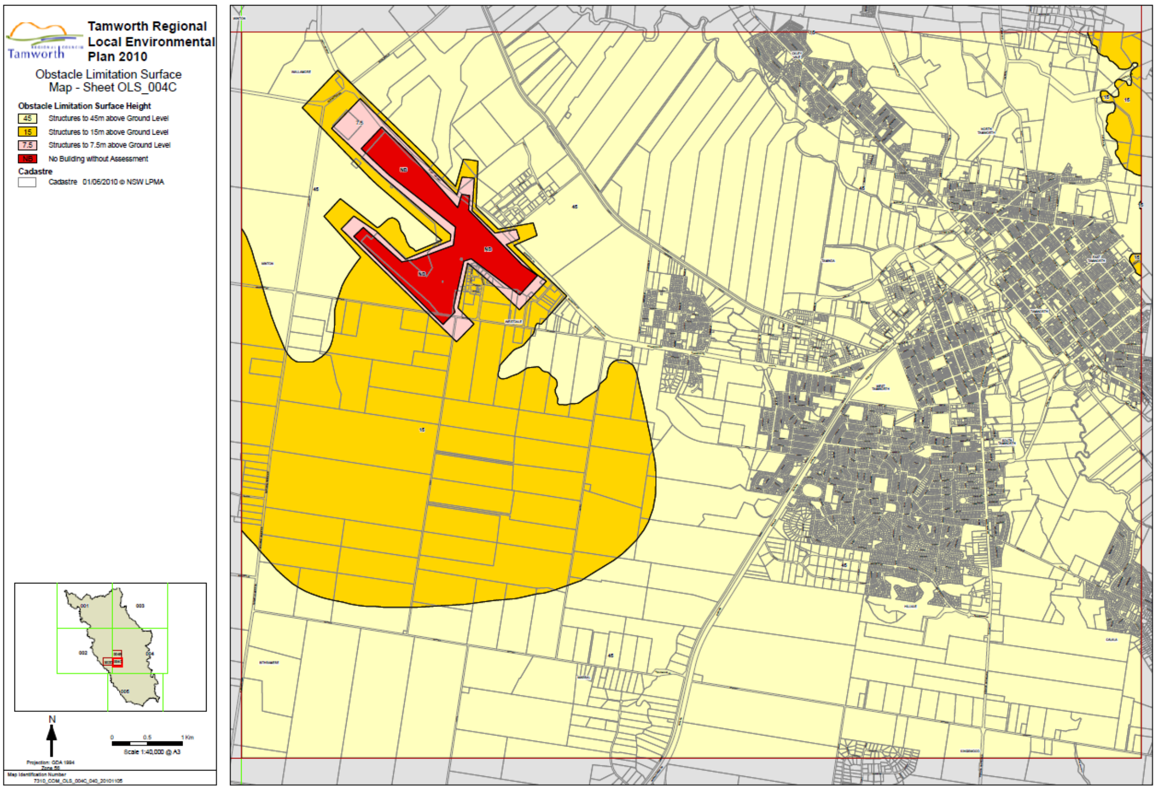

Figure 3 Tamworth Airport (YSTW) obstacle limitation surface

The Project is located approximately 59 km (32 nm) south east of Tamworth Airport.

Therefore, the Project will not have an impact on the airspace associated with Tamworth Airport.

3.4. Upper Hunter Shire Council

The *Upper Hunter Local Environmental Plan 2013* (dated 17 April 2020) includes provisions for airspace operations at Scone Airport (YSCO). Section 6.7 Airspace operations details the following:

> *(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) to protect the community from undue risk from that operation.*
>
> *(2) If a development application is received and the consent authority is satisfied that the proposed development will penetrate the Limitation or Operations Surface, the consent authority must not grant development consent unless it has consulted with the relevant Commonwealth body about the application.*

(3) The consent authority may grant development consent for the development if the relevant Commonwealth body advises that—

> *(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.

Refer to Figure 4 for a map depicting the obstacle limitation surface for Scone Airport (source: Upper Hunter LEP 2013, Sheet OLS_008). There is no map for the airport's PANS-Ops surfaces.

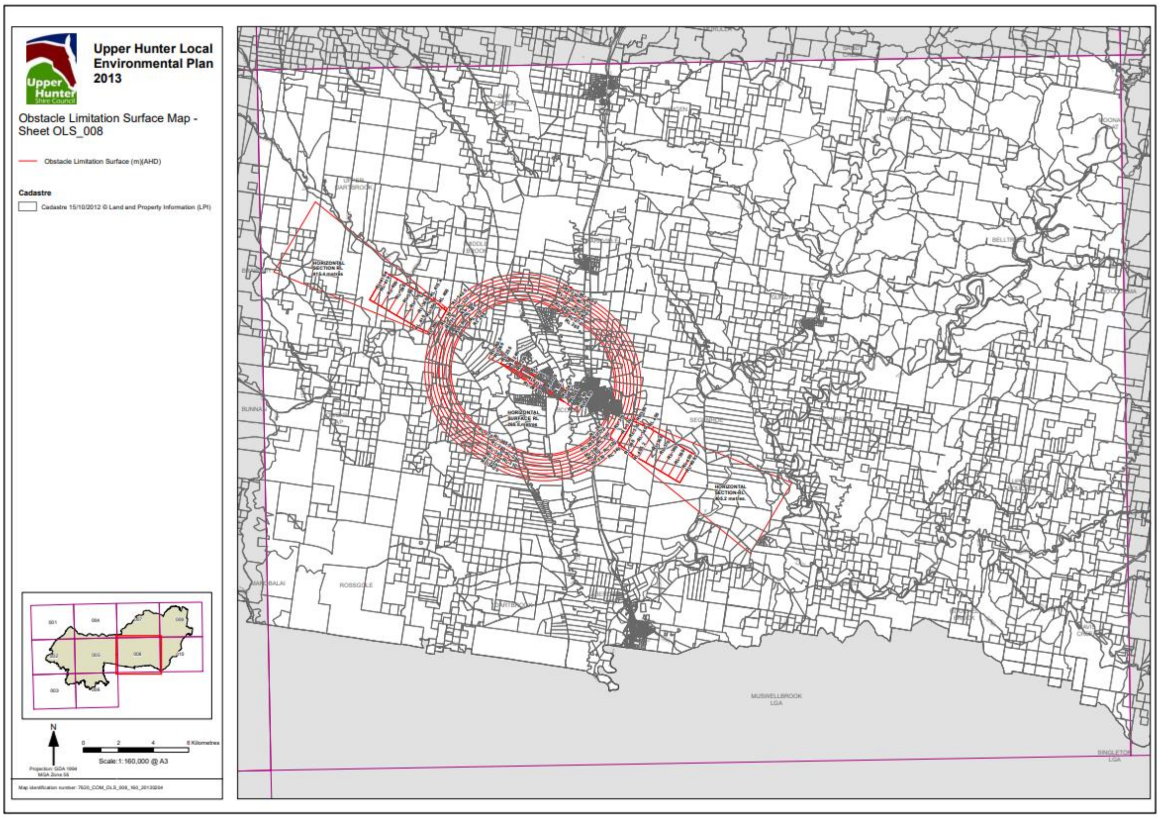

Figure 4 Scone Airport (YSCO) obstacle limitation surface

The Project is located approximately 52 km (28 nm) north of Scone Airport and outside of the OLS associated with Scone Airport, refer to Section 6.2 for detailed analysis.

3.5. Liverpool Plains Shire Council

The *Liverpool Plains Shire Council Development Control Plan 2012* (Amendment No 4, 26 February 2020), does not mention or include any provisions regarding Quirindi Airport, nor does it have any provisions for wind turbines.

The *Liverpool Plains Local Environmental Plan 2011* (dated 17 April 2020) includes provisions for the protection of airspace operations at Quirindi Airport. Section 7.5 Airspace operations details the following:

> *(1) The objectives of this clause are as follows—*
>
> > *(a) to provide for the effective and ongoing operation of the Quirindi 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.*
>
> *(2) If a development application is received and the consent authority is satisfied that the proposed development will penetrate the Limitation or Operations Surface, the consent authority must not grant development consent unless it has consulted with the relevant Commonwealth body about the application.*
>
> *(3) The consent authority may grant development consent for the development if the relevant Commonwealth body advises that—*
>
> > *(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.*

The Project is located approximately 53 km (28.5 nm) east of Quirindi Airport and outside of the OLS associated with Quirindi Airport. It is unlikely that the Project will have an impact on the airspace associated with Quirindi Airport, refer to Section 6.7 for further analysis.

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 5 and Figure 6.

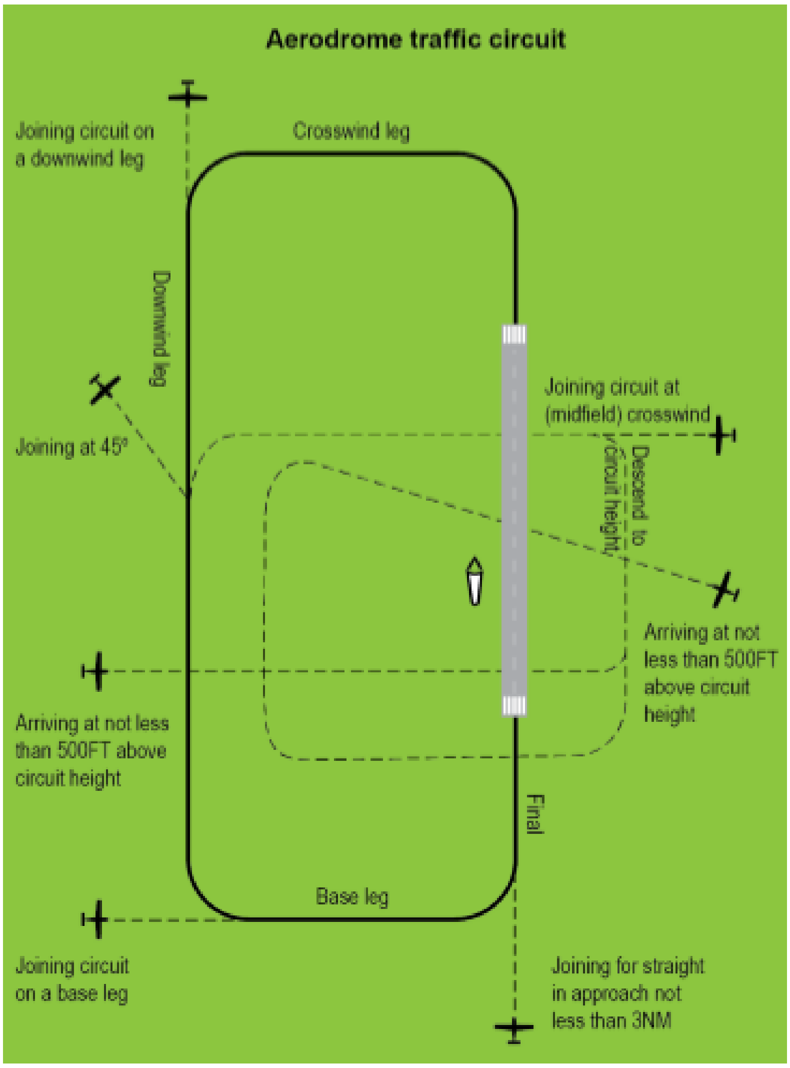

Figure 5 Aerodrome standard traffic circuit, showing arrival and joining procedures

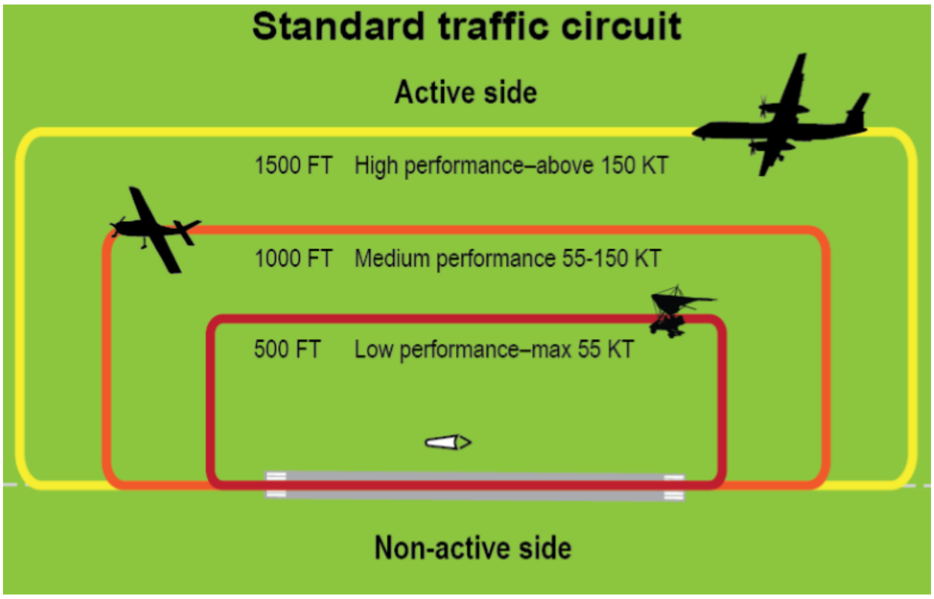

Figure 6 Lateral and vertical separation in the standard aerodrome traffic circuit

CAAP 166-01 v4.2 paragraph 5.4.1 makes reference 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 Area 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.

The Department of Defence advised during consultation that it has no objections to the Project. Refer to Section 5 for a detailed response from the Department of Defence.

3.12. Aerial agricultural 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.

There is a medium rate of aerial application operations in the area.

Due to the nature of the operations conducted, aerial agriculture pilots are subject to rigorous training and assessment requirements in order 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 was assessed.

Refer to Section 5 for detailed responses from aerial agricultural operator stakeholders.

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 still be possible on properties within the Project site and neighbouring the Project site, 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 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.

Consultation between ERM and Forestry Corporation of New South Wales confirmed aerial activities within the area:

> *There are routine aerial operations (wild dog baiting) on the SF run by LLS as well as the adjoining NP, usually once, but sometimes twice per year. NPWS also conduct aerial shooting and use aircraft for all sorts of things including feral animal monitoring, HR burning, weed mapping/spraying.*

NSW National Parks and Wildlife Service (NSW NPWS) manage the Ben Halls Gap Nature Reserve which borders the project area to the immediate east and the Crawney National Park, which borders the project area to the west. Consultation between NSW NPWS and ERM identified the activities in the area:

> *NPWS undertakes low-level daylight flying operations over and around BHGNR and CPNP. These include:*

- *aerial shooting of pest species from helicopters;*
- *aerial baiting for wild dogs and foxes from either fixed-wing or helicopters at ~100 feet (30 metres) above the canopy; and*
- *firefighting and fire management operations (including bucketing and dropping incendiaries) generally using helicopters, but occasionally by fixed wing aircraft.*

Further consultation should be held with Forestry Corporation of New South Wales, NSW NPWS and WEP to ensure that pilots are aware of the turbine locations and can plan operations appropriately.

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 2.0, dated 30 October 2014.

Of specific interest in this document is the paragraph copied below:

> *Aerial firefighting operations will treat turbine towers similar to other tall obstacles. Pilots and Air Operations Managers will assess these risks as part of routine procedures. Risks due to wake turbulence and the moving blades should also be considered. Wind turbines are not expected to pose unacceptable risks.*

During discussions with New South Wales National Parks and Wildlife Service (NSW NPWS), ERM was made aware of a dam located on the Project Area, which has historically been used during bushfires. The dam would be used by helicopters to aide in the fight of bushfires in the area, refer to Figure 7 for context of the dam in relation to the Project Area (Source: Google Earth, Someva).

Figure 7 Location of Project in relation to Dam

The Ben Halls Gap National Park Bushfire Management Plan identifies a helipad located within the Project Area for the purpose of bushfire management. Refer to Figure 8 (source: Google Earth, Someva).

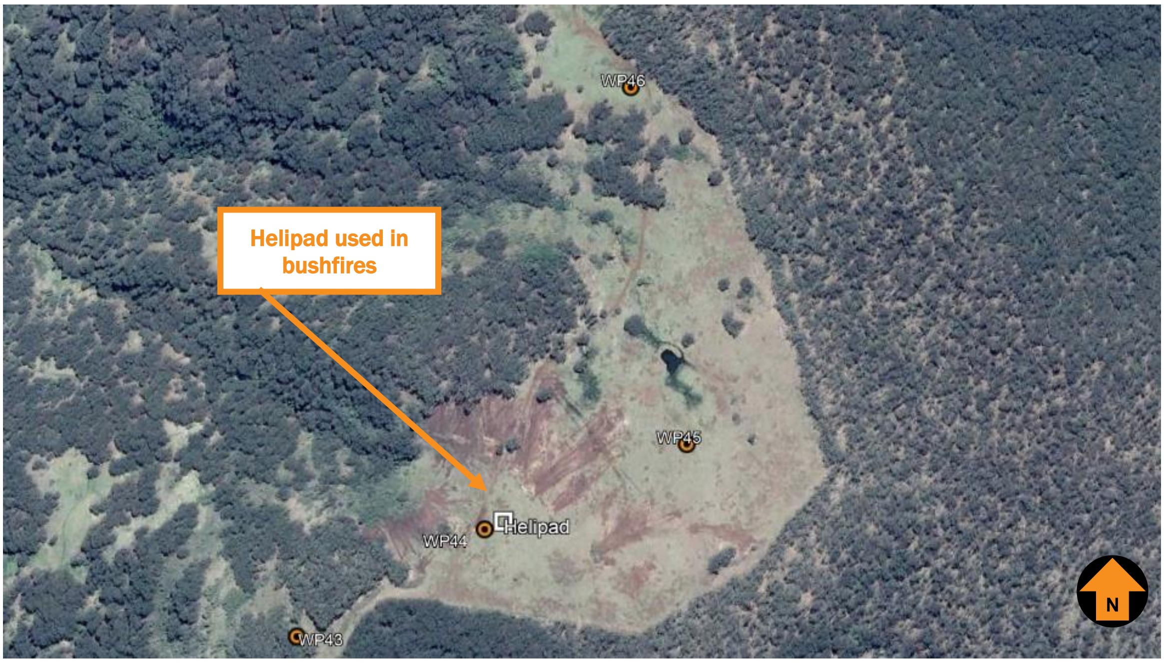

Figure 8 Location of Project in relation to helipad

During periods of bushfire it is difficult to establish the exact directions that helicopter pilots would be flying in due to smoke, wind and visibility at each particular time. Without knowing what the determining factors are for pilots operating during bushfire operations, it is prudent to ascertain the impact of the Project on this dam.

Further consultation should be held with New South Wales Rural Fire Service (NSW RFS) and WEP to ensure that appropriate mitigation methods are in place, so that in the event of a bushfire in the area, pilots are aware of the turbine locations and can respond appropriately.

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.

Refer to Section 5 for detailed responses from emergency services stakeholders.

4. INTERNAL CONTEXT

4.1. Wind farm description

The wind farm is situated in an area comprised mainly of farming properties on a landscape with medium terrain hills, the site is located east of Crawney Road.

Figure 9 shows a view looking east from stakeholder property towards the northern aspect of the proposed Project.

Figure 9 looking east towards the northern end of the proposed Project site

Figure 10 shows a view situated at Head of Peel Road looking east towards the Project site.

Figure 10 Head of Peel Road looking east at the Project site

Figure 11 shows a view from Crawney Road looking to the south east towards the Project site.

Figure 11 Crawney Road looking to the south east at the Project site

Figure 12 taken on stakeholder property shows a view looking towards the northern most tip of the Project site.

Figure 12 View looking towards the northern most tip of the Project site

4.2. Wind turbine description

The maximum blade tip height of the proposed wind turbines will be up to 230 m AGL.

The maximum ground elevation for the proposed wind turbine WP20 wind turbine is 1410.8 m AHD, which results in a maximum overall height of 1646 m AHD (5400 ft AMSL).

Figure 13 demonstrates the Project layout identifying the highest wind turbine WP20 (source: Someva, Google Earth).

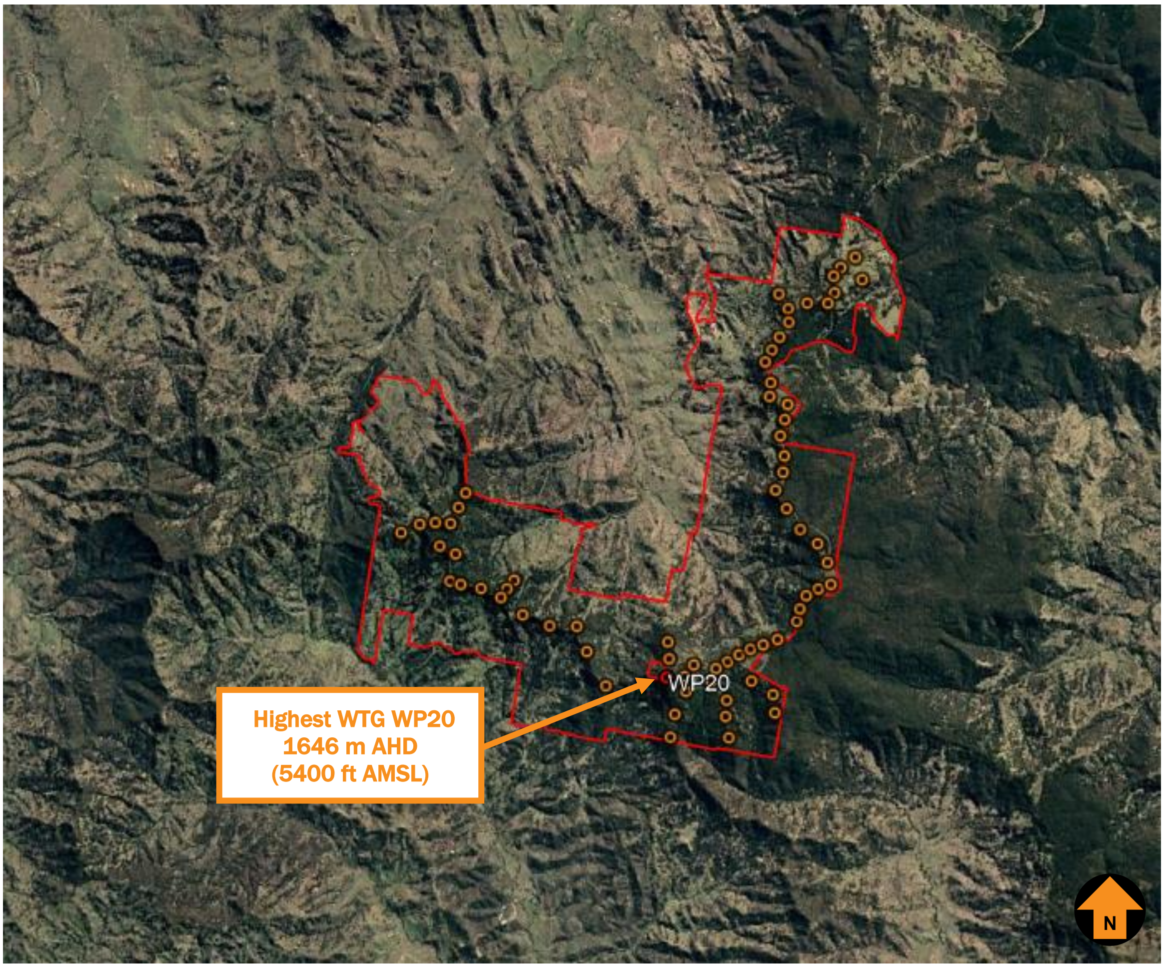

Figure 13 Project layout and highest wind turbine

'Micrositing of turbines' and wind monitoring towers means an alteration to the siting of a turbine or wind monitoring towers by not more than 100 m and any consequential changes to access tracks and internal power cable routes. The potential micrositing of the turbines and wind monitoring towers have been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal turbine position. The micrositing of the turbines and wind monitoring towers is not likely to result in a change in the maximum overall blade tip height of the Project.

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

4.3. Wind monitoring tower description

There are currently 3 existing temporary WMTs installed onsite as part of the Project. The temporary WMTs are constructed of steel lattice construction with a maximum of 110 m AGL in height.

The temporary WMTs are guyed at several levels in three directions, the guy wires have aviation markers located near the top of the WMTs.

WEP is proposing to install 5 permanent WMTs with a maximum of 155 m (509 ft) AGL in height. The locations of permanent WMTs will be determined as part of the final construction design and their details will be reported to Airservices Australia.

Note: 5 m budget error has been applied for an assessment of the WMTs maximum height.

WEP also has 3 temporary LiDAR measuring devices onsite to sure up wind data.

The highest overall ground level for the temporary WMT MM3 is approximately 1381 m AHD (± 5 m), resulting in a maximum overall height of 1491 m AHD (4892 ft AMSL). Refer to Figure 14 for the location of the temporary WMTs (noted as monitoring masts (MM)) within the Project site (source: Someva, Google Earth).

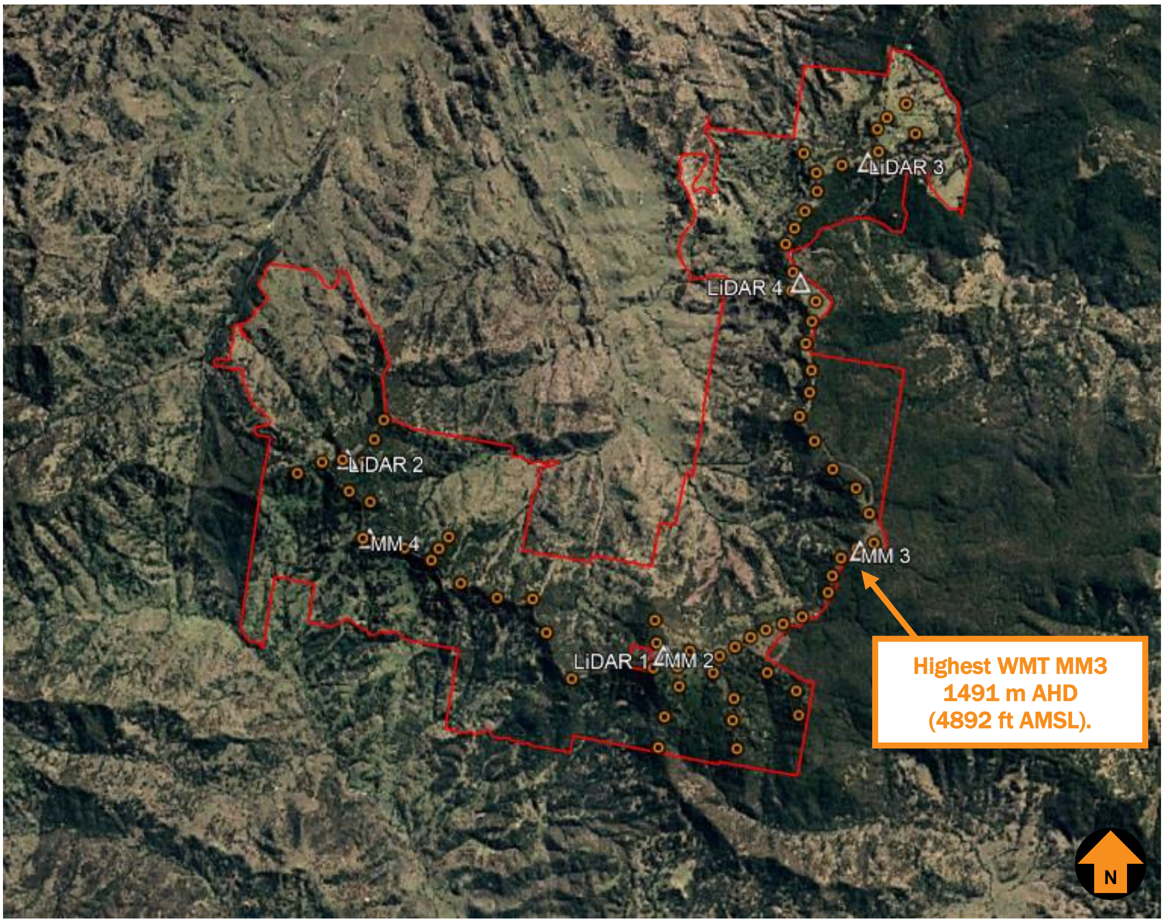

Figure 14 Temporary WMT locations within Project site

The known details including coordinates and ground elevations of the temporary WMTs are listed in Table 1 (source: Someva).

Table 1 Temporary WMT details

Details	WMT *MM2*	WMT *MM3*	WMT *MM4*
WMT ID	MM2	MM3	MM4
Location	31° 37' 40.05" S 151° 8' 11.36" E	31° 36' 35.579" S, 151° 10' 33.6" E	31° 36' 28.3788" S, 151° 4' 37.002" E
Error budget (m)	5	5	5
Ground elevation at site (approximate)	1420 m AHD (4659 ft AMSL)	1381 m AHD (4531 ft AMSL)	1170 m AHD (3836 ft AMSL)
Height of tower AGL	80 (262 ft)	110 m (360 ft)	110 m (360 ft)
WMT tip height AHD	1500 m AHD (4921 ft AMSL)	1491 m AHD (4892 ft AMSL)	1280 m AHD (4199 ft AMSL)
Lighting	Nil	Nil	Nil
Marking	Marker balls	Marker balls	Marker balls
Design	Steel lattice	Steel lattice	Steel lattice
Construction date	July 2019	July 2019	July 2019
Reported to Airservices Australia	Reported 19 July 2019	Reported 19 July 2019	Reported 19 July 2019

The details of the WMTs were reported to LGAs and Airservices Australia on 19 July 2019 for entry into Vertical Obstruction Database.

The details of the proposed permanent WMTs will be reported to Airservices Australia.

Figure 15 shows the final installation of temporary WMT MM4 (source: Someva).

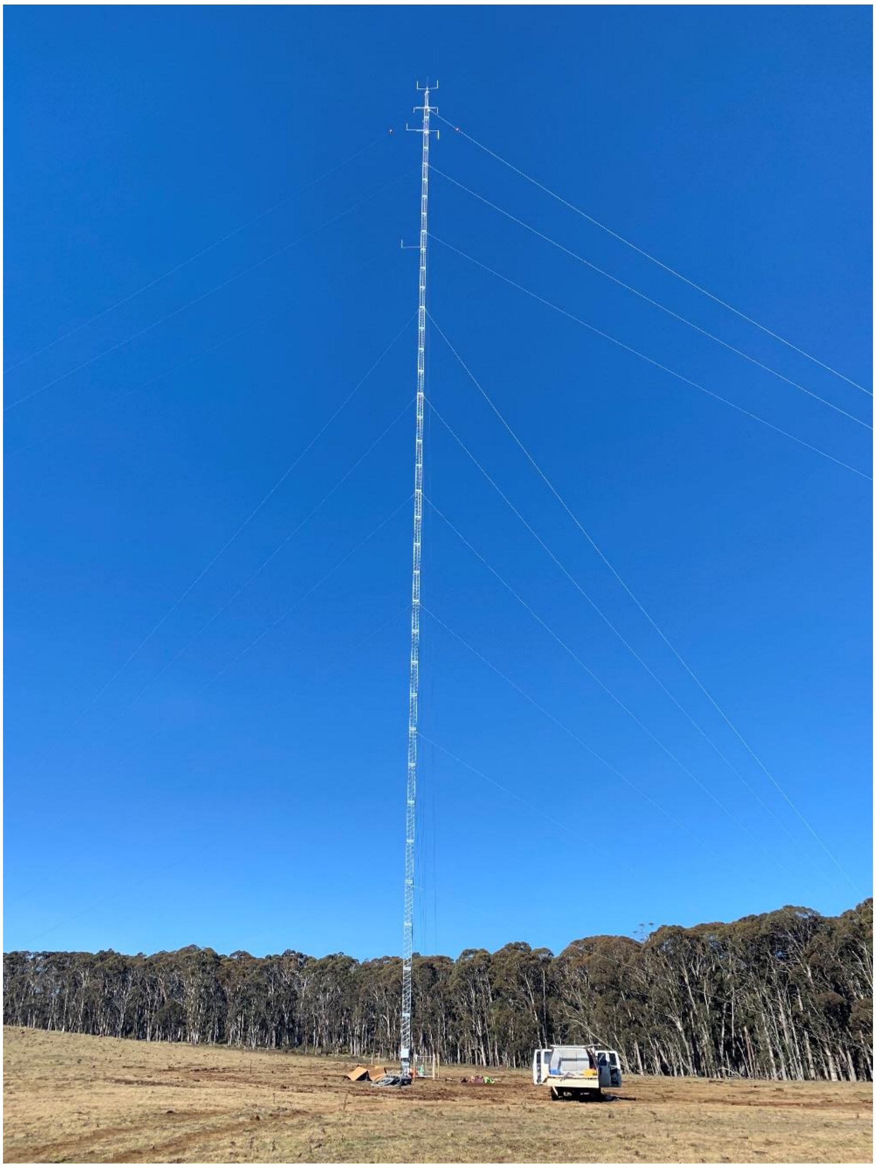

Figure 15 WMT MM4 installed onsite

4.4. Overhead transmission line

Someva is considering the provision of a 330kV transmission line which would connect the on-site wind farm substations to the wider grid network, including the following components:

- an underground 33kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where possible)
- a 330kV overhead transmission line to connect the onsite substation to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network, located approximately 23 km west of the Project Area. A switching station will be constructed to connect the Project to the 330kV TransGrid Liddell to Tamworth line.

It is anticipated that the transmission line will have a 9 m clearance to ground and a maximum height of 35 m AGL, with transmission poles at a maximum height of approximately 50 m AGL. Refer to Figure 16 for the Powerline Concept Design (source: Someva, Google Earth).

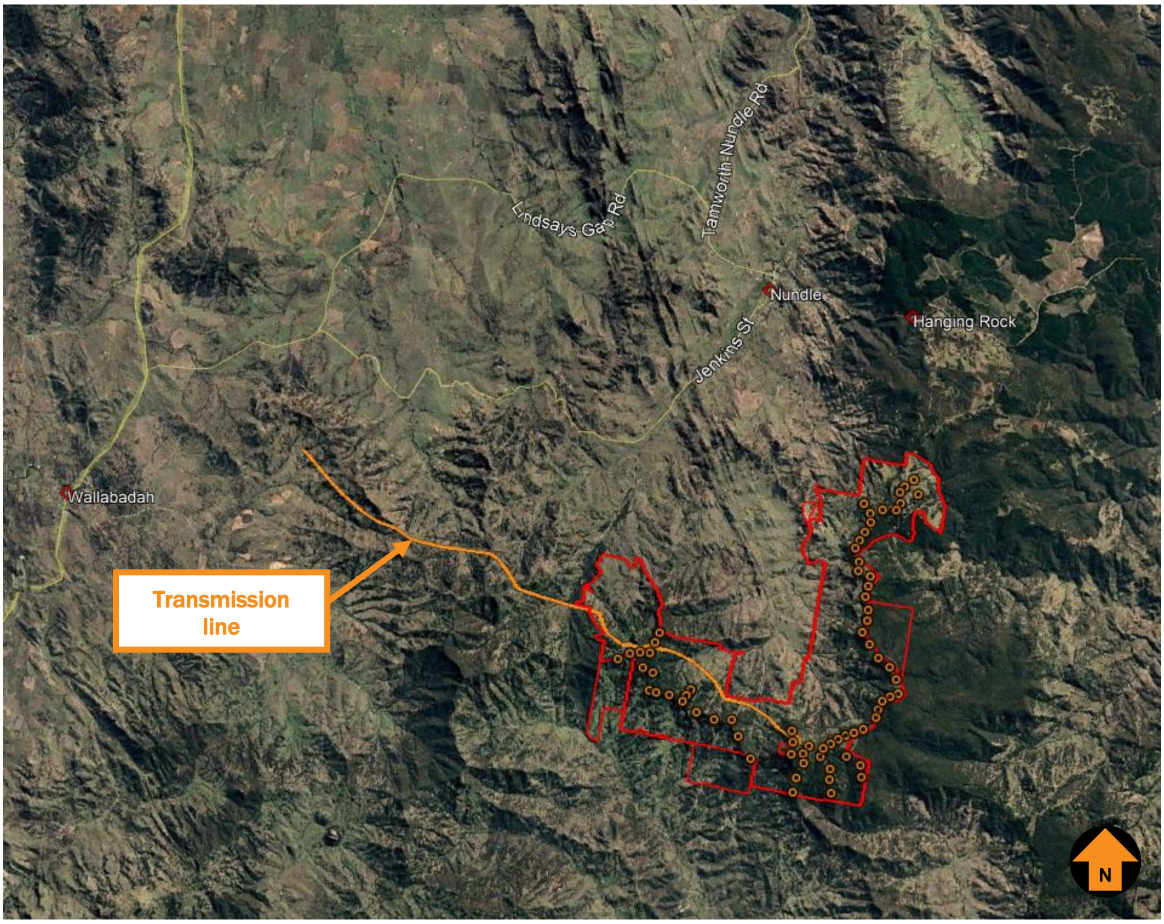

Figure 16 Powerline Concept Design

5. CONSULTATION

The stakeholders consulted include:

- Airservices Australia
- aircraft operators
- aerodrome operators
- Department of Defence
- Liverpool Plains Shire Council
- NSW National Parks and Wildlife Service
- NSW Rural Fire Service
- Royal Flying Doctor Service
- Tamworth Regional Council
- Upper Hunter Shire Council
- Westpac Life Saver Rescue Helicopter Service.

Details and results of the consultation activities are provided in Table 2.

Table 2 Stakeholder consultation details

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
Aerial Application of Australia	29 September 2020 Email to Aerial Application Association of Australia	No response received	During initial consultation Aviation Projects advised the Aerial Application Association of Australia about the Project and requested comment. No response was received.	No further actions required.
Airservices Australia	26 August 2020 Email to Airport Developments	Email from Mr William Zhao (Advisor Airport Development)	During initial consultation Aviation Projects advised Airservices Australia about the Project. In an email response dated 16 October 2020, Mr Williams Zhao (Advisor Airport Development) advised the following: ***Airspace Procedures*** *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1646m (5400ft) AHD, the Hills of Gold Wind Farm will affect the minimum sector altitude (MSA) instrument procedure at Scone aerodrome.* *The Scone MSA will require permanent amendment in the Northern sector from 6300ft to 6400ft AHD. In addition, the start altitude for the RNAV-Z (GNSS) RWY 29 procedure will require permanent amendment to 6400ft AHD.* *The maximum height of Hills of Gold Wind Farm without affecting any procedures at Scone aerodrome is 1620.3m (5316ft) AHD.*	Consult with stakeholders for amendments to instrument procedures at Scone Airport – **completed** WEP to enter into a commercial agreement with Airservices Australia to amend flight procedures – **to be completed** Once construction commences, complete Vertical Obstacle Notification Form – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1646m (5400ft) AHD, the Hills of Gold Wind Farm will affect the air route H99. *The air route H99 will require permanent amendment of the minimum safe altitude from 6100ft to 6400ft AHD.* *The maximum height of Hills of Gold Wind Farm without affecting air route H99 is 1554.4m (5100ft) AHD.* *Note: Procedures not designed by Airservices at Scone aerodrome were not considered in this assessment.* ***Communications/Navigation/Surveillance (CNS) Facilities*** *This proposal, to a maximum height of 1646m (5400ft) AHD, will not adversely impact the performance of any Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.* ***Summary*** *Based on the above assessment, Airservices view is that the proposed Hills of Gold Wind Farm would have an impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of Scone Airport.* *If this proposal is to proceed, Airservices recommends that both aviation operators and the airport are consulted to ensure that all stakeholders fully understand the extent of the impact of these proposed changes. Furthermore, any Airservices work associated with amending the flight*	

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			procedures will be undertaken on a commercial basis and require further consultation	
Aircraft operators (Airspeed Aviation)	26 August 2020 Email to Airspeed Aviation	6 October 2020 Email from Mr Ben Wyndham (Director & Head of Operations)	During email consultation Airspeed Aviation was informed about the Project. In an email response Mr Wyndham advised that he *had nothing to add, nor any questions at this time.*	No further actions required
Aircraft operators (Forestry Corporation of NSW)	26 August 2020 Email to Forestry Corporation of NSW	17 September 2020 Letter from Mr Scott Mallyon (Manager, Forest Occupancy & Materials)	During email consultation Forestry Corporation of NSW was informed about the Project. In a letter response Mr Mallyon advised the following: *I had passed this report on to our operational staff for comment on the likely impact on any aviation work that Forestry Corporation of NSW (FCNSW) might undertake as part of our land management activities. FCNSW infrequently engages aviation contractors for the purposes of weed spraying and wild dog baiting. The main reason for engagement is for fire fighting which would involve the use of fixed wing aircraft and helicopters.* *It was felt that the proposed wind turbine towers would not have a substantial impact on our aviation activities.*	No further actions required
Aircraft operators (Local Land Services –Hunter and Northwest)	23 September 2020 Email to Local Land Services Hunter and	No response received	During initial consultation Aviation Projects advised the Local Land Service at the Hunter and Northwest Regions about the Project and requested comment. A follow up email was sent on 6 October 2020. No response was received.	No further actions required

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
	Northwest Regions			
Aircraft operators (Middlebrook Air)	26 August 2020 Email to Middlebrook Air	6 October 2020 Email from Mr Jono Middlebrook (Owner and Director)	During initial consultation Aviation Projects advised Middlebrook Air about the Project. In an email response Mr Middlebrook advised the following: *It will impact on approximately $80000. Of work that we currently do on an annual basis. We take the same stance as the AAAA and oppose all wind farms*	No further actions required
Aircraft operators (Pays Air Service)	26 August 2020 Email to Pays Air Service	No response received	During initial consultation Aviation Projects advised Pays Air Service about the Project. A follow up email was sent on 6 October 2020, no response was received.	No further actions required
Aircraft operator (Precision Helicopters)	26 August 2020 Email to Precision Helicopters	No response received	During initial consultation Aviation Projects advised Precision Helicopters about the Project. A follow up email was sent on 6 October 2020, no response was received.	No further actions required
CASA	CASA has advised that it will only review assessments referred to it by a planning authority or agency.			No further action required; Project will be referred to CASA by planning authority
Department of Defence	26 August 2020 Email to Department of Defence	16 September 2020 Letter from Mr Charles Mangion (Director – Land	During email consultation Department of Defence was informed about the Project. In a letter response Department of Defence advised: *Defence has conducted an assessment of the proposed wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar.*	Once construction commences, complete Vertical Obstacle Notification Form – **to be completed**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
		Planning & Regulation)	*The proposed structures will meet the 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 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.*	
Liverpool Plains Shire Council	26 August 2020 Email to Liverpool Plains Shire Council	13 October 2020 Email from Chris Norvill (Ganger)	During initial consultation Aviation Projects advised the Liverpool Plains Shire Council about the Project. In an email response Mr Norvill advised the following: *Council had no comments / concerns regarding the Hills of Gold Wind Farm Project , the only aircraft operator at our Aerodrome has no concern either as it is well away from our Airport and will have no impact on operations .*	No further actions required

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
NSW National Parks and Wildlife Service	26 August 2020 Email to NSW National Parks and Wildlife Service	No response received	During initial consultation Aviation Projects advised NSW National Parks and Wildlife Service about the Project. The multiple attempts were made to follow up NPWS for comments on the Project but no response has been received.	No further actions required
NSW RFS	26 August 2020 Email to NSW Rural Fire Service	19 October 2020 Email from	During initial consultation Aviation Projects advised NSW Rural Fire Service about the Project. In an email response Mr O'Rourke advised the following: *We have no comments on the proposed wind farm. Wind farms will be treated like any other potential hazard to aircraft operations.*	No further actions required
RFDS	26 August 2020 Email to Royal Flying Doctor Service	7 September 2020 Email from Mr Justin Marr (General Manager Aviation, RFDS South Eastern Section)	During initial consultation Aviation Projects advised the Royal Flying Doctor Service about the Project. In an email response Mr Marr advised the following: *Our Flight Operations team have highlighted the following implications:* *- the increase in 25 nm MSA at Scone* *- the increase to the initial approach altitude of the Scone RNAV* *- increase to LSALT of nearby IFR routes* *None of these changes will significantly impact the RFDS operations into Scone. The most recent data we have (from 2006-2016), we have visited Scone on average 5.5 times per annum. Many patients are transferred by*	No further actions required

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			road to either Tamworth, or Newcastle given the relatively short distances involved.	
Stakeholder 1	10 June 2020 In person meeting with landowners	10 June 2020 Meeting with the landowners of ALA1	During the site visit conducted on 10 June 2020, a meeting was held with the landowners of ALA1. During this meeting, the landowner advised Aviation Projects that operations at the property includes cattle farming. Mainly chopper spraying in vicinity of land and they use Middlebrook Air or Precision Helicopters for this service. Items of concern for the landholders included the following: • Impact the Project will have on spraying/seeding – worried that companies will charge them extra knowing that they have turbines located in proximity to their land • Impact the Project will have on emergency services, bush fires, and transiting aircraft – accessibility in times of bushfires, and whether this would impose on firefighting efforts in general • Lighting on turbines, specifically whether pilots flying at night will be able to see turbines (with or without lighting).	Consult with aerial application operators and emergency services - **Completed**
Stakeholder 2	10 June 2020 In person meeting with landowners	10 June 2020 Meeting with the landowners	During the site visit conducted on 10 June 2020, a meeting was held with the stakeholder 2. The landowner advised they were concerned about the impact of the Project on their property. Other issues discussed included: • Aerial spraying using fixed wing and helicopters – super, dog baiting	At the time of writing this report, there was no established runway/s on the landowner's property. Therefore, it is impractical to ascertain what, if any impacts

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			• Does not have any runways established on property, currently using neighbour's runway for spraying • Looking at establishing two potential locations for runway on property (showed both options during visit) • Concerned about applicator issues with turbulence due to wind turbines • Wants a blanket solution to aerial impact on property – so not limited to a singular aerial ag operator and can shop around. (Concerned that different companies will not take spraying job knowing turbines are located in close proximity to land) If and when the landowner establishes a runway on the property, details of the Project, including location and height information of wind turbines, wind monitoring towers and overhead powerlines should be provided to the landowner so that, when asked for hazard information on their property, the stakeholder may provide the aerial application pilot with all relevant information.	there would be on the property. No further actions required.
TRC	26 August 2020 Email to Tamworth Regional Council	7 September 2020 Email from Mr Matthew Thorncroft (Airport Assets & Technical Officer, Business and Community)	During initial consultation Aviation Projects advised the Tamworth Regional Council about the Project. In an email response Mr Thorncroft advised the following: *We note from your EIS that the proposed development will not impact the airspace associated with the Tamworth Airport OLS.* *We also note that Airservices Australia have been notified of the penetration of the Pans-Ops surfaces.*	No further actions required.

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Reference is made to notifying the Royal Australian Air Force with regard the proposed obstacles and the discussions to be had with emergency services providers. *Given the assurance that Tamworth's OLS is not affected, that the guidelines for reporting and notification per AC 139-08 have been met, and relevant users are being consulted, Tamworth Regional Airport has no objection to the proposal as outlined.*	
UHSC	26 August 2020 Email to Upper Hunter Shire Council	23 October 2020 Email response from Mr Mat Pringle (Director Environmental & Community Services)	During initial consultation Aviation Projects advised the Upper Hunter Shire Council about the Project. In an email response Mr Pringle advised the following: *We note that the project will affect the minimum sector altitude (MSA) instrument procedure at Scone aerodrome and will affect the air route H99. As advised by Airservices, this will impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of Scone Airport. On this basis, Upper Hunter Shire Council objects to the proposed development.* *In order for Council to provide a more detailed response, we will need to review the full Aviation Impact Assessment once completed* Following the Council's response, a videoconference was organised between UHSC, ERM, Someva and Aviation Projects to discuss Council's concerns about the Project in relation to aviation matters. Aviation Projects addressed Councils' concerns by discussing identified impacts on Scone Airport's 25 nm MSA, instrument procedures and air route H99 LSALT.	Consult with Scone Airport users – **to be completed.** Provide the Final AIA to UHSC – **to be completed.** ERM send the Final Bushfire Management Plan– **completed.**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			ERM responded to the Council's concerns in relation to Bushfire Management and explained relevant considerations for bushfire management. After careful consideration of identified impacts and proposed mitigations solutions to the 25 nm MSA, instrument procedures at Scone Airport, and the air route H99 LSALT, the Council's representative confirmed that it reconsidered its previous advice, and in principle, had no objections to the Project. It expressed an intention to consult with Scone Airport users to confirm this position. Aviation Projects has already consulted with Airspeed Aviation, Pay Air Service, Precision Helicopters, RFDS and Westpac Helicopters, with no objections received. In summary, UHSC has no objections to the Project in principle, subject to further consultation with Scone Airport users.	
Westpac Life Saver Rescue Helicopter Service	26 August 2020 Email to Westpac Life Saver Rescue Helicopter Service	7 October 2020 Email response from Mr Robert Jenkins (Operations Manager)	During initial consultation Aviation Projects advised Westpac Life Saver Rescue Helicopter Service about the Project. In an email response Mr Jenkins advised the following: *The location of the wind farm does not affect the LL IF route from TW to JHH.* *Also, can we please provide feedback that in the interests of "safety" that all the wind turbines be fitted with a NVG compatible obstruction light.*	Further discussion was held with Mr Jenkins regarding the lighting of the turbines, and it was advised that a risk assessment concluded that lighting was not required, however would be determined by CASA. No further actions required.

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The Project site is located within 30 nm (55.56 km) of two certified airports: Scone Airport (YSCO) and Quirindi Airport (YQDI).

Tamworth Regional Airport (YSTW) is located outside of the 30 nm (55.56 km) radius and will not be impacted by the proposed Project in terms of issues associated with airspace protection.

Quirindi Airport is located approximately 53 km (28.6 nm) west of the Project and Scone Airport is located approximately 52 km (28 nm) south west of the Project.

The locations of the Project Area relative to Quirindi Airport, Scone Airport, and Tamworth Regional Airport are shown in Figure 17 (source: Someva, OzRunways, Australian 250K Topographical Chart, dated 8 October 2020).

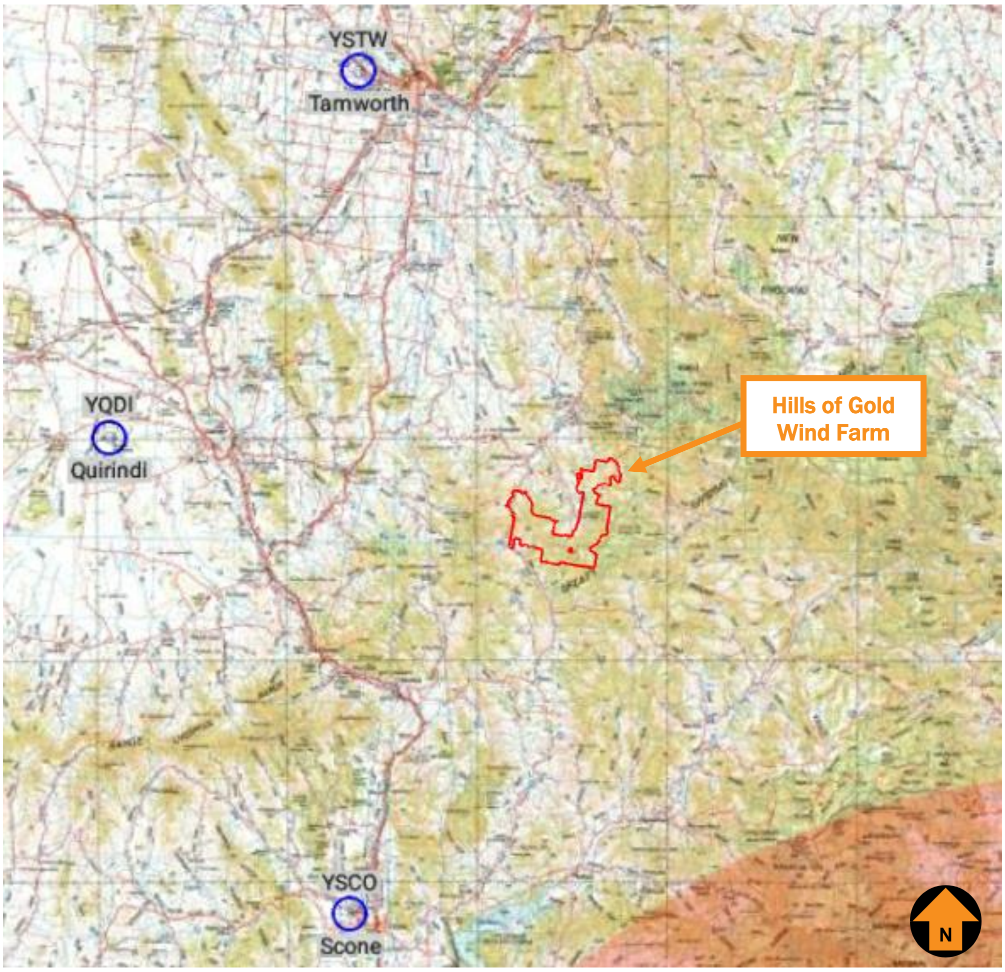

Figure 17 Project Area relative to nearby certified airports

Figure 18 shows 30 nm buffer areas for Quirindi Airport and Scone Airport which are associated with 25 nm MSAs of these airports plus associated 5 nm buffer areas (source: Someva, Google Earth).

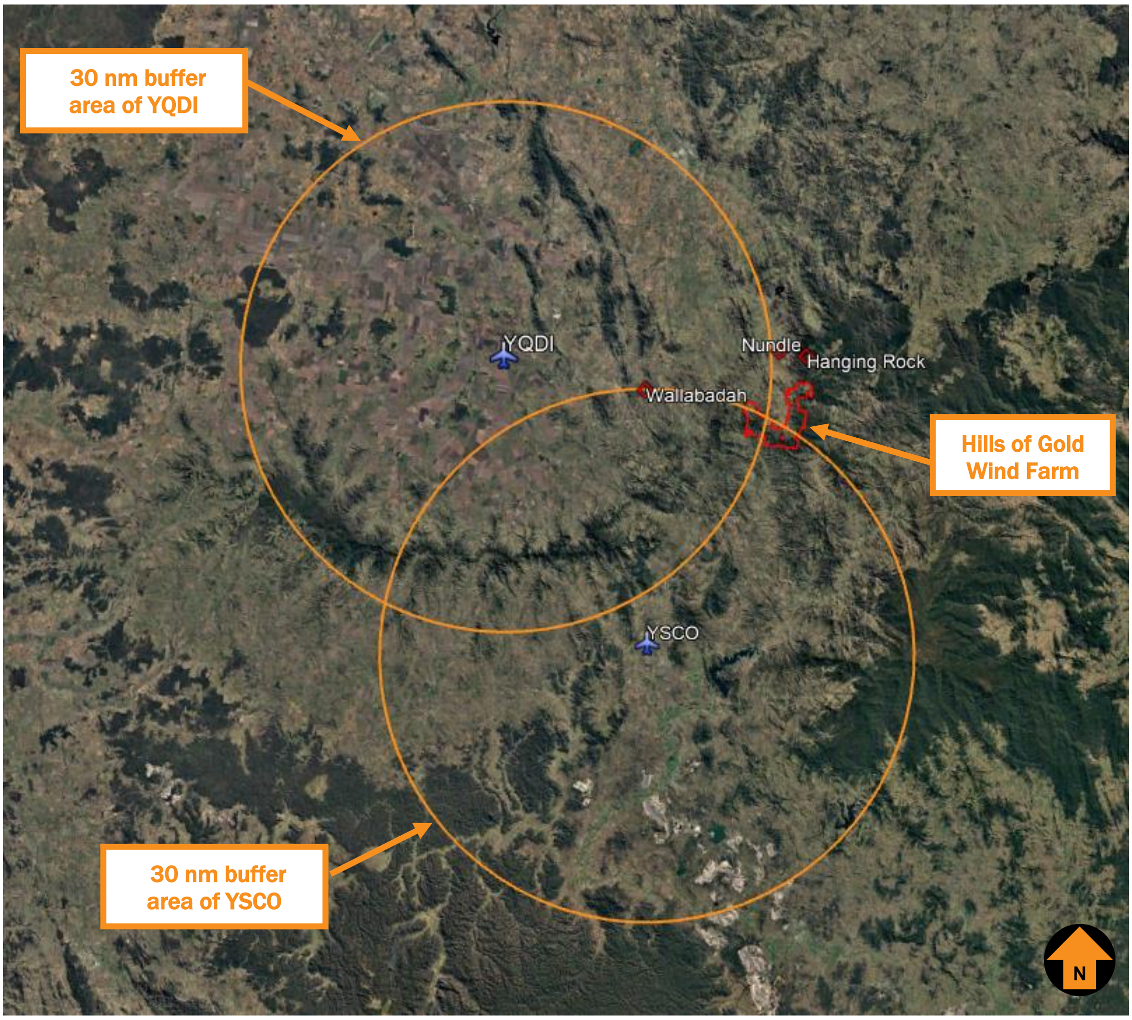

Figure 18 Quirindi Airport and Scone Airport's 30 nm buffer areas

6.2. Scone Airport

Scone Airport (YSCO) is a certified, code 2, non-precision approach runway, operated by Upper Hunter Shire Council, with a published aerodrome elevation of 227 m AHD (745 ft AMSL) (source: Airservices Australia, Aerodrome Chart SCOAD01-164, 13 August 2020).

Scone Airport has one sealed runway 11/23 with a length of 1404 m, width 30 m and runway strip 90 m.

Figure 19 shows the Scone Airport (YSCO) runway layout (source: AsA, Aerodrome Chart, dated 13 August 2020).

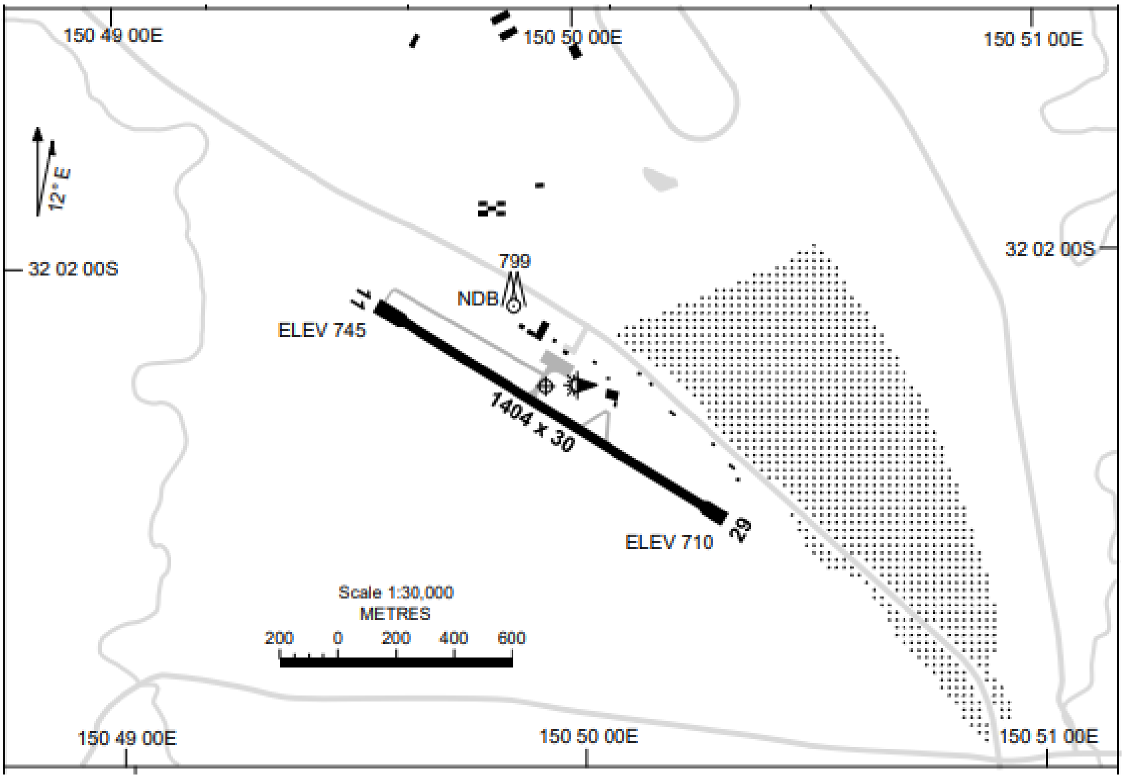

Figure 19 Scone Airport (YSCO) runway layout

Scone Airport's Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's DAH are Latitude 32°02'14"S and Longitude 150°49'56"E.

Scone Airport has aerodrome lighting and radio navigation and landing aids (a non-directional (radio) beacon NDB).

6.3. Instrument procedures – Scone Airport

A check of the AIP via the Airservices Australia website showed that Scone Airport is served by non-precision terminal instrument flight procedures, as per Table 3 (source: Airservices Australia, effective 13 August 2020).

Procedure charts for Scone Airport are designed by Airservices Australia.

Table 3 Scone Airport (YSCO) aerodrome and procedure charts

Chart name	Effective date
AERODROME CHART (AsA)	13 August 2020 (SCOAD01-164)
NDB-A (AsA)	15 August 2019 (SCONB01-160)
RNAV-Z GNSS RWY 29 (AsA)	13 August 2020 (SCOGN01-164)

6.4. PANS-OPS surfaces – Scone Airport

An image of the MSA published for Scone Airport is shown in Figure 20.

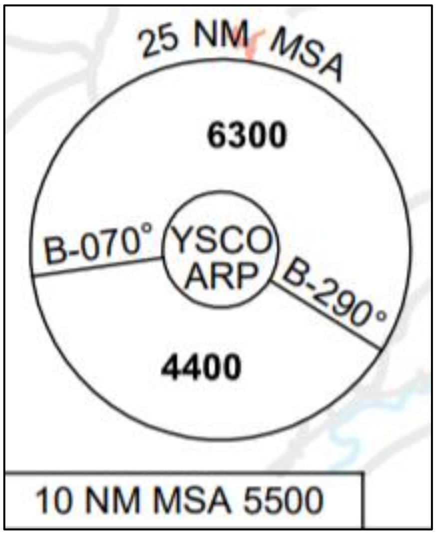

Figure 20 MSA at Scone Airport

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 1000 ft below the published MSA is maintained.

Obstacles within 15 nm (10 nm MSA + 5 nm buffer) and within 30 nm (25 nm MSA + 5 nm buffer) of Scone Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm.

The Project Area is located outside the 10 nm MSA of Scone Airport but within the 25 nm MSA of Scone Airport in the sectors bounded by bearings of 070° and 290°.

Figure 21 shows the 10 nm (+ 5 nm buffer) and 25 nm MSAs (+ 5 nm buffer) of Scone Airport relative to the Project (source: Someva, Google Earth).

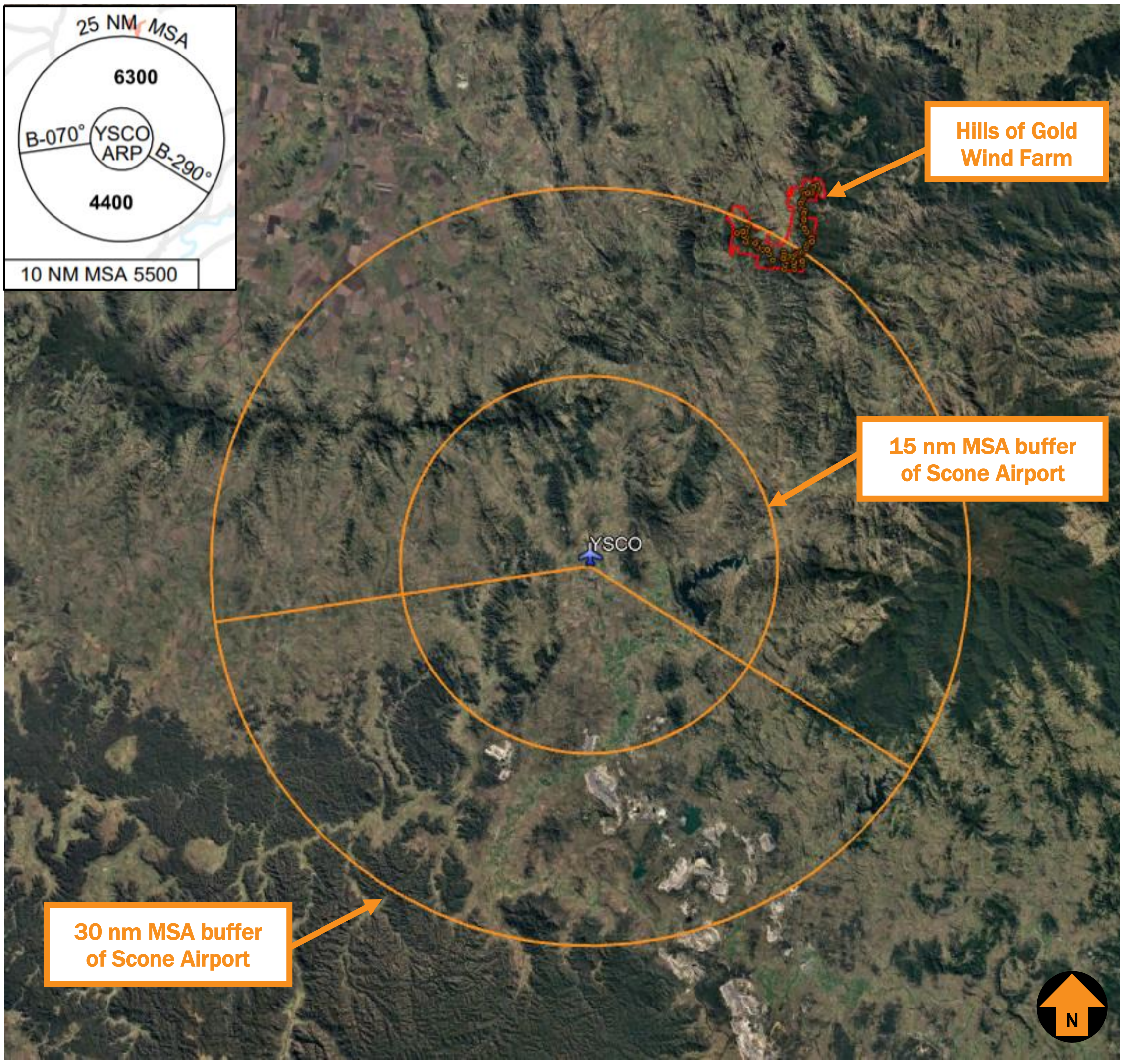

Figure 21 Scone Airport (YSCO) MSA sectors

A close up of the proposed WTGs located within the horizontal extend of the 25 nm MSA (+ 5 nm buffer) (in the sectors bounded by bearings of 070° and 290°) of Scone Airport is shown in Figure 22 (source: Someva, Google Earth).

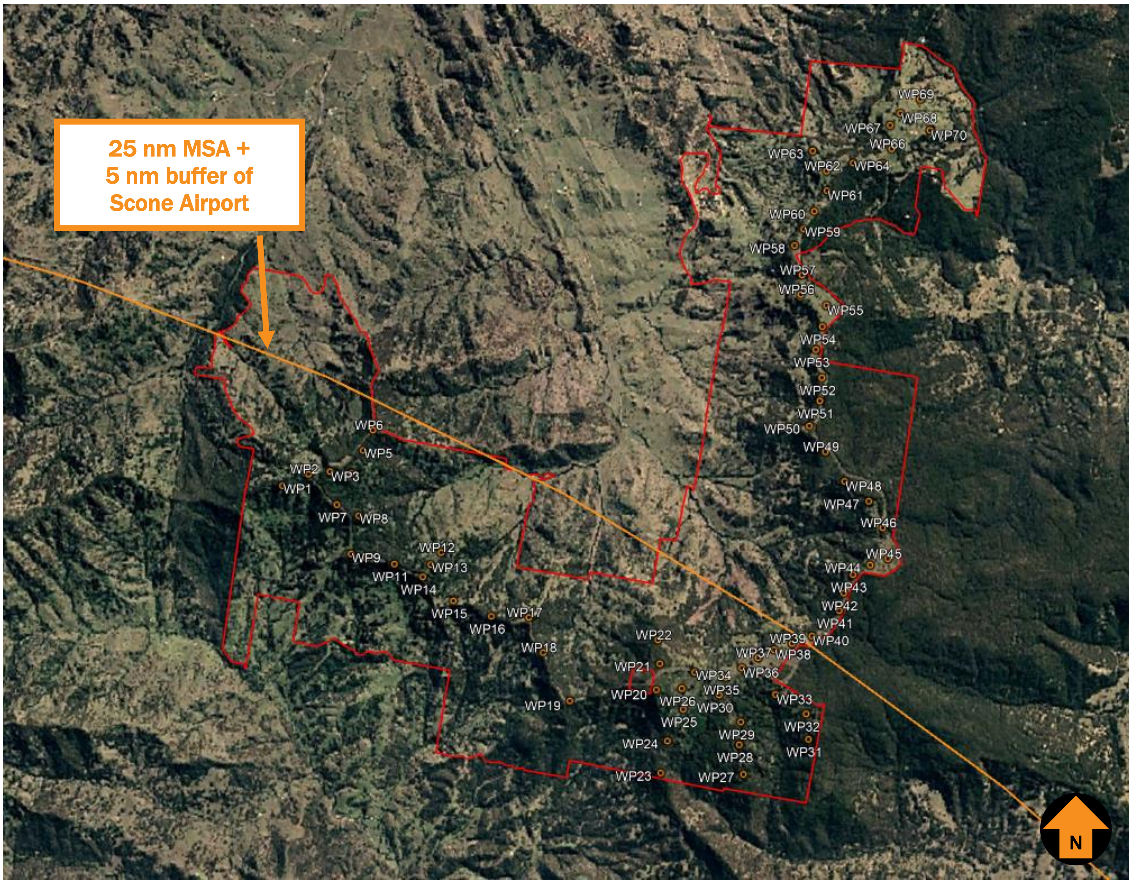

Figure 22 Close up of Scone Airport (YSCO) MSA sectors

The highest WTG which is located inside of the horizontal extent of the 25 nm MSA buffer area (+ 5 nm buffer) of Scone Airport in the sectors bounded by bearings of 245° and 065° is WP20.

An impact analysis of Scone Airport's MSA is provided in Table 4.

Table 4 Scone Airport MSA impact analysis

MSA	Minimum altitude	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	5500 ft AMSL (1676 m AHD)	4500 ft AMSL (1372 m AHD)	Nil (outside the controlling altitude)	N/A	N/A
25 nm (sector B070° and B290°)	6300 ft AMSL (1920 m AHD)	5300 ft AMSL (1615 m AHD)	Above the controlling altitude by approximately 100 ft (30 m) AHD	25 nm MSA of 6300 ft AMSL will need to be increased by 100 ft to 6400 ft AMSL.	Nil (see justification below)
25 nm (sector B290° and B070°)	4400 ft AMSL (1341 m AHD)	3400 ft AMSL (1036 m AHD)	Nil (outside the controlling altitude)	N/A	N/A

The highest WTG, which is WP20, is located inside of the horizontal extent of the 25 nm MSA of Scone Airport (+ 5 nm buffer). The maximum overall height for wind turbine WP20 is approximately 1646 m AHD (5400 ft AMSL). As a result, the WP20 will be approximately 30 m (100 ft) higher than the 5300 ft MOC. Therefore, the 25 MSA of 6300 ft AMSL in the sector bounded by bearings of 070º and 290º will need to be increased by 100 ft to 6400 ft AMSL.

A detailed impact analysis of the proposed wind turbines within the 25 nm MSA (+ 5 nm buffer) in the sector bounded by bearings of 070º and 290º is provided in Table 5.

Note: the WTG heights include a 5 m allowance for variance in site elevation.

Table 5 Scone Airport 25 nm MSA (+ 5 nm buffer) detailed impact analysis

Wind turbine ID	Ground elevation (m AHD)	Overall height with 230 (m AHD) wind turbine with 5 m buffer	Overall height with 230 m wind turbine (ft AMSL)	Penetrates 25 nm MSA MOC (ft/m) (in the sector between B070° and B290°)
WP45	1383.036	1618.0	5308.8	8.8 ft (2.7 m)
WP26	1391.794	1626.8	5337.5	37.5 ft (11.4 m)
WP34	1405.229	1640.2	5381.6	81.6 ft (24.8 ft)
WP21	1408.267	1643.3	5391.6	91.6 ft (27.9 m)
WP20	1410.867	1645.9	5400.1	100 ft (30.4 m)

Since the 25 nm MSA (+ 5 nm buffer) (between bearings 070º and 290º) need to be increased by 100 ft to 6400ft AMSL to accommodate the Project, the initial approach altitude for RNAV-Z GNSS approach procedure for runway 29 should be amended to 6400 ft AMSL to safeguard the approach procedure.

The Project will not impact RNAV-Z GNSS missed approach procedure for runway 29 and NDB-A procedure.

Consultation should be undertaken with Airservices Australia to assess potential impacts of the Project on instrument flight procedures at Scone Airport.

6.5. Circling areas - Scone Airport

All turbines are located beyond the horizontal extent of category A, category B and category C circling areas at Scone Airport (source: AsA, AIP, ENR 1.5-4, paragraph 1.7.6, dated 13 August 2020).

The maximum horizontal distance that category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.8 km) from the threshold of each usable runway.

The closest proposed wind turbine WP23 is located approximately 52 km (28 nm) north east from Scone Airport. Therefore, the Project Area is located outside the horizontal extent of circling areas at Scone Airport and will have no impact.

6.6. Obstacle limitation surfaces – Scone Airport

The maximum horizontal distance that an obstacle limitation surface (OLS) may extend for an aerodrome in Australia is 15 km (8.1 nm) from the edge of a runway strip.

The closest proposed wind turbine WP23 is located approximately 52 km (28 nm) north east from Scone Airport. Therefore, the Project Area is located outside the horizontal extent of any OLS and will not impact the OLS of Scone Airport.

6.7. Quirindi Airport

Quirindi Airport (YQDI) is a certified, code 3, non-precision approach aerodrome, operated by Liverpool Plains Shire Council, with a published aerodrome elevation of 322 m AHD (1058 ft AMSL) (source: Airservices Australia, FAC, dated 13 August 2020).

Quirindi Airport has two runways:

- runway 14/32 sealed surface with a length of 1770 m, width 30 m and runway strip 150 m
- runway 06/24 sealed with a length of 1106 m, width 18 m and runway strip 90 m and has shared glider operations.

Figure 23 shows the Quirindi Airport (YQDI) runway layout and location of the airstrip used for glider operations (source: Airservices Australia, Aerodrome Chart, 2 March 2017).

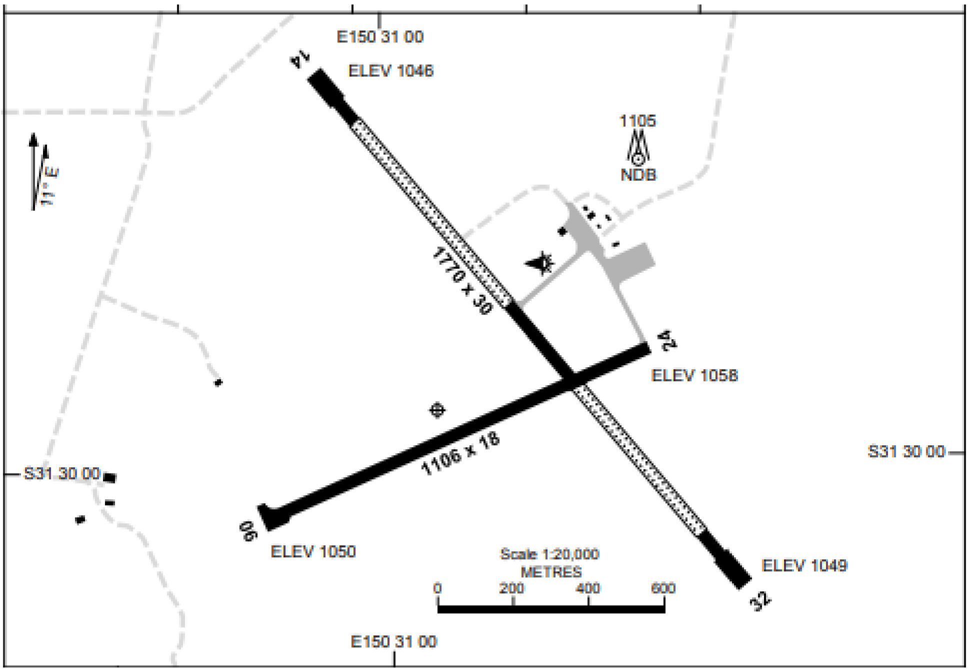

Figure 23 Quirindi Airport (YQDI) runway layout

Quirindi Airport' ARP coordinates published in Airservices Australia's DAH are Latitude 31°29'55"S and Longitude 150°31'05"E.

Quirindi Airport has low intensity runway edge lights (LIRL).

Quirindi Airport has a non-directional (radio) beacon (NDB).

6.8. Instrument procedures

A check of the AIP via the Airservices Australia website showed that Quirindi Airport is served by non-precision terminal instrument flight procedures, as per Table 6 (source: Airservices Australia, effective 15 August 2019).

Procedure charts for Quirindi Airport are designed by either Airservices Australia (AsA) or The Airport Group (TAG). TAG was recently liquidated, consequently the procedures are now managed by Airservices Australia.

Table 6 Quirindi Airport (YQDI) aerodrome and procedure charts (source: Airservices Australia, TAG).

Chart name	*Effective date*
AERODROME CHART (AsA)	2 March 2017 (QDIAD01-150)
NDB-A (AsA)	2 March 2017 (QDINB01-150)
RNAV-W (GNSS) (TAG)	18 August 2016 (QDIGN01-148)
RNAV-E (GNSS) (TAG)	18 August 2016 (QDIGN02-148)

6.9. PANS-OPS surfaces

The minimum safe altitude (MSA) is applicable for each instrument approach procedure at Quirindi Airport. An image of the MSA published for the aerodrome is shown in Figure 24 (source: Airservices Australia, RNAV-W GNSS Chart, 18 August 2016).

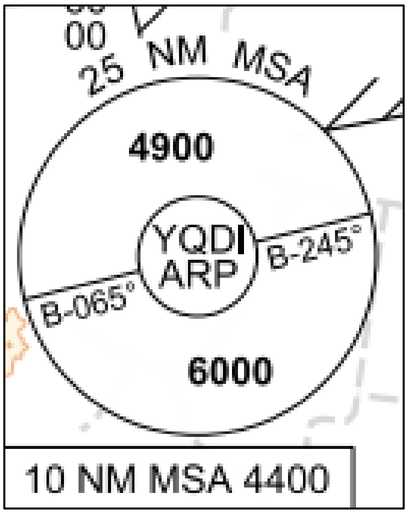

Figure 24 MSA at Quirindi Airport

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 1000 ft below the published MSA is maintained.

Obstacles within 15 nm (10 nm MSA + 5 nm buffer) and within 30 nm (25 nm MSA + 5 nm buffer) of Quirindi Airport's NDB and ARP define the height at which an aircraft can fly when within 10 nm and 25 nm.

The Project Area is located outside the 10 nm MSA (+ 5 nm buffer) of Quirindi Airport but within the 25 nm MSA (+ 5 nm buffer) of Quirindi Airport in the sectors bounded by bearings of 245° and 065°.

Figure 25 shows the 10 nm and 25 nm MSA (+ 5 nm buffer) and MSA sectorization of Quirindi Airport (source: Someva, Google Earth).

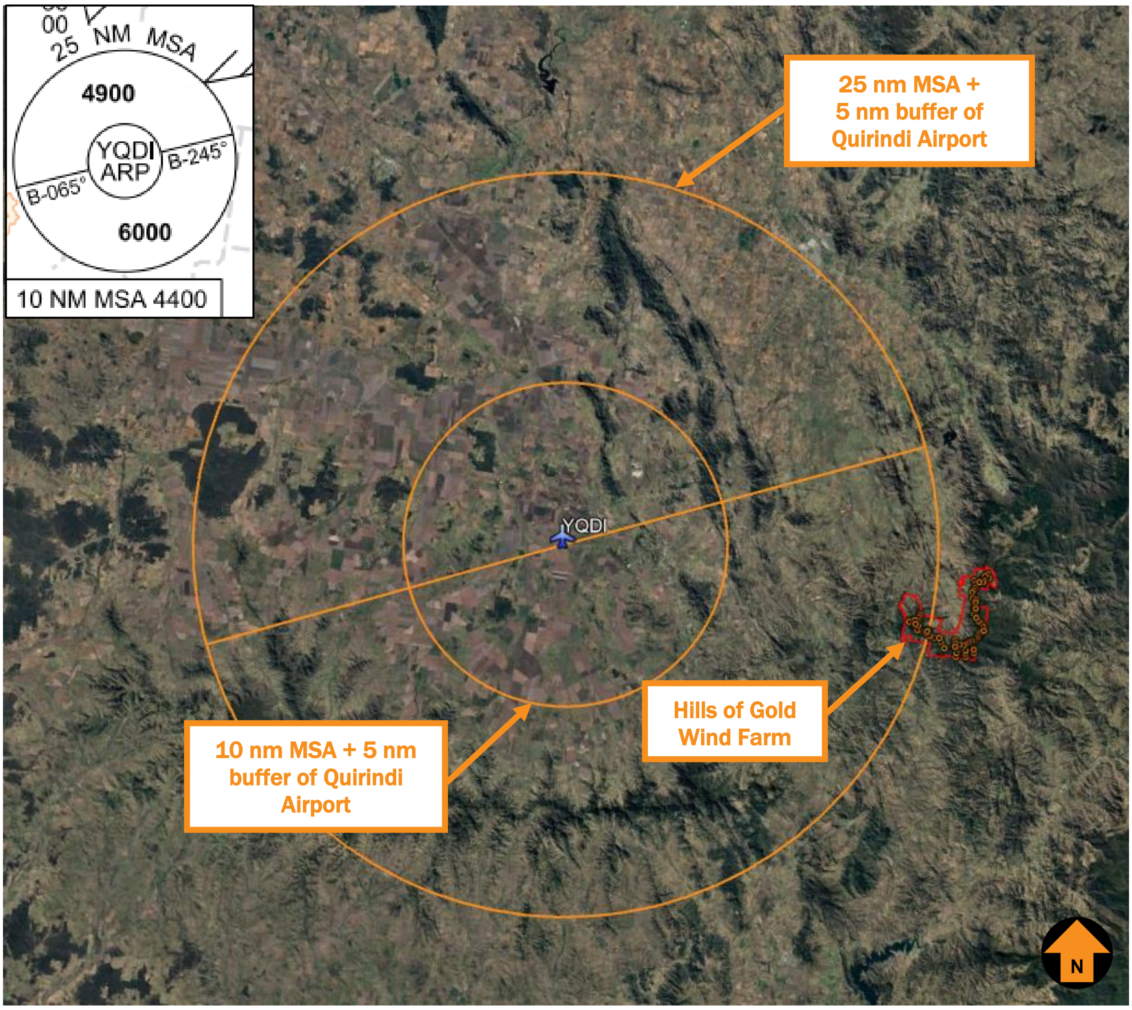

Figure 25 Quirindi Airport (YQDI) MSA sectors

A close up of the proposed WTGs located within the horizontal extend of the 25 nm MSA (+ 5 nm buffer) in the sectors bounded by bearings of 245° and 065° of Quirindi Airport is shown in Figure 26 (source: Someva, Google Earth).

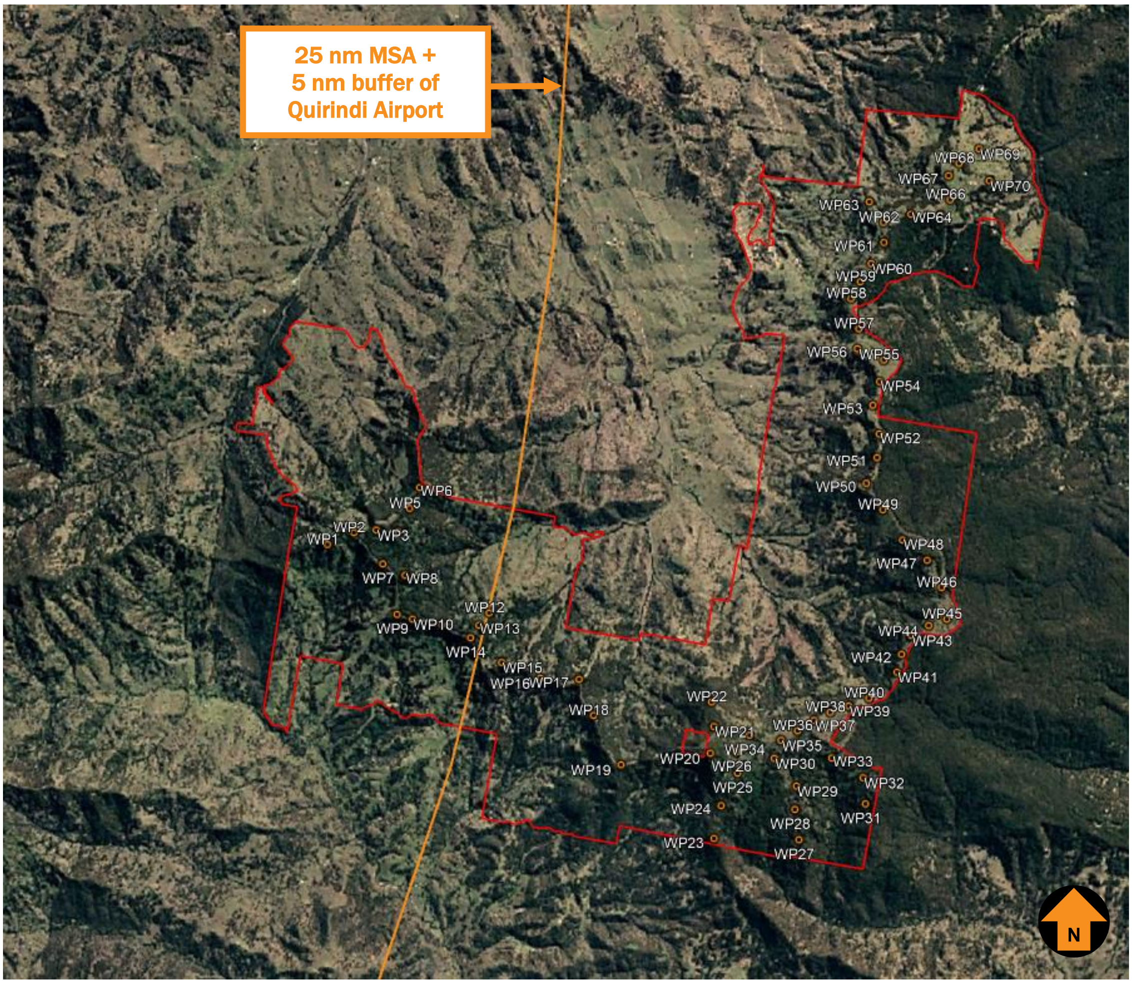

Figure 26 Close up of Quirindi Airport (YQDI) MSA sectors

The highest WTG which is located inside of the horizontal extent of the 25 nm MSA of Quirindi Airport (+ 5 nm buffer) in the sectors bounded by bearings of 245° and 065° is WP2.

The maximum overall height for wind turbine WP2 is approximately 1495 m AHD (4904 ft AMSL). As a result, the WP2 will be approximately 29 m (96 ft) below the 5000 ft MOC. Therefore, the 25 MSA of 6000 ft AMSL in the sector bounded by bearings of 245° and 065° will not be impacted.

An impact analysis of Quirindi Airport's MSA is provided in Table 7.

Table 7 Quirindi Airport MSA impact analysis

MSA	Minimum altitude	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	4400 ft AMSL (1341 m AHD)	3400 ft AMSL (1036 m AHD)	Nil (outside the controlling altitude)	N/A	N/A
25 nm (sector B065° and B245°)	4900 ft AMSL (1493 m AHD)	3900 ft AMSL (1189 m AHD)	Nil (outside the controlling altitude)	N/A	N/A
25 nm (sector B245° and B065°)	6000 ft AMSL (1829 m AHD)	5000 ft AMSL (1524 m AHD)	Nil (below the controlling altitude)	N/A	N/A

The Project will not impact instrument procedures at Quirindi Airport.

A detailed impact analysis of the proposed wind turbines within the 25 nm (+ 5 nm buffer) in the sector bounded by bearings of 245° and 065° is provided in Table 8.

Note: the WTG heights include a 5 m allowance for variance in site elevation. WTG 12 is included in the assessment.

Table 8 Quirindi Airport 25 nm MSA (+ 5 nm buffer) detailed impact analysis

Wind turbine ID	Ground elevation (m AHD)	Overall height with 230 (m AHD) wind turbine with 5 m buffer	Overall height with 230 m wind turbine (ft AMSL)	Below the 25 nm MSA MOC (ft)
WP1	1222.331	1457.3	4781.5	218.5
WP2	1259.577	1494.6	4903.7	96.3
WP3	1254.732	1489.7	4887.8	112.2
WP4	1199.659	1434.7	4707.1	292.9
WP5	1142.293	1377.3	4518.9	481.1
WP6	1171.941	1406.9	4616.2	383.8
WP7	1185.671	1420.7	4661.2	338.8
WP8	1167.515	1402.5	4601.7	398.3

Wind turbine ID	*Ground elevation (m AHD)*	*Overall height with 230 (m AHD) wind turbine with 5 m buffer*	*Overall height with 230 m wind turbine (ft AMSL)*	*Below the 25 nm MSA MOC (ft)*
WP9	1153.009	1388.0	4554.1	445.9
WP10	1160.409	1395.4	4578.3	421.7
WP11	1127.112	1362.1	4469.1	530.9
WP12	1131.467	1366.5	4483.4	516.6
WP13	1161.777	1396.8	4582.8	417.2
WP14	1161.323	1396.3	4581.3	418.7

The Project will not impact instrument procedures at Quirindi Airport.

6.10. Quirindi Airport - circling areas

All turbines are located beyond the horizontal extent of all circling areas at Quirindi Airport.

6.11. Obstacle limitation surfaces

The maximum horizontal distance that an obstacle limitation surface (OLS) may extend for an aerodrome in Australia is 15 km (8.1 nm) from the edge of a runway strip.

The closest proposed wind turbine WP1 is located approximately 53 km (28.6 nm) south east from Quirindi Airport. Therefore, the Project Area is located outside the horizontal extent of obstacle limitation surfaces and will not impact the OLS of Quirindi Airport.

6.12. 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) and Aircraft Owners and Pilots Association (AOPA) Australia Airfield Directory, returned with four nearby non-regulated aerodromes within a nominal 3 nm buffer from the Project Area. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

A search on Google Earth also showed that there are another four private ALAs located nearby the Project site, and a private ALA which is located approximately 2.5 km (1.3 nm) west of the Project Area.

Figure 27 shows the location of nearby ALAs relative to the Project Area and a nominal 3 nm buffer from the ALAs (source: Someva, Google Earth).

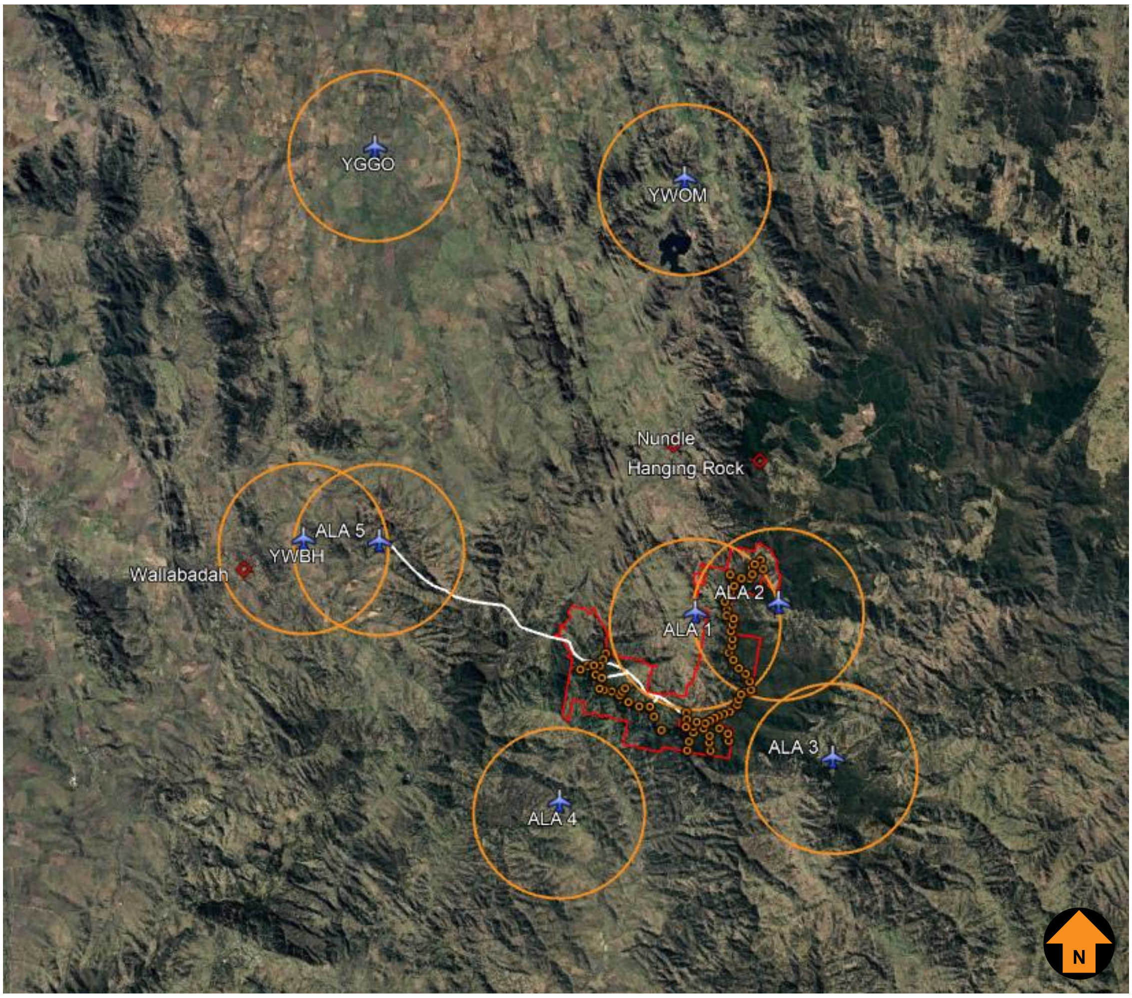

Figure 27 Project relative to closest ALAs

ALA 3, ALA 4, Wallabadah ALA (YWBH), Woolomin ALA (YWOM), and Goonoo Goonoo ALA (YGGO) are located outside a nominal 3 nm buffer and will not be impacted by the Project.

However, some of the proposed WTGs and associated Project infrastructure are located within a 3 nm radius of ALA 1, ALA 2 and ALA 5 and may impact these ALAs.

A close up of the Project Area relative to these ALAs is shown in Figure 28 (source: Someva, Google Earth).

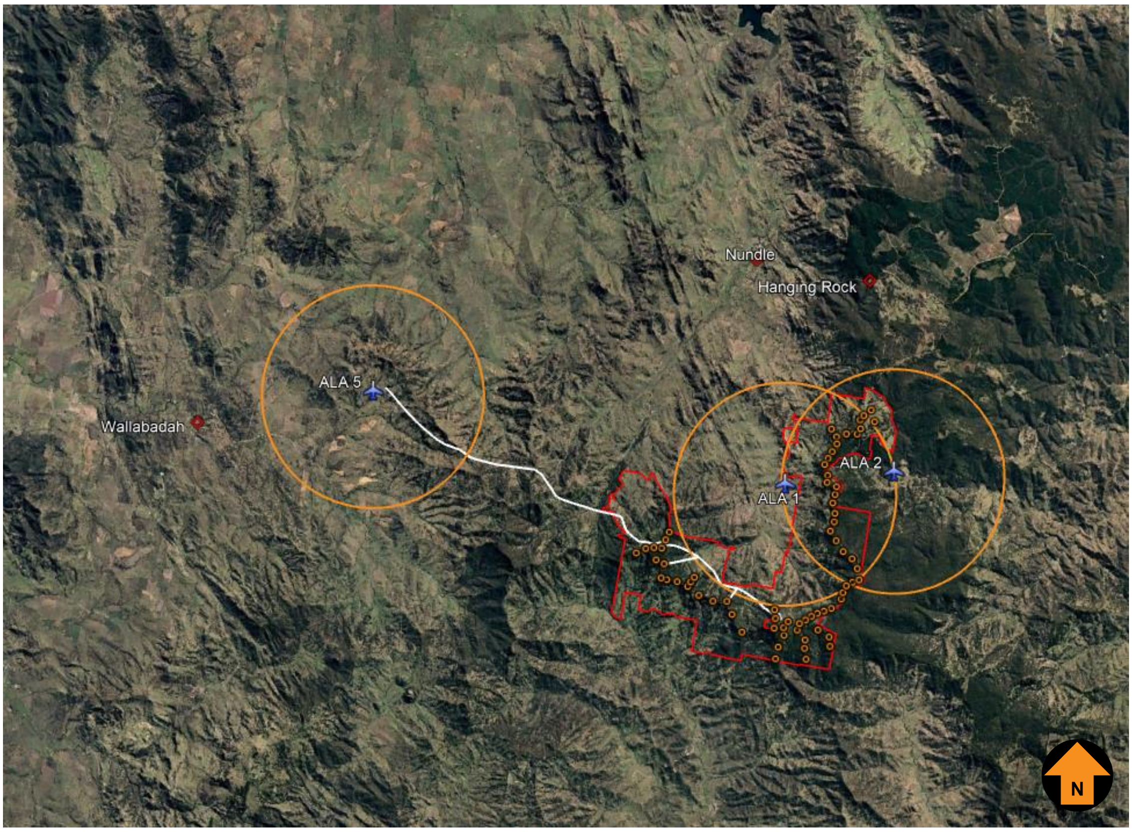

Figure 28 ALA 1, ALA 2 and ALA 5 relative to the Project Area

6.13. ALA 1

ALA 1 is located on the eastern side of Head of Peel Road and downhill of Ben Halls Gap National Park.

The eastern runway end of ALA 1 is located approximately 1.8 km (1 nm) west from the closest wind turbine WP56.

ALA 1 is mainly used by helicopters, but occasionally fixed wing aerial aircraft lands at this ALA.

In terms of helicopter operations to/from this ALA, their operations will not be impacted by the Project. However, as ALA 1 is used by aerial fixed wing aircraft, the analysis of indicative approach and take-off paths, aerodrome circuit operations and potential wake turbulence impact is discussed further in this section.

A close up of ALA 1 relative to the Project boundary and site is shown in Figure 29 (source: Someva, Google Earth).

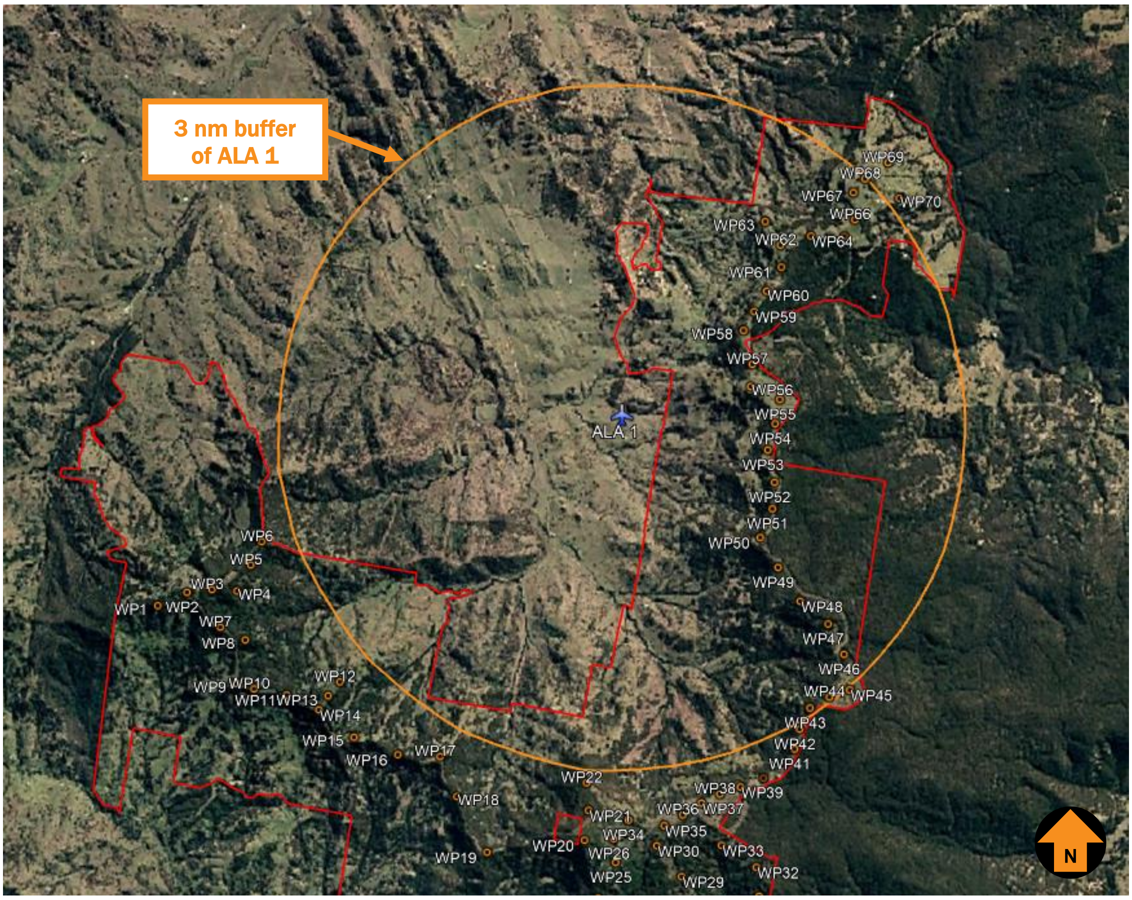

Figure 29 Close up of ALA 1

The layout of ALA 1 runway is shown in Figure 30 (source: Google Earth).

Figure 30 ALA 1 runway layout

<u>Approach and take-off surfaces</u>

As a means of providing guidance to ALA operators, CASA has published recommended practices in its Civil Aviation Advisory Publication (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 applicable to the circumstances, is provided in Figure 31 (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

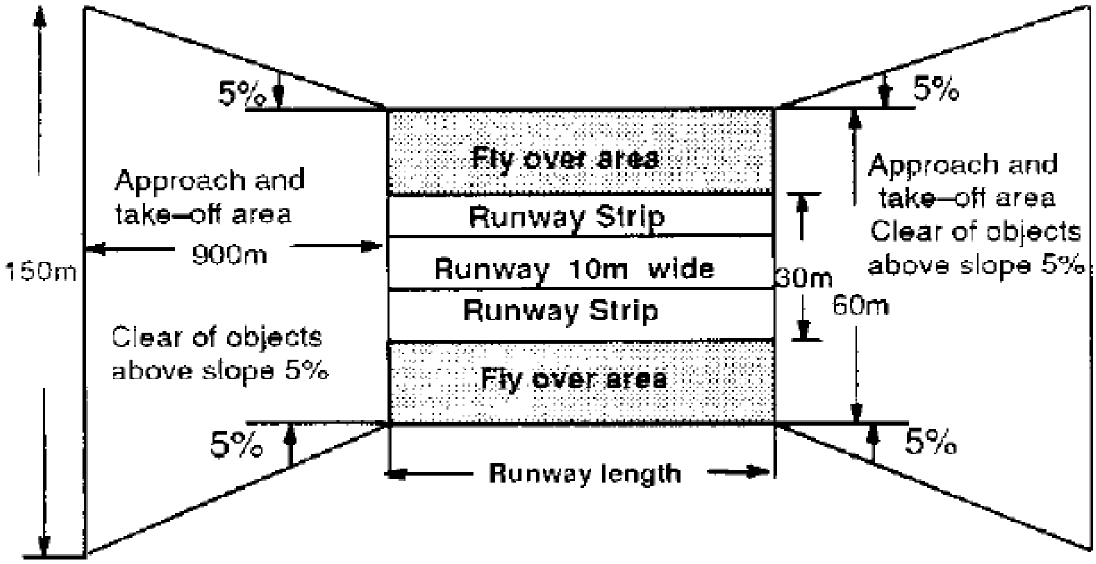

Figure 31 CAAP 92-1(1) Figure 2A

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.

<u>Aerodrome circuits</u>

For the purpose of this AIA the wind turbines located in proximity to ALA 1 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
- Roll out at 1 nm final, not below 500 ft AGL.

Figure 32 shows an indicative illustration of aerodrome circuits.

Figure 32 ALA 1 vs indicative aerodrome circuits

Some of the wind turbines are located within the indicative horizontal extension of ALA 1 aerodrome circuits. These turbines include WP56, WP57 and WP58. However, the runway is located in the valley with higher terrain from the eastern runway end, refer to Figure 33 (source: Google Earth).

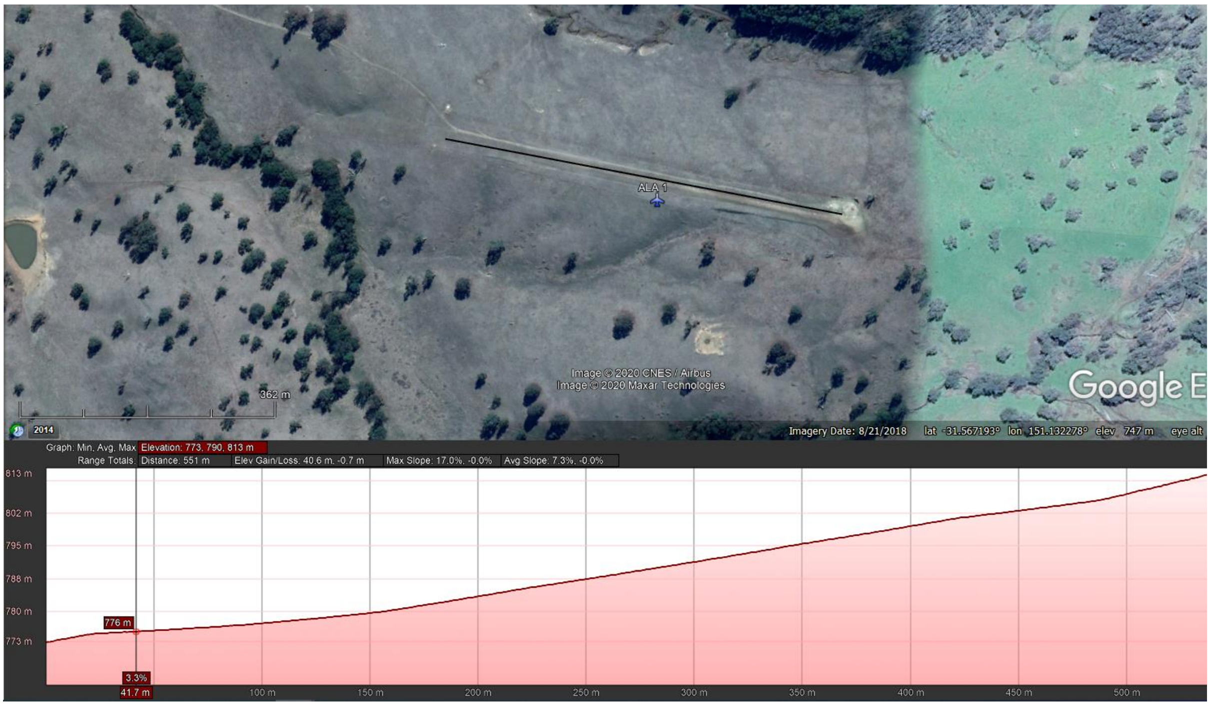

Figure 33 ALA 1 ground elevation profile

Taking into consideration the topography of ALA 1 and its runway orientation, approaches to ALA 1 are likely performed to the east (eastern approaches) and departures to the west (western departures).

The views from ALA 1 are shown in Figure 34 and Figure 35 (source: Google Earth).

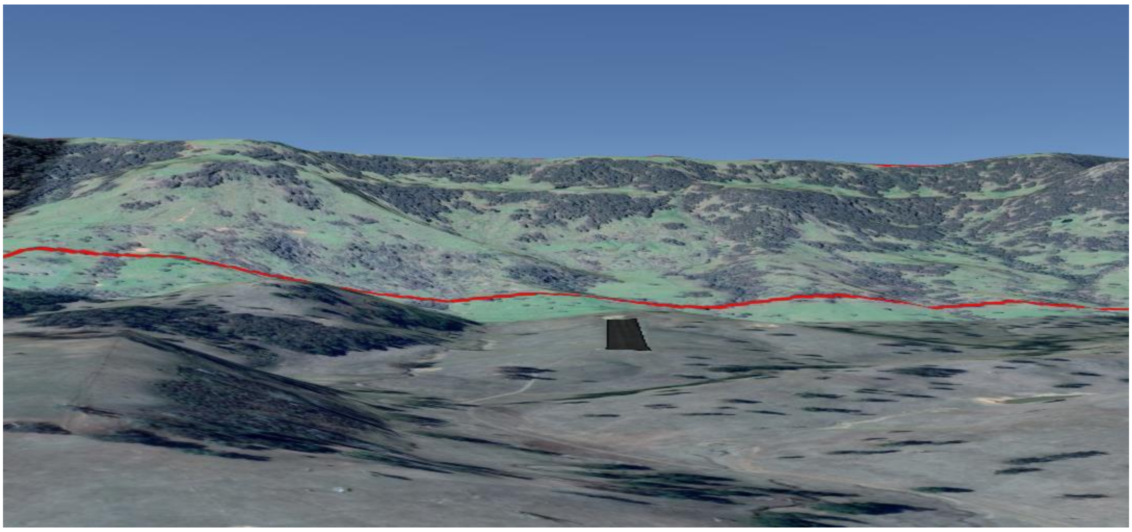

Figure 34 Eastern view from ALA 1

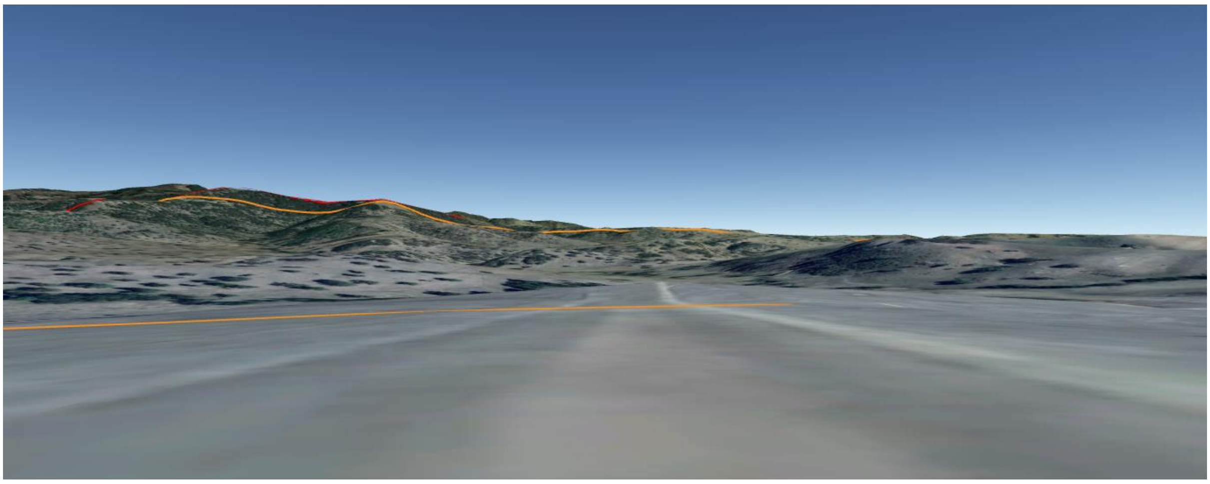

Figure 35 Western view from ALA 1

Based on the information available and analysis of ALA 1, flight operations will still be able to occur for eastern approaches, and western departures. It is unlikely that western approaches and eastern departures, occur at the site due to natural topography of the site, providing a one way in, one way out ALA.

The landowner advised that helicopters are generally used at the property, which have a greater manoeuvrability to avoid any potential obstacles.

<u>Potential wake turbulence impacts</u>

National Airports Safeguarding Framework (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.

NASF Guideline D provides guidance regarding wind turbine wake turbulence which 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 125 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…*

Further investigation will be required to determine the impact, if any, of wake turbulence at ALA 1.

For the purpose of the wake turbulence analysis, a 170 m rotor diameter has been used.

Based on this scenario, the effects of wake turbulence could be noticeable at a distance of 2720 m from the wind turbines.

Figure 36 shows 2720 m rings (associated with potential maximum horizontal extend of wake turbulence) around wind turbines located within a 3 nm radius of ALA 1.

For this scenario, it can be seen that the the effects of wake turbulence would extend from some of the WTGs into the nominal circuit pattern whenever there is a wind from the north east and east through to south east.

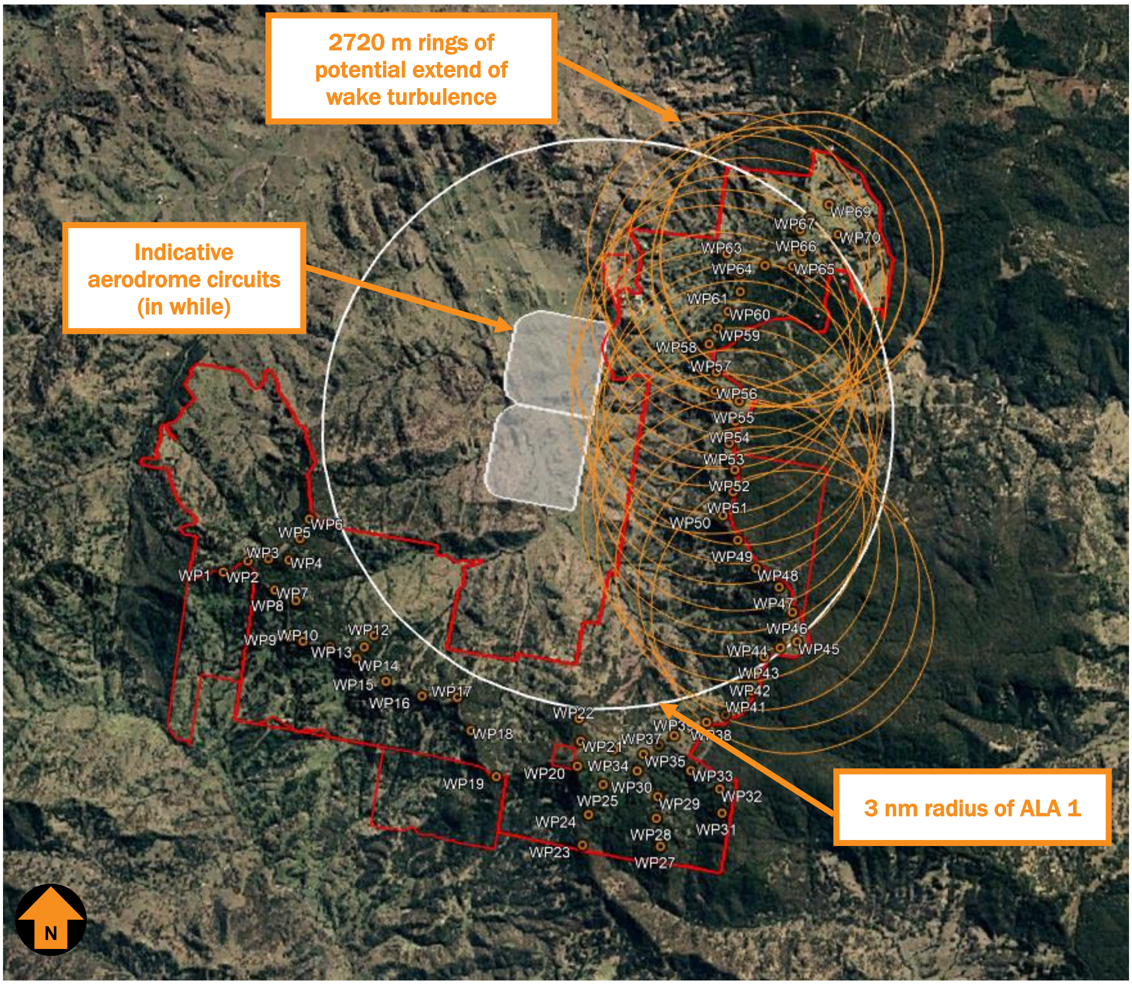

Figure 36 Potential extent of downstream wake turbulence – ALA 1

As discussed previously, it is unlikely that western approaches and eastern departures, occur at the site due to natural topography of the site, providing a one way in, one way out ALA. Refer to Figure 37 for take-off pattern (showing in yellow arrow) and for landing (showing in yellow arrow for final leg and in blue arrows for base legs).

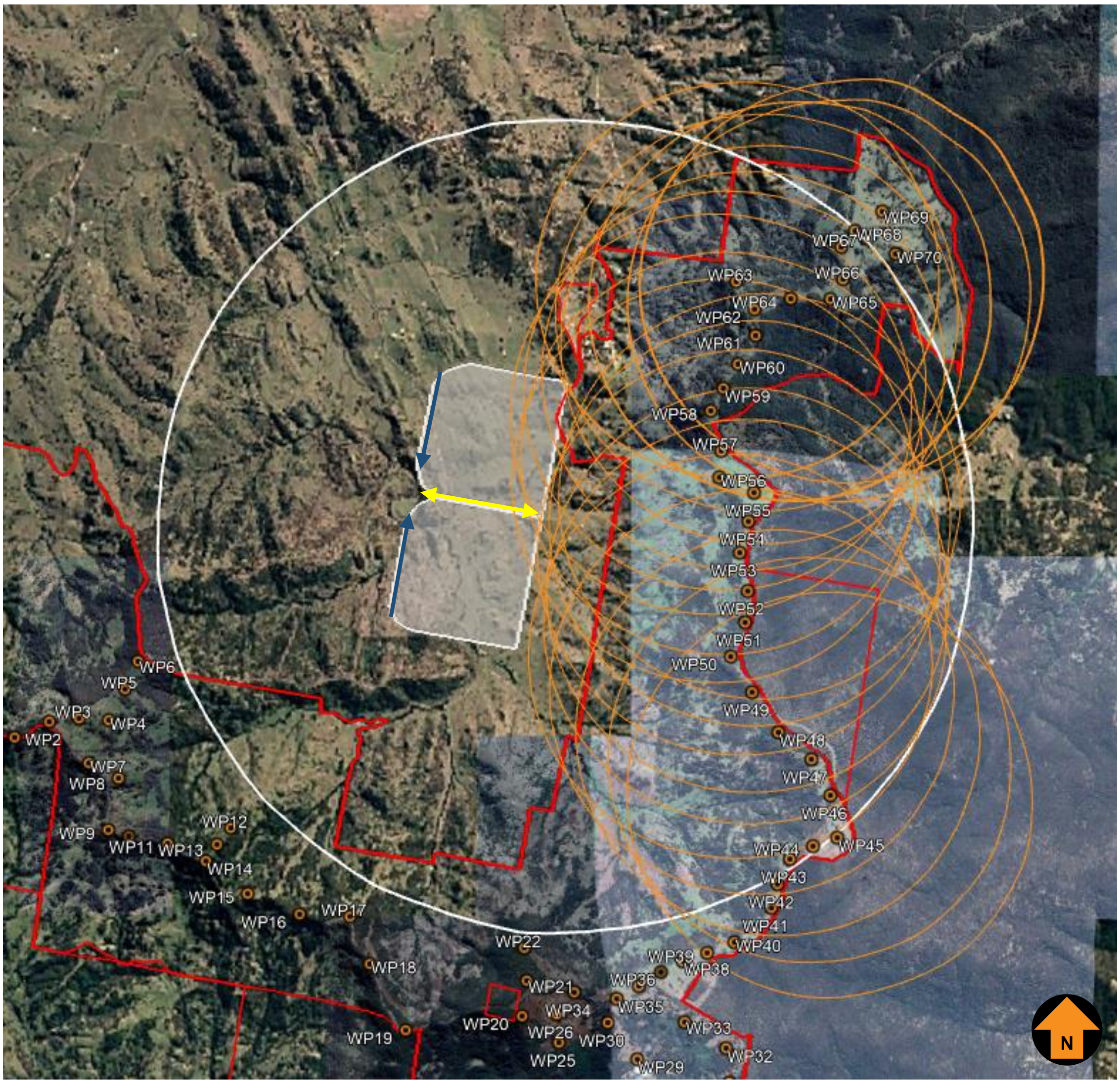

Figure 37 ALA 1 circuit patterns

Dependent on the wind direction and wind speed at the time, if wind turbines are operating when the ALA 1 is used, the potential extent of downstream wake turbulence is could be noticeable from the following wind turbines:

- WP50, WP51, WP52, WP53, WP54, WP55, WP56, WP57, WP58, WP59, WP60, WP61, WP62 and WP63.

In this configuration, the proposed Project will likely impact circuit operations at ALA 1, although the magnitude of the impact will be a function of wind direction and wind speed and the aircraft being used.

Given the proposed wind turbines will be constructed on an area with a higher terrain from the east, the intensity of wake turbulence can be greater because of mountain waves.

Mountain Waves is defined as oscillations to the lee side (downwind) of high ground resulting from the disturbance in the horizontal air flow caused by the high ground.

WEP should consult with the operator of the ALA 1 to agree on a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that the ALA 1 is in use for take-off and landing.

Note: The potential extent of downstream wake turbulence will be less noticeable from a wind turbine model with a smaller rotor diameter.

6.14. ALA 2

The unnamed ALA 2 is not documented in OzRunways, there is no information published regarding operating procedures and use of this ALA.

A close up of ALA 2 relative to the Project Area is shown in Figure 38 (source: Someva, Google Earth).

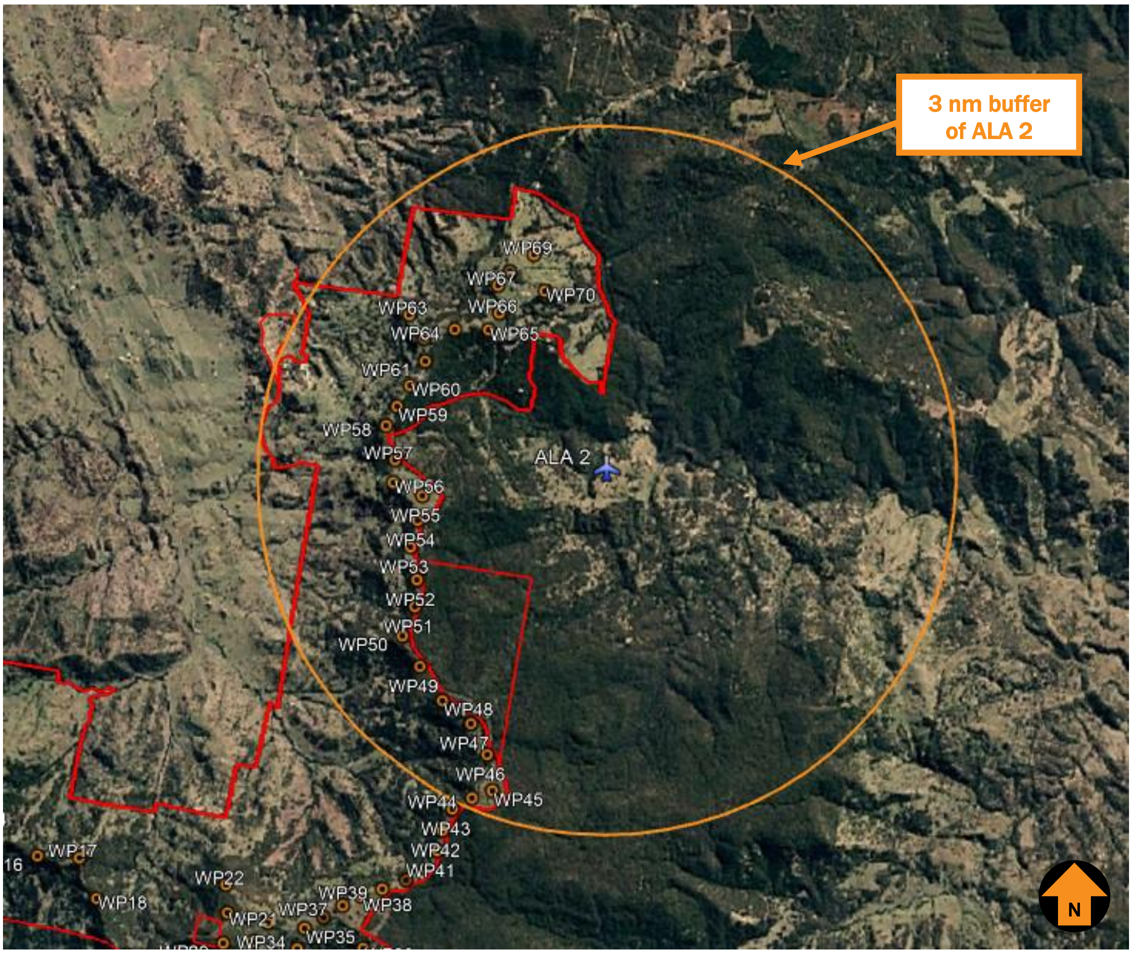

Figure 38 Close up of ALA 2

The layout of ALA 2 runway is shown in Figure 39 (source: Google Earth).

Figure 39 ALA 2 runway layout

The closest wind turbine from ALA 2 runway is WP55, which is located approximately 2.7 km (1.4 nm) from the south western end of the runway. Therefore, the Project will not impact on the approach and departure paths of this ALA.

For aerodrome circuit analysis, the same design parameters as for ALA 1 have been adopted. The illustration of indicative flight circuits for ALA 2 is shown in Figure 40 (source: Someva, Google Earth).

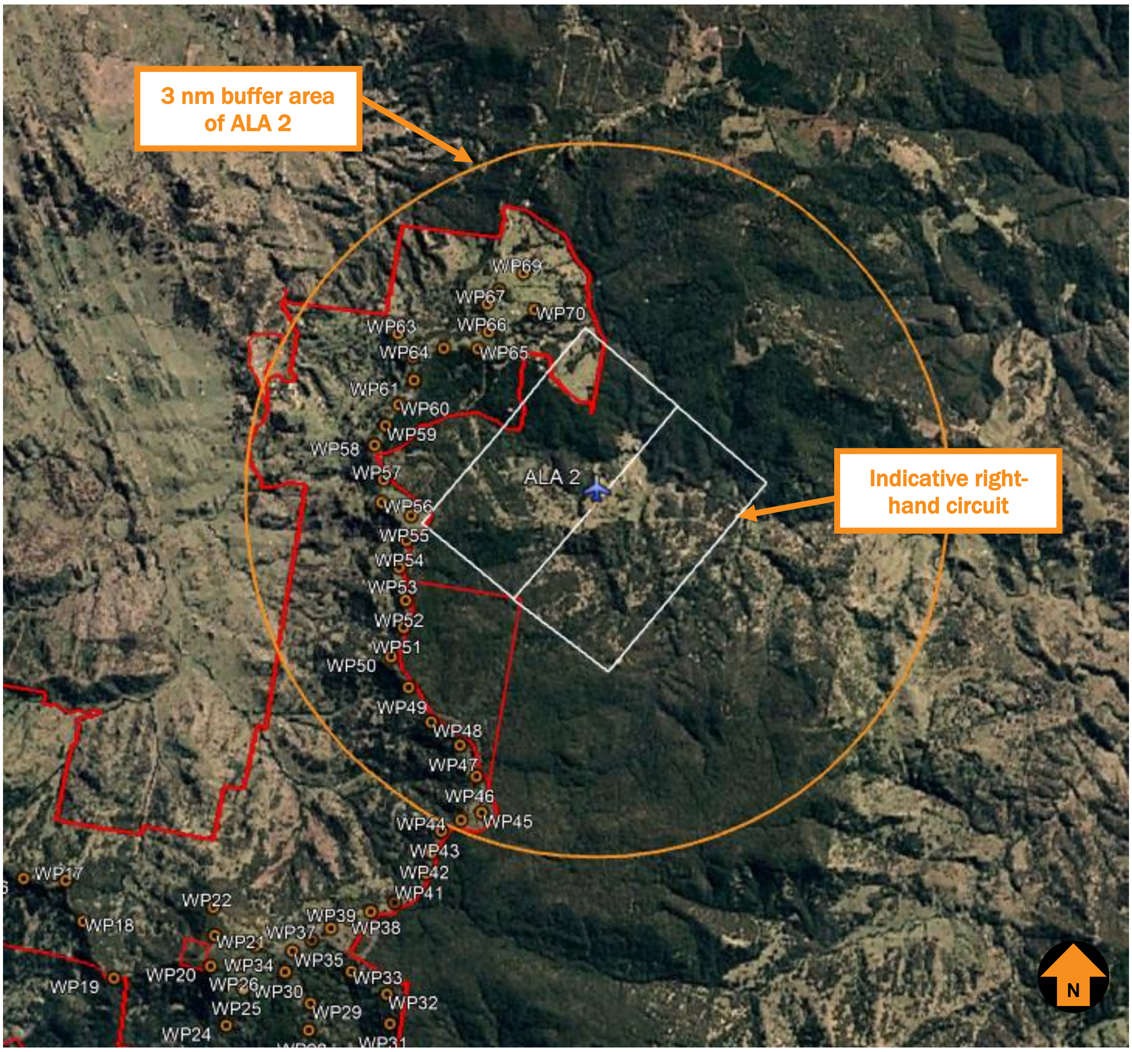

Figure 40 ALA 2 and indicative flight circuits

However, the effects of the wake turbulence could be noticeable at a distance of 2720 m (based on a 170 m rotor diameter) from some of the wind turbines.

Note that our analysis and findings are subject to validation, pending a more detailed understanding of the scope of operations and take-off and landing directions. Given the presence of trees on the south western end of the runway, it would be very unlikely that the ALA will support operations in both runway directions, in which case, take-off would be to the north east and landing would be to the south west.

Figure 41 shows 2720 m rings (associated with potential maximum horizontal extend of wake turbulence) around wind turbines located within a 3 nm radius of ALA 2 (source: Someva, Google Earth).

For this scenario, it can be seen that the the effects of wake turbulence would extend into the nominal circuit pattern whenever there is a wind from the north east and east through to south east.

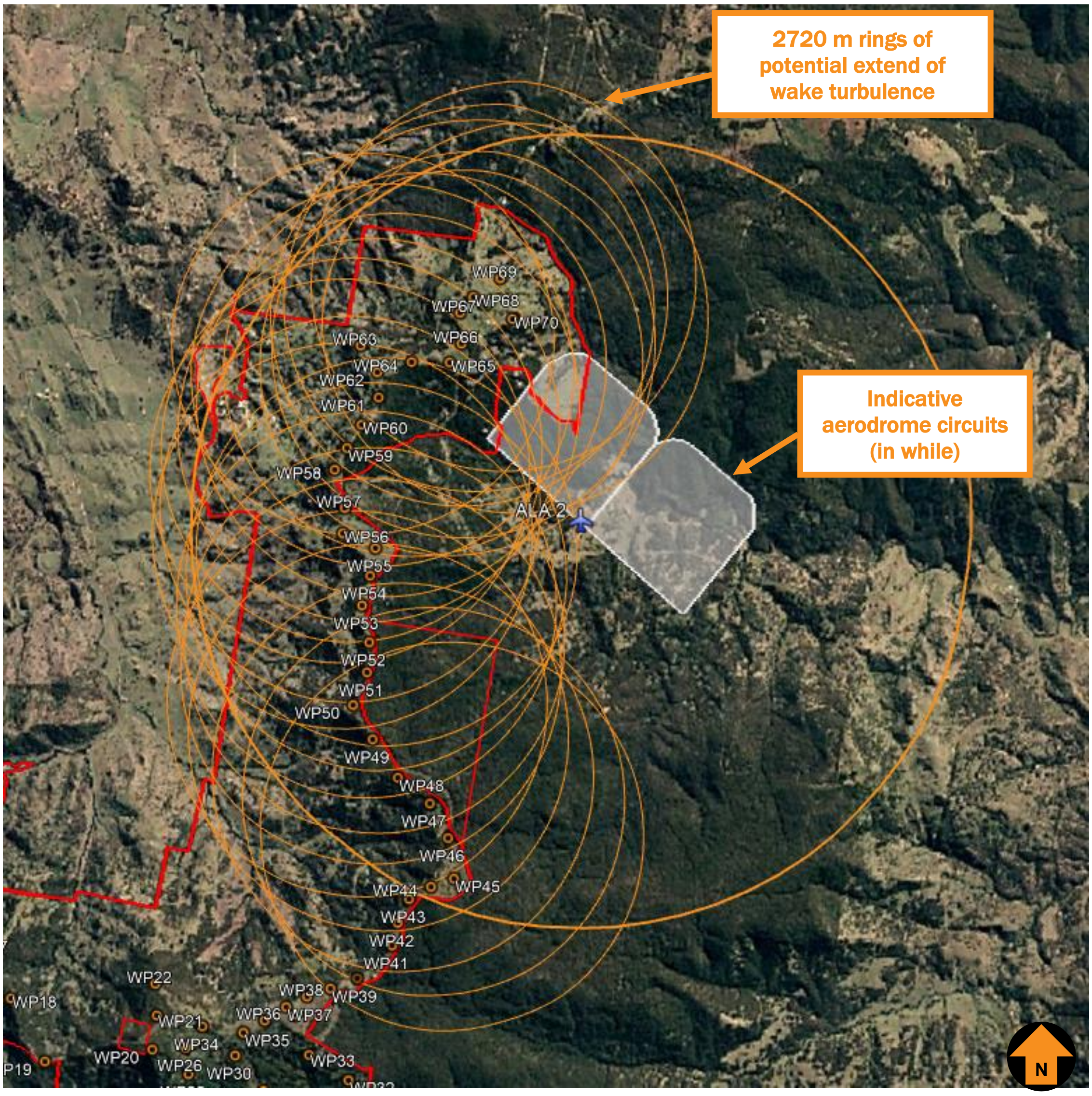

Figure 41 Potential extent of downstream wake turbulence – ALA 2

Figure 42 for take-off pattern (showing in yellow arrow) and for landing (showing in blue arrows for base legs and in yellow arrow for final leg) (source: Someva, Google Earth).

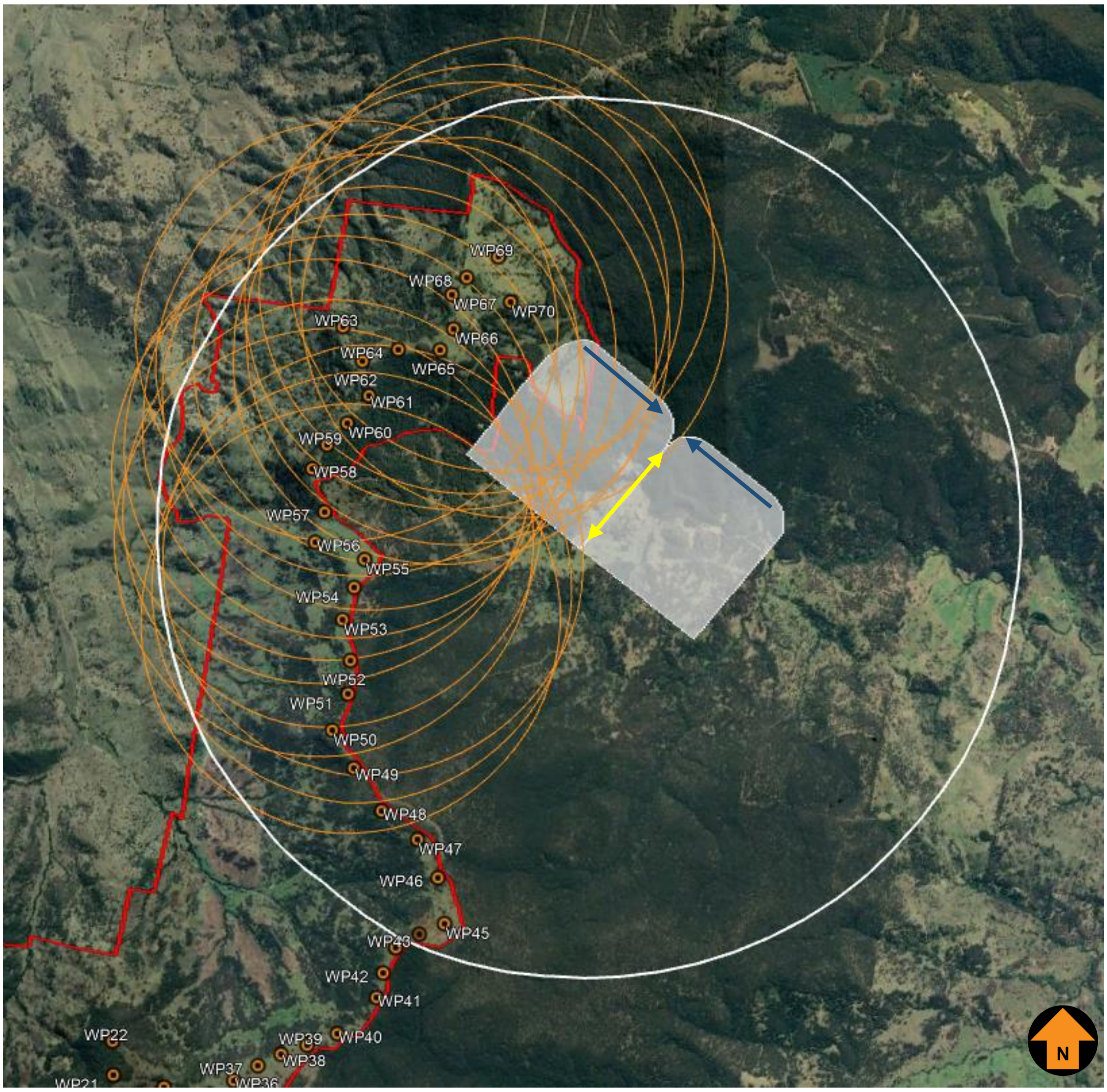

Figure 42 ALA 2 circuit patterns

Dependent on the wind direction and wind speed at the time, if wind turbines are operating when the ALA 2 is used, the potential extent of downstream wake turbulence is could be noticeable from the following wind turbines:

- WP53, WP54, WP55, WP56, WP57, WP58, WP59, WP60, WP61, WP62, WP63, WP64, WP65, WP66, WP67, WP68, WP69 and WP70.

In this configuration, the proposed Project will likely impact circuit operations at ALA 2, although the magnitude of the impact will be a function of wind direction and wind speed and the aircraft being used.

WEP should engage with the operator of the ALA 2 to firstly determine if the wake is an operational issue and then secondly if it is, agree on a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that ALA 2 is in use for take-off and landing.

Note: The potential extent of downstream wake turbulence will be less noticeable from a wind turbine model with a smaller rotor diameter.

6.15. ALA 5

The unnamed ALA 5 is not documented in OzRunways, there is no information published regarding operating procedures and use of this ALA.

A close up of ALA 5 relative to the Project Area and associated infrastructure is shown in Figure 43 (source: Someva, Google Earth).

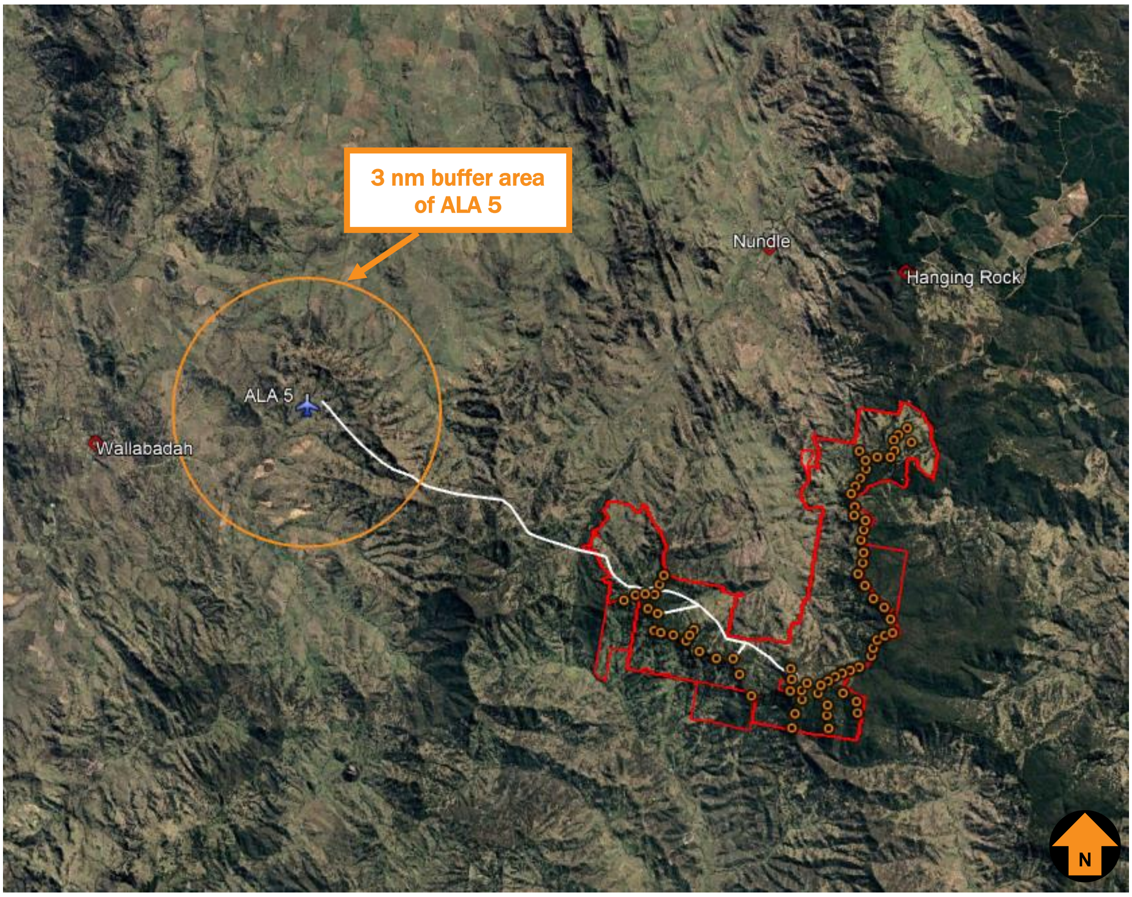

Figure 43 ALA 5 in relation to Project Area

The proposed WTGs for the Project are located outside of the nominal 3 nm radius for ALA 5 and will therefore not impact ALA 5.

However, ALA 5 is located in proximity to proposed infrastructure for the Project and the existing 330kV TransGrid Liddell to Tamworth overhead transmission line.

Figure 44 identifies the Liddell to Tamworth transmission line (in red), the proposed switching yard (in purple) the proposed overhead transmission line (OHTL) (in pumpkin) in relation to ALA 5 (source: Someva, TransGrid and Google Earth).

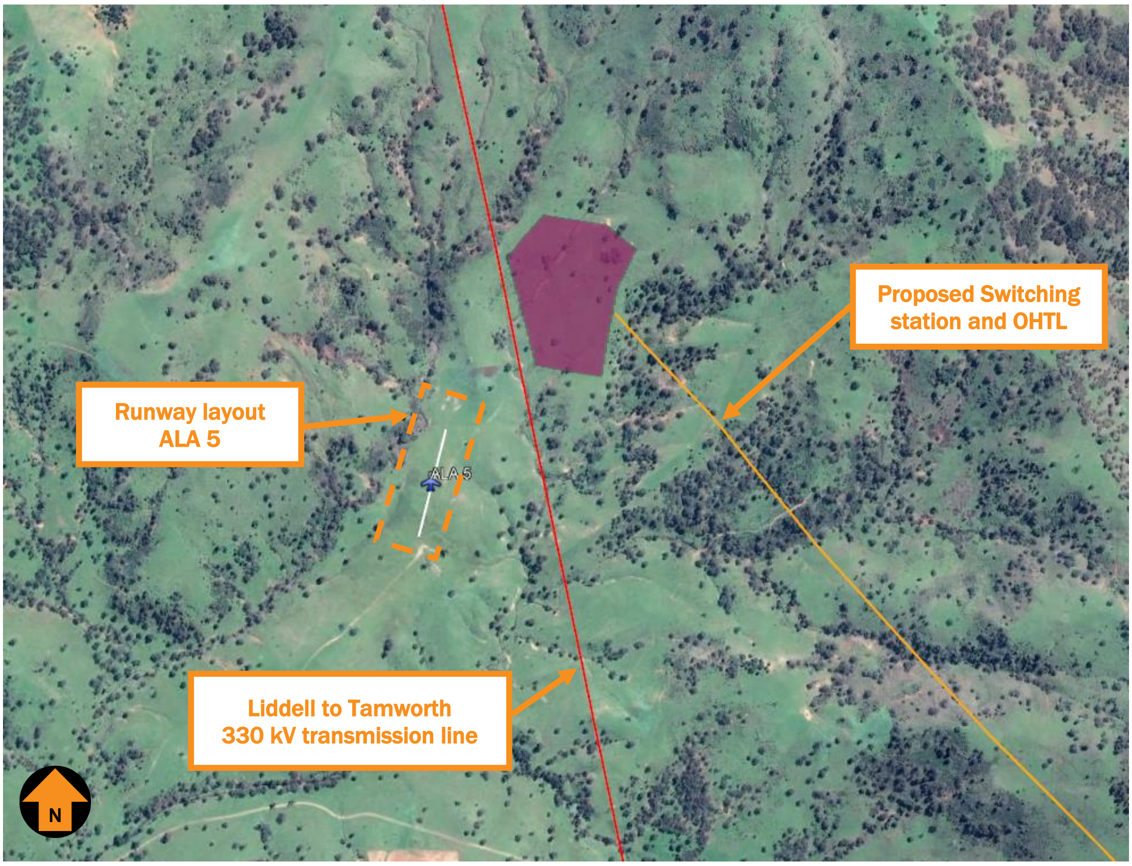

Figure 44 ALA 5 runway layout

The existing TransGrid Liddell to Tamworth 330 kV OHTL is located approximately 530 m at a bearing of 014° magnetic from ALA 5.

The ground level at the proposed location in the proximity of ALA 5 is approximately 772 m AHD and the height of the existing OHTL is approximately 40 m AGL, resulting in an overall height of approximately 812 m AHD.

The critical obstacles for the ALA 5 approach and take off surfaces are powerlines and power poles of the existing OHTL.

Figure 45 shows the location of the existing OHTL, power poles and the extension of ALA 5 approach and take-off surface (source: Someva, TransGrid, NSW Globe and Google Earth).

Figure 45 TransGrid Liddell to Tamworth 330 kV OHTL and ALA 5 locations

In this configuration, the existing OHTL with a pole sitting at height 40 m AGL and ground elevation of approximately 772 m AHD, resulting in an overall height of approximately 812 m AHD. ALA 5 approach and take-off surface at 530 m has a height of approximately 798.5 m AHD. The existing 40 m high poles will penetrate the ALA 5 approach and take-off surface by 13.5 m AHD.

In terms of the proposed OHTL of the Project, it will not cross the horizontal extent of the ALA 5 approach and take off surfaces and will not provide any impact. However, the western area, where the proposed switching yard infrastructure is to be constructed, is located under the horizontal extent of the ALA 5 approach and take off surfaces.

Figure 46 shows the locations of the proposed OHTL and switching station relative to the ALA 5 approach and take off surfaces (source: Someva, Google Earth).

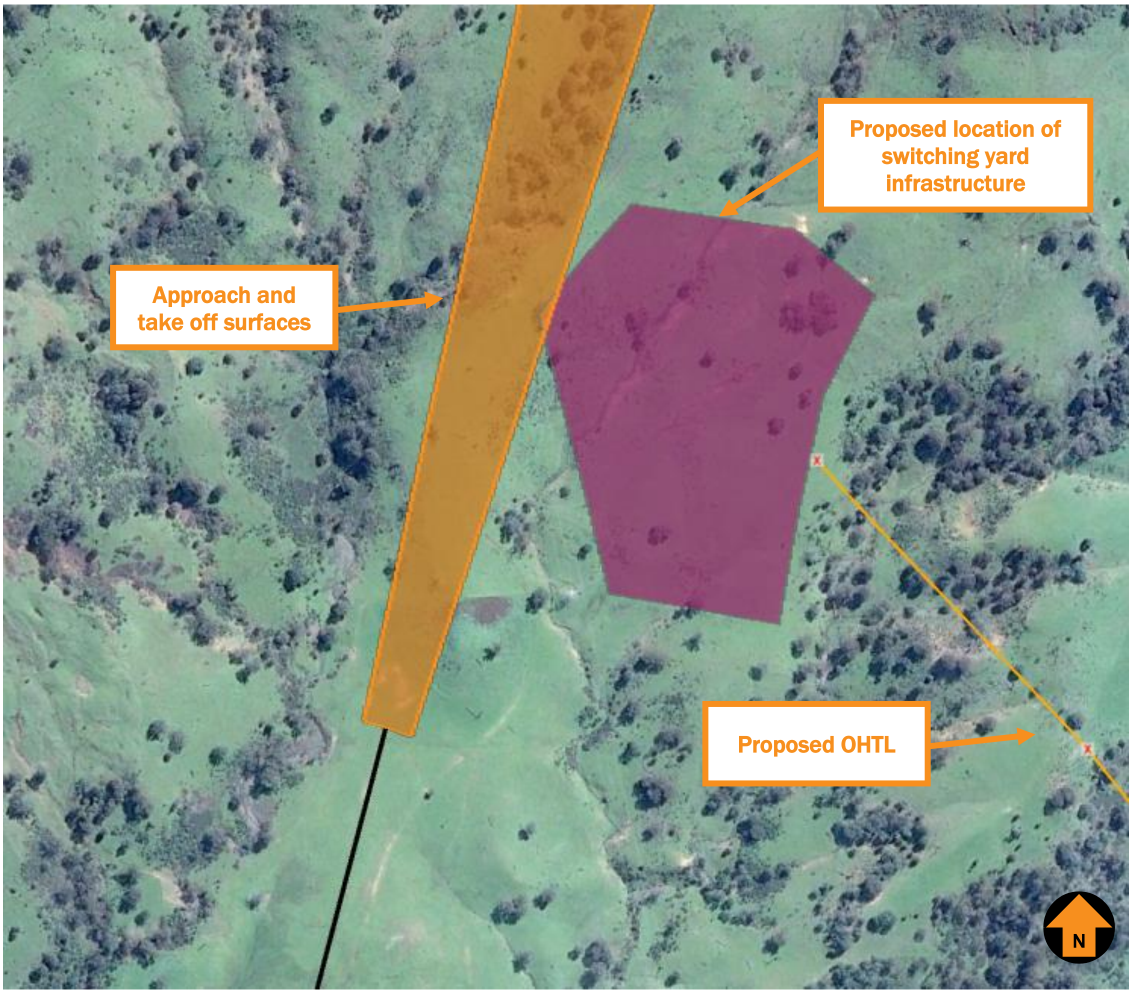

Figure 46 Proposed OHTL and the location of switching yard infrastructure relative to ALA 5

It can be seen from Figure 46 that the proposed OHTL will not impact on the approach and take-off surfaces at ALA 5.

The proposed switching yard infrastructure, at a maximum height of 18 m AGL constructed on the ground elevation of approximately 773 m AHD, results in an overall height of approximately 791 m AHD. The ALA 5 approach and take-off surface at 515 m has a height of approximately 797 m AHD. The proposed switching yard infrastructure at height of 18 m AGL will be below the ALA 5 approach and take-off surface by approximately 6 m AHD. Therefore, the proposed switching yard infrastructure will not impact the ALA 5 approach and take-off surface.

In any case, northern departures and southern approaches at ALA 5 would be restricted due to the Liddell to Tamworth OHTL and other existing obstacles such as trees.

6.16. 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 solely located in the area with a grid lowest safe altitude of 2011 m AHD (6600 ft AMSL) with a MOC surface of 1707 m AHD (5600 ft AMSL).

The highest wind turbine is WP20, with a maximum overall height of 1646 m AHD (5400 ft AMSL) and is below the LSALT MOC of 5600 ft AMSL by 61 m (200 ft AMSL). Therefore, the proposed Project will not affect the grid LSALT MOC of 5600 ft AMSL.

Figure 47 provides the grid LSALT and air routes in proximity to the proposed Project (source: Someva, OzRunways, ERC Low National, 8 October 2020).

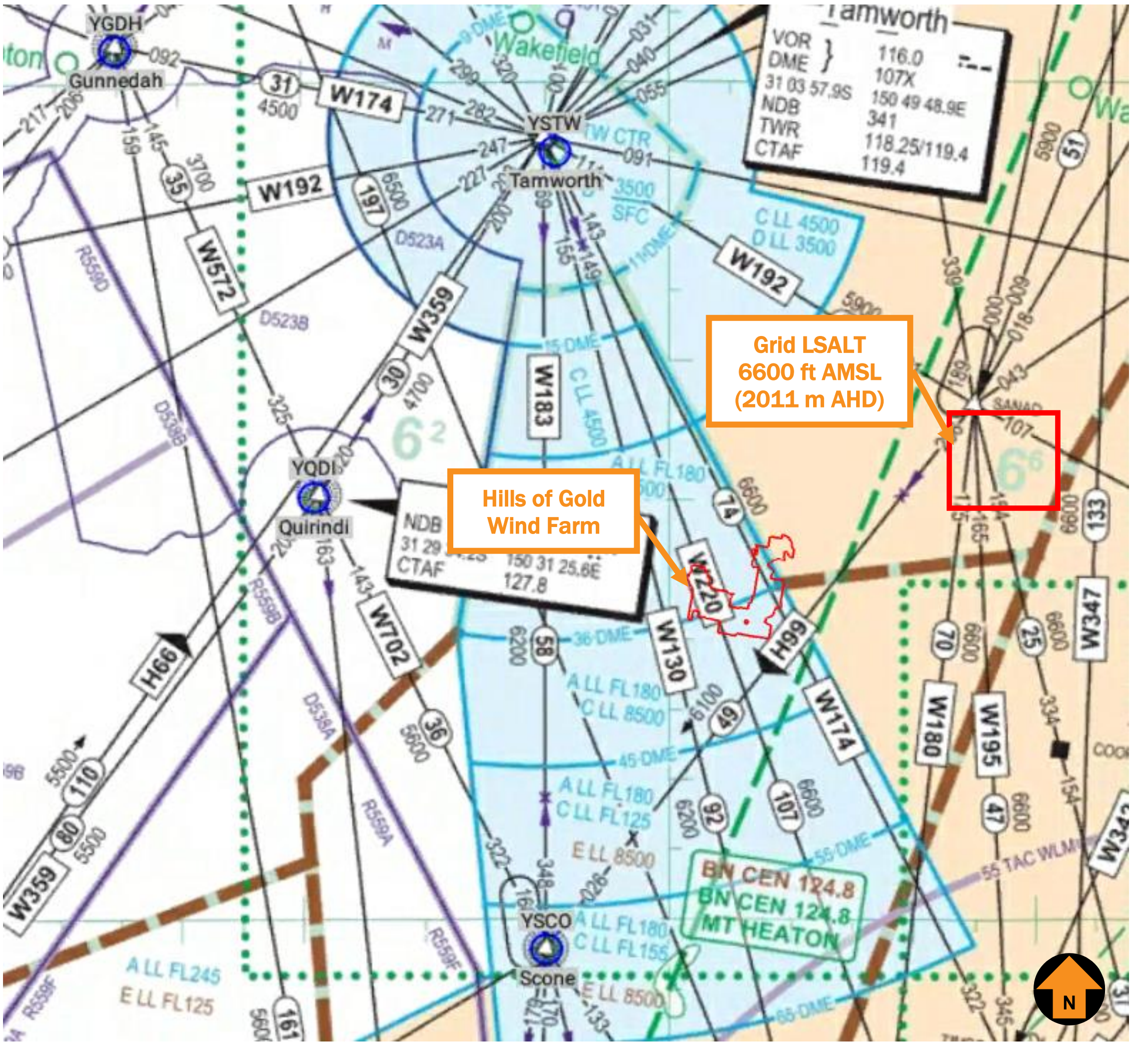

Figure 47 Air routes in proximity to the proposed Project

An impact analysis of the surrounding air routes is provided in Table 9.

Table 9 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
H99	SANAD and YSCO	6100 ft AMSL	1554 m AHD 5100 ft AMSL	Within 5 nm of air route and 91 m (300 ft) above MOC	Increase route LSALT by 300 ft from 6100 ft to 6400 ft to provide clearance of the Project	N/A
W174	YSTW and TIMBO	6600 ft AMSL	1707 m AHD 5600 ft AMSL	Nil	N/A	N/A
W130	OLTIN and YSTW	6200 ft AMSL	1585 m AHD 5200 ft AMSL	Nil (WTGs WP1-WP15 below the 5200 ft MOC)	N/A	N/A
W220	YSTW and YMND	6600 ft AMSL	1707 m AHD 5600 ft AMSL	Nil	N/A	N/A

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

The Project will have an impact on route LSALT, however not on any grid LSALTs.

6.17. Airspace

The Project Area is located within the horizontal extent but below Tamworth Airport's controlled airspace (lower limit of 6500 ft AMSL).

The Project Area is also located within close proximity to Danger Area D523B and other restricted and danger areas associated with the Royal Australian Air Force (RAAF) Base Richmond.

The proposed Project Area is located outside of controlled airspace (wholly within Class G airspace) and is not located in any Prohibited, Restricted and Danger areas.

Therefore, the Project will not impact controlled airspace.

6.18. Aviation facilities

NASF Guideline G *Protecting Aviation Facilities – Communication, Navigation and Surveillance (CNS)* provides guidance regarding the assessment and potential impact on aviation facilities.

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

- Mt Sandon VHF Tower located approximately 27 km (14.5 nm) to the north east from the Project
- a non-directional (radio) beacon (NDB) at Quirindi Airport located approximately 52.5 km (28.3 nm) to the north west from the Project
- NDB at Scone Airport located approximately 52 km (28 nm) to the south west from the Project Area.

Figure 48 shows the location of the Project Area relative to nearby aviation facilities (source: Google Earth).

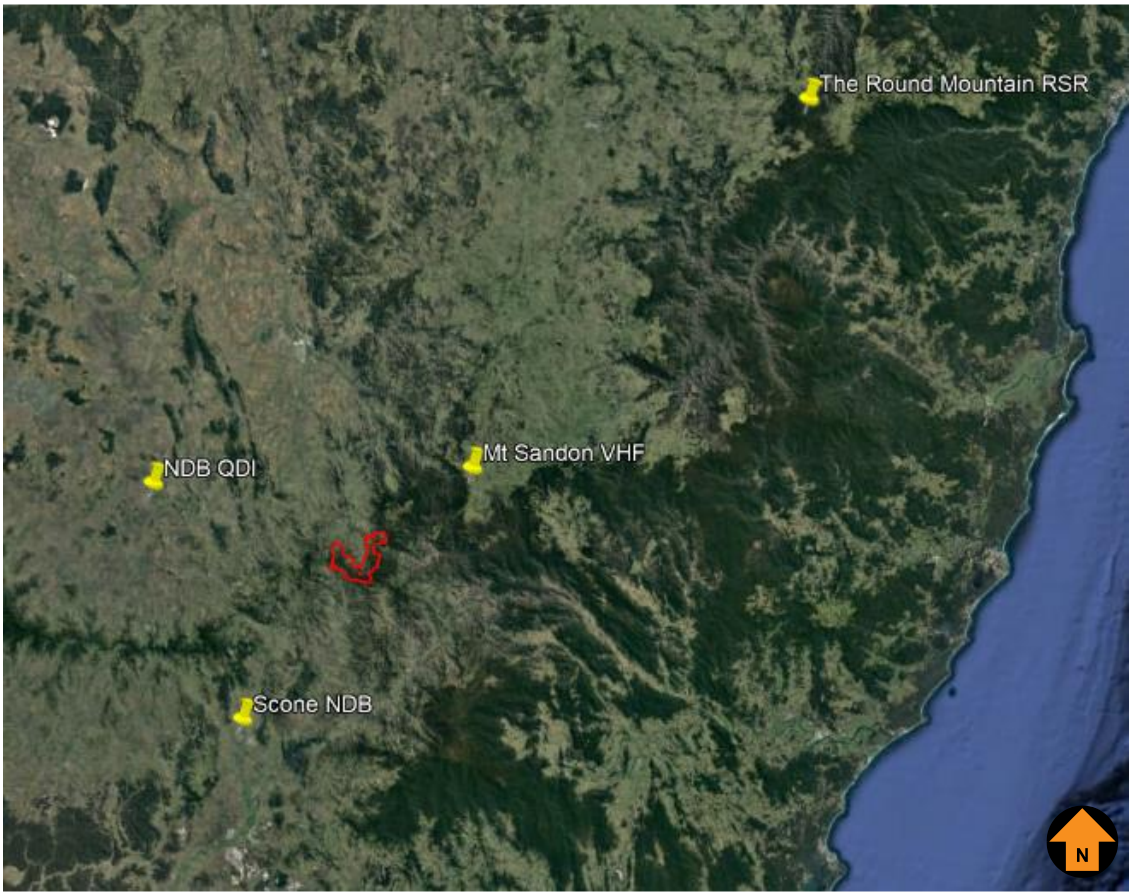

Figure 48 Project area relative to nearby aviation facilities

The Project will not penetrate any protection areas associated with NDB, additionally the Project is located outside the area of interest (2000 m radius) associated with the Mt Sandon VHF Radar.

6.19. Radar

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

With respect to aviation radar facilities, the closest radar is the Round Mountain Route Surveillance Radar (RSR) which is located approximately 158 km (85 nm) north east of the Project Area.

The proposed Project Area 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 the Round Mountain RSR.

Note: Route Surveillance Radar (RSR) and Secondary Surveillance Radar (SSR) is the same radar system.

6.20. Bureau of Meteorology

With respect to the Bureau of Meteorology (BoM) radars, the closest weather radar is the Namoi Black Jack Mountain DWSR 8502S 2° S-band Doppler radar located at Black Jack Mountain near Gunnedah approximately 104 km (56 nm) north east of the Project (source: BoM, NSW radar information).

Therefore, it is unlikely that the Project will impact the Doppler radar located at Black Jack Mountain.

6.21. 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.

6.22. AIS summary

Based on the Project layout and overall turbine blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is WTG WP20, will not exceed 1646 m AHD (5400 ft AMSL) and:

- will not penetrate any OLS surfaces
- will penetrate PAN-OPS surfaces
- will have an impact on nearby designated air route H99
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

6.23. ALA analysis summary

Based on the Project layout, a summary of the analysis completed on nearby ALAs is detailed as below:

- The Project Area will not impact on the approach and take-off surfaces of ALA 3, ALA 4, ALA 5 (Golland), Wallabadah ALA (YWBH), Woolomin ALA (YWOM) and Goonoo Goonoo ALA (YGGO).
- ALA 3, ALA 4, ALA 5 (Golland), Wallabadah ALA (YWBH), Woolomin ALA (YWOM), and Goonoo Goonoo ALA (YGGO) are located outside a nominal 3 nm buffer and will not be impacted by the Project.
- Some of the wind turbines are located within the indicative horizontal extension of ALA 1 aerodrome circuits. These turbines include WP56, WP57 and WP58. However, the runway is located in the valley with higher terrain from the eastern runway end.
- Taken into consideration the topography of ALA 1 and its runway orientation, approaches to ALA 1 are likely performed to the east (eastern approaches) and departures to the west (western departures) and is likely to be a one way in, one way out runway. Therefore, it is unlikely that the Project will impact approach and departure paths of ALA 1.
- The Project will not impact on the approach and departure paths of ALA 2.
- The Project and associated infrastructure will not impact on operations at ALA 5 (Golland).
- Based on the analysis conducted in this section and the information gathered, it is unlikely that the Project will impact on circuit operations at ALA 2, ALA 3, ALA 4, ALA 5 (Golland), Wallabadah ALA (YWBH), Woolomin ALA (YWOM) and Goonoo Goonoo ALA (YGGO).
- Dependent on the wind direction and wind speed at the time, if wind turbines are operating when the ALA 1 and ALA 2 are used, the potential extent of downstream wake turbulence could be noticeable from some of the proposed wind turbines at these ALAs.

6.24. Assessment recommendations

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

- 25 nm MSA at Scone Airport in the sector bounded by bearings 070° and 290° should be increased by 100 ft to 6400 ft AMSL
- the initial approach altitude for RNAV GNSS approach procedures for runway 29 at Scone Airport should be amended to 6400 ft AMSL to safeguard the approach procedure
- air route H99 LSALT should be increased by 300 ft from 6100 ft to 6400 ft AMSL
- WEP should consult with the operator of the ALA 1 and ALA 2 to agree on a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that the ALAs are in use for take-off and landing.

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 summarized in **Annexure 5.**

7.1. Wind monitoring tower

WMTs already installed onsite have been reported to Airservices Australia for entry into the Vertical Obstacle Database. In terms of obstacle marking and lighting requirements, relevant requirements set out in MOS 139 and NASF are provided below.

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

> *8.109 Obstacles and hazardous obstacles*
>
> *(1) The following objects or structures at an aerodrome are obstacles and must be marked in accordance with this Division unless CASA determines otherwise under subsections (3) and (5):*
>
> > *any fixed object or structure, whether temporary or permanent in nature, extending above the obstacle limitation surfaces. Note an ILS building is an example of a fixed object;*
> >
> > *any object or structure on or above the movement area that is removable and is not immediately removed.*
>
> *8.110 Marking of hazardous obstacles*
>
> *(5) long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that:*
>
> > *(a) the darker colour is at the top; and*
> >
> > *(b) the bands:*
> >
> > > *i. are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and*
> > >
> > > *ii. have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of:*
> > >
> > > > *(A) 1/7 of the height of the structure; or*
> > > >
> > > > *(B) 30 m.*
>
> *(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:*
>
> > *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
>
> *(b) be spaced 30 m apart along the length of the wire or cable.*

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 be 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.*

Refer to Section 4.3 for additional information regarding the permanent WMTs.

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) operation type is considered by the Australian Transport Safety Bureau (ATSB) to be all flying activities that do not involve scheduled (RPT) and non-scheduled (charter) passenger and freight operations. It may involve Australian civil (VH–) registered aircraft, or aircraft registered outside of Australia. General aviation encompasses:

- Aerial work. This includes flying for the purposes of agriculture (spraying and spreading), mustering, search and rescue, fire control, or survey and photography
- Flying training
- Private, business and sports aviation. Sports aviation includes gliding, parachute operations, ballooning, warbird operations, and acrobatics.

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 2008-2017

The Australian Transport Safety Bureau recently published a summary of aviation occurrence statistics for the period 2008 to 2017 (AR-2018-030) Final, 21 December 2018.

According to the report, there were no fatalities in high or low capacity RPT operations during the period 2008-2017. In 2017 there was 21 fatalities from 93 accidents in general aviation operations.

Of the 337 fatalities recorded in the 10-year period, almost two thirds (206 or 61.12%) occurred in the general aviation segment. On average, there were 1.44 fatalities per aircraft associated with a fatality in this segment. The fatalities to aircraft ratio ranges from 1 to 1.7:1. 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 10 (source: ATSB).

Table 10 Number of fatalities by GA sub-category – 2008 to 2017

Sub-category	*Aircraft assoc. with fatality*	*Fatalities*	*Fatalities to aircraft ratio*
Agriculture	19	19	1:1
Mustering	14	15	1.07:1
Search and rescue	2	2	1:1
Fire control	2	2	1:1
Survey and photography	5	8	1.6:1
Other aerial work	3	5	1.66:1
Flying training	11	17	1.545:1
Private/business	68	116	1.7:1
Sport aviation (excluding gliding)	4	4	1:1
Gliding	10	12	1.2:1
Foreign registered	1	1	1:1
Totals	139	201	1.44:1

According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 10-year reporting period ranged between 3.6 in 2016 and 10.8 in 2008. Figure 49 refers to Fatal Accident Rate by operation type per million departures over the 10-year period (source: ATSB).

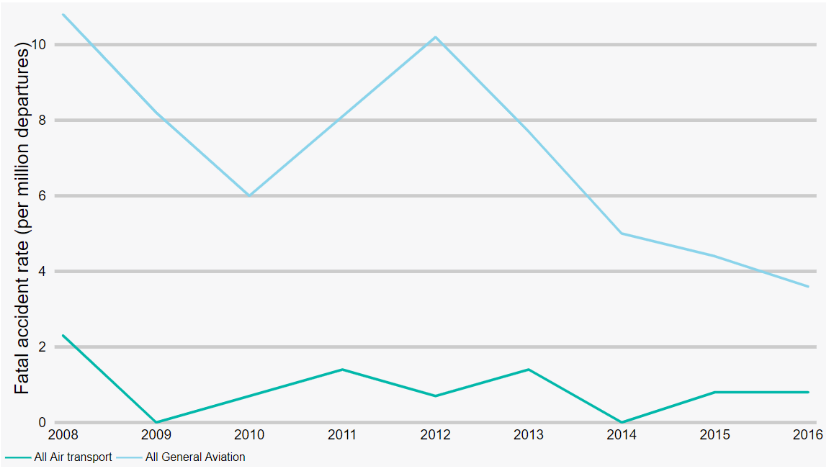

Figure 49 Fatal Accident Rate (per million departures) by Operation Type

In 2015, there were 10 fatal accidents and 12 fatalities involving GA aircraft, resulting in a rate of 4.4 fatal accidents per million departures and 8.4 fatal accidents per million hours flown.

In 2016, there were 1,920,000 departures, and 1,301,000 hours flown by VH-registered general aviation aircraft in Australia, with 7 fatal accidents and 10 fatalities. Based on these results, in 2016 there were 3.6 fatal accidents per million departures and 5.4 fatal accidents per million hours flown. A summary of fatal accidents from 2008-2017 by GA sub-category is provided in Table 11 (source: ATSB).

Table 11 Fatal accidents by GA sub-category – 2008 -2017

Sub-category	Fatal accidents	Fatalities
Aerial agriculture	19	19
Aerial mustering	14	15
Search and rescue	2	2
Fire control	2	2
Survey and photography	5	8
Other	3	5
Flying training	11	17
Private/business	68	116
Sports	4	4

Sub-category	Fatal accidents	Fatalities
Gliders	10	12
Foreign registered	1	1
Totals	139	201

Over the 10-year period, there were 17,331,000 general aviation departures in Australia, during which time no aircraft collided with a wind turbine or a wind monitoring tower.

Of the 26,373 incidents, serious incidents and accidents in GA operations in the 10-year period, 1378 (5.22%) were terrain collisions.

There is an underlying fatality rate for GA operations that 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.

Global Wind Energy Council reports on its website there were 341,320 wind turbines operating around the world at the end of 2016.

Australia's Clean Energy Council reports on its website there were 94 wind farms in Australia at the end of 2018.

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 12.

Table 12 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

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 Hills of Gold 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; and
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 13 to Table 17.

Table 13 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; and
- 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 8.4.

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 Project 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 Project 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 230 m (755 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 78 m (255 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 AGL (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 110 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 Area. ○ 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 14 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.

There are 3 temporary WMTs as part of the Project.

The WMTs have been constructed of steel lattice and are at a maximum of 110 m (361 ft) AGL in height.

The towers are steel lattice masts (at or below the wind turbine hub height) and have been installed at different locations around the Project Area.

The WMTs have high visibility aviation marker balls up on the top-level guy wires.

The location of the temporary WMT locations and other applicable details have been reported to Airservices Australia.

The Project includes decommissioning of the three current monitoring masts and installation of up to five additional monitoring masts for power testing.

WEP is proposing to install 5 permanent WMTs with a maximum of 155 m (509 ft) AGL in height. The five monitoring masts will be located close to a WTG location and will have the same WTG hub height. The exact number and location will be defined at the detailed design stage. The locations of permanent WMTs and their details 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 temporary WMT locations have been reported to CASA and Airservices Australia. • The locations of permanent WMTs will be determined as part of the final construction design and their details will be reported to 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 WMTs are at a maximum height of 155 m (509 ft) AGL, which will be approximately 0.3 m (1 ft) above 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 110 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 temporary WMTs were reported to Airservices Australia when they were constructed. • The locations of permanent WMTs will be determined as part of the final construction design and their details should be reported to Airservices Australia, local and regional aerodrome and aircraft operators before, during and following construction.

• The WMTs have been marked with aviation marker balls and consideration was 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 temporary WMTs on the Project site have been 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 **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 the WMTs, without obstacle lighting on the WMTs of the Project.**	
Residual Risk	7 - Tolerable

Table 15 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 Project 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 230 m (755 ft) at the top of the blade tip The rotor blade at its maximum height will be approximately 78 m (255 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 110 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 Project 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 230 m (755 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 78 m (255 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 110 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, WEP may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project Area.
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 16 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 Project 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 230 m (755 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 78 m (255 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. • 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 110 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, WEP 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 **as low as reasonably practicable 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 17 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 (b) whether it requires an obstacle light that is essential for the safety of aircraft operations. In general, objects outside an OLS and above 110 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 110 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 • mitigating light glare from obstacle lighting through measures such as baffling or shielding. 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 Project will comprise the following:

- up to 70 wind turbines
- maximum overall height (tip height) of the wind turbines is up to 230 m AGL
- highest wind turbine is WP20 with ground elevation of 1410 m AHD and overall height of 1646 m AHD (5400 ft AMSL)
- 3 existing temporary wind monitoring towers (WMTs) with a maximum height of up to 110 m (361 ft) AGL, which have been reported to Airservices Australia. Additionally, decommissioning of three current monitoring masts and installation of up to five additional monitoring masts for power testing
- 5 proposed permanent WMTs with a maximum height of up to 155 m (509 ft) AGL, which will be reported to Airservices Australia
- 330 kV single circuit twin conductor overhead transmission line (transmission line) to connect the onsite substation to the existing 330 kV TransGrid Liddell to Tamworth overhead transmission line network.

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 Project as proposed does not satisfy the following Local Environmental Plan in relation to impacts to 'Operations Surfaces', noting however, that Procedures for Air Navigation Services Operations Surface Maps are not published in any of the Plans:

- Upper Hunter LEP 2013, dated 17 April 2020

Under the planning provisions, the impacts would be acceptable if the relevant Commonwealth body (assumed to be Airservices Australia or CASA) advises that the development will penetrate Operations Surfaces but it has no objection to its construction.

The Project as proposed satisfies the following planning documents:

- Tamworth Regional Development Control Plan 2010, Amendment No 13. Adopted 26 October 2010
- Tamworth Regional LEP 2010, dated 17 April 2020
- Liverpool Plains Shire Council Development Control Plan 2012, Amendment No 4, 26 February 2020
- Liverpool Plains LEP 2011, dated 17 April 2020.

10.4. Consultation

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

10.5. Aviation Impact Statement

Based on the Project layout and overall turbine overall blade tip height limit of 230 m AGL, the blade tip elevation of the highest wind turbine, which is WP20, will not exceed 1646 m AHD (5400 ft AMSL) and:

- will not penetrate any OLS surfaces
- will penetrate PAN-OPS surfaces of Scone Airport
- will have an impact on nearby designated air route H99
- will not have an impact on the grid LSALT
- will not have an impact on prescribed airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

Airservices Australia response is copied below:

> *Airspace Procedures*
>
> *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1646m (5400ft) AHD, the Hills of Gold Wind Farm will affect the minimum sector altitude (MSA) instrument procedure at Scone aerodrome.*
>
> *The Scone MSA will require permanent amendment in the Northern sector from 6300ft to 6400ft AHD. In addition, the start altitude for the RNAV-Z (GNSS) RWY 29 procedure will require permanent amendment to 6400ft AHD.*
>
> *The maximum height of Hills of Gold Wind Farm without affecting any procedures at Scone aerodrome is 1620.3m (5316ft) AHD.*
>
> *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 1646m (5400ft) AHD, the Hills of Gold Wind Farm will affect the air route H99.*

The air route H99 will require permanent amendment of the minimum safe altitude from 6100ft to 6400ft AHD.

The maximum height of Hills of Gold Wind Farm without affecting air route H99 is 1554.4m (5100ft) AHD.

Note: Procedures not designed by Airservices at Scone aerodrome were not considered in this assessment.

Communications/Navigation/Surveillance (CNS) Facilities

This proposal, to a maximum height of 1646m (5400ft) AHD, will not adversely impact the performance of any Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Summary

Based on the above assessment, Airservices view is that the proposed Hills of Gold Wind Farm would have an impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of Scone Airport.

If this proposal is to proceed, Airservices recommends that both aviation operators and the airport are consulted to ensure that all stakeholders fully understand the extent of the impact of these proposed changes. Furthermore, any Airservices work associated with amending the flight procedures will be undertaken on a commercial basis and require further consultation.

Department of Defence response is copied below:

Defence has conducted an assessment of the proposed wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar.

The proposed structures will meet the 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 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.

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.

WEP 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 Area.

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 MOS 139 Chapter 8 Division 10 section 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 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.
- There are 3 temporary WMTs at a height of up to 110 m (361 ft) AGL. The WMTs have been reported to Airservices Australia. WEP is also proposing 5 additional permanent WMTs at a height of up to 155 m (509 ft) AGL, which will be reported to Airservices Australia. Additionally, the Project includes decommissioning of the three current monitoring masts and installation of up to five additional monitoring masts for power testing.
- Consideration was made in marking the temporary WMTs, which has been completed according to the requirements set out in MOS 139 Section 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D).

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 18.

Table 18 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 110 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; and

    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 wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations. Specifically, details should be provided to the New South Wales Regional Airspace and Procedures Advisory Committee (rapac@casa.gov.au) for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm.

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. Whilst not a statutory requirement, WEP 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.

7. WEP should consult with the operator of the ALA 1 and ALA 2 to agree on a mitigation plan, which may include suspending the relevant wind turbine's operation (dependent on wind direction and wind speed) for the period that the ALAs are in use for take-off and landing.

Marking of turbines

8. 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.

Overhead transmission line

9. Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture

operators and marked in accordance with MOS 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

Lighting of turbines

10. **Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft, once the proposed mitigation solutions outlined in Section 6.24 are implemented.**

Marking of wind monitoring towers

11. Consideration has been given to marking the wind monitoring towers according to the requirements set out in MOS 139 Chapter 8 Division 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) guy wire ground attachment points should be in contrasting colours to the surrounding ground/vegetation; and

    c) paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast. For ease of application, it would be reasonable to simplify the requirement to paint in bands with a width of approximately 1/7 of the longest dimension, by painting whole sections of the mast to the nearest whole section with an overall width of approximately 1/7 of the longest dimension, in three equal bands – red/orange, white, red/orange, so that at least the top 1/3 of the tower is marked.

Micrositing

12. The potential micrositing of the turbines and wind monitoring towers have been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level is within 100 m of the nominal turbine and wind monitoring tower positions. Providing the micrositing is within 100 m of the turbines and wind monitoring towers is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this aviation impact assessment would remain the same.

Triggers for review

13. 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.

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 13 August 2020
- Airservices Australia, Designated Airspace Handbook, effective 21 May 2020
- Bureau of Meteorology, NSW/ACT Radar Sites Table and Information, http://www.bom.gov.au/australia/radar/nsw_radar_sites_table.shtml
- 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
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- Liverpool Plains Shire Council, Liverpool Plains Local Environmental Plan 2011, current version dated 17 April 2020
- Liverpool Plains Shire Council, Liverpool Plains Shire Council Development Control Plan 2012, Amendment No 4, dated 26 February 2020
- OzRunways, aeronautical navigation charts extracts, dated 8 October 2020

- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- Tamworth Regional Council, Tamworth Regional Local Environmental Plan 2010, current version dated 17 April 2020
- Tamworth Regional Council, Tamworth Regional Development Control Plan 2010, amendment No 13. Adopted 26 October 2010
- Upper Hunter Shire Council, Upper Hunter Local Environmental Plan 2013, current version dated 17 April 2020.

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
Civil Aviation Safety Regulations 1998 (CASR)	Contain the mandatory requirements in relation to airworthiness, operational, licensing, enforcement.
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.
Manual of Standards (MOS)	The means CASA uses in meeting its responsibilities under the Act for promulgating aviation safety standards
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.

Term	Definition
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.
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; and 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.

ANNEXURE 3 – TURBINE COORDINATES AND HEIGHTS

Source: ERM, Hills of Gold Wind Farm - Project layout, *Turbine Co-ordinates.xlsx*, received 6 July 2020.

Note: the WTG heights include a 5 m allowance for variance in site elevation

WTG ID	*Easting*	*Northing*	*Base Elevation (m AHD)*	*Maximum Tip Height (m AGL)*	*Error budget + 5 m*	*Wind turbine tip height (m AHD)*	*Wind turbine tip height (ft AMSL)*
WP1	316190.846	6502649.423	1222.331	230	5	1457.3	4781.5
WP2	316660.033	6502869.954	1259.577	230	5	1494.6	4903.7
WP3	317061.845	6502922.861	1254.732	230	5	1489.7	4887.8
WP4	317449.239	6502903.104	1199.659	230	5	1434.7	4707.1
WP5	317646.578	6503320.59	1142.293	230	5	1377.3	4518.9
WP6	317817.553	6503696.303	1171.941	230	5	1406.9	4616.2
WP7	317184.441	6502322.26	1185.671	230	5	1420.7	4661.2
WP8	317588.545	6502126.598	1167.515	230	5	1402.5	4601.7
WP9	317453.026	6501426.236	1153.009	230	5	1388.0	4554.1
WP10	317732.464	6501347.185	1160.409	230	5	1395.4	4578.3
WP11	318250.898	6501255.867	1127.112	230	5	1362.1	4469.1
WP12	319102.057	6501480.181	1131.467	230	5	1366.5	4483.4
WP13	318924.1	6501258.676	1161.777	230	5	1396.8	4582.8

WTG ID	Easting	Northing	Base Elevation (m AHD)	Maximum Tip Height (m AGL)	Error budget + 5 m	Wind turbine tip height (m AHD)	Wind turbine tip height (ft AMSL)
WP14	318777.791	6501032.549	1161.323	230	5	1396.3	4581.3
WP15	319341.128	6500599.035	1118.492	230	5	1353.5	4440.8
WP16	320042.268	6500328.808	1069.753	230	5	1304.8	4280.9
WP17	320736.01	6500326.421	1169.627	230	5	1404.6	4608.6
WP18	321007.066	6499684.836	1130.549	230	5	1365.5	4480.4
WP19	321513.273	6498815.938	1195.134	230	5	1430.1	4692.3
WP20	323082.517	6499076.731	1410.867	230	5	1645.9	5400.1
WP21	323138.002	6499550.962	1408.267	230	5	1643.3	5391.6
WP22	323095.633	6499977.322	1372.691	230	5	1607.7	5274.8
WP23	323198.929	6497537.828	1211.541	230	5	1446.5	4746.1
WP24	323308.03	6498134.149	1255.078	230	5	1490.1	4888.9
WP25	323580.758	6498725.926	1366.018	230	5	1601.0	5252.9
WP26	323545.962	6499107.037	1391.794	230	5	1626.8	5337.5
WP27	324703.502	6497555.803	1294.542	230	5	1529.5	5018.4
WP28	324612.564	6498100.249	1344.47	230	5	1579.5	5182.2
WP29	324632.3	6498514.803	1333.736	230	5	1568.7	5147.0

WTG ID	Easting	Northing	Base Elevation (m AHD)	Maximum Tip Height (m AGL)	Error budget + 5 m	Wind turbine tip height (m AHD)	Wind turbine tip height (ft AMSL)
WP30	324229.061	6498998.423	1341.849	230	5	1576.8	5173.6
WP31	325872.662	6498217.873	1312.107	230	5	1547.1	5076.1
WP32	325818.826	6498681.887	1319.679	230	5	1554.7	5100.9
WP33	325257.989	6499019.076	1335.646	230	5	1570.6	5153.3
WP34	323773.148	6499406.095	1405.229	230	5	1640.2	5381.6
WP35	324341.665	6499321.566	1358.823	230	5	1593.8	5229.3
WP36	324635.236	6499495.047	1365.77	230	5	1600.8	5252.1
WP37	324927.945	6499682.672	1341.408	230	5	1576.4	5172.2
WP38	325216.988	6499831.368	1336.228	230	5	1571.2	5155.2
WP39	325542.572	6499948.689	1332.414	230	5	1567.4	5142.7
WP40	325908.197	6500088.913	1282.261	230	5	1517.3	4978.1
WP41	326393.749	6500561.993	1317.789	230	5	1552.8	5094.7
WP42	326467.498	6500880.587	1325.202	230	5	1560.2	5119.0

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 <u>at or below, an acceptable level</u> 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 110 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/m^2 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; and
  - 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; and
- 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

The details of the WMTs were introduced in **Section 4.3** of this report.

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 Marking of Hazardous Obstacles*
>
> *(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.*
>
> *(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:*
> *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
> *(b) be spaced 30 m apart along the length of the wire or cable.*

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.

Overhead transmission lines

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with MOS 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8):

8.110 Marking of hazardous obstacles

(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:
(a) be approximately equivalent in size to a cube with 600 mm sides; and
(b) be spaced 30 m apart along the length of the wire or cable.

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