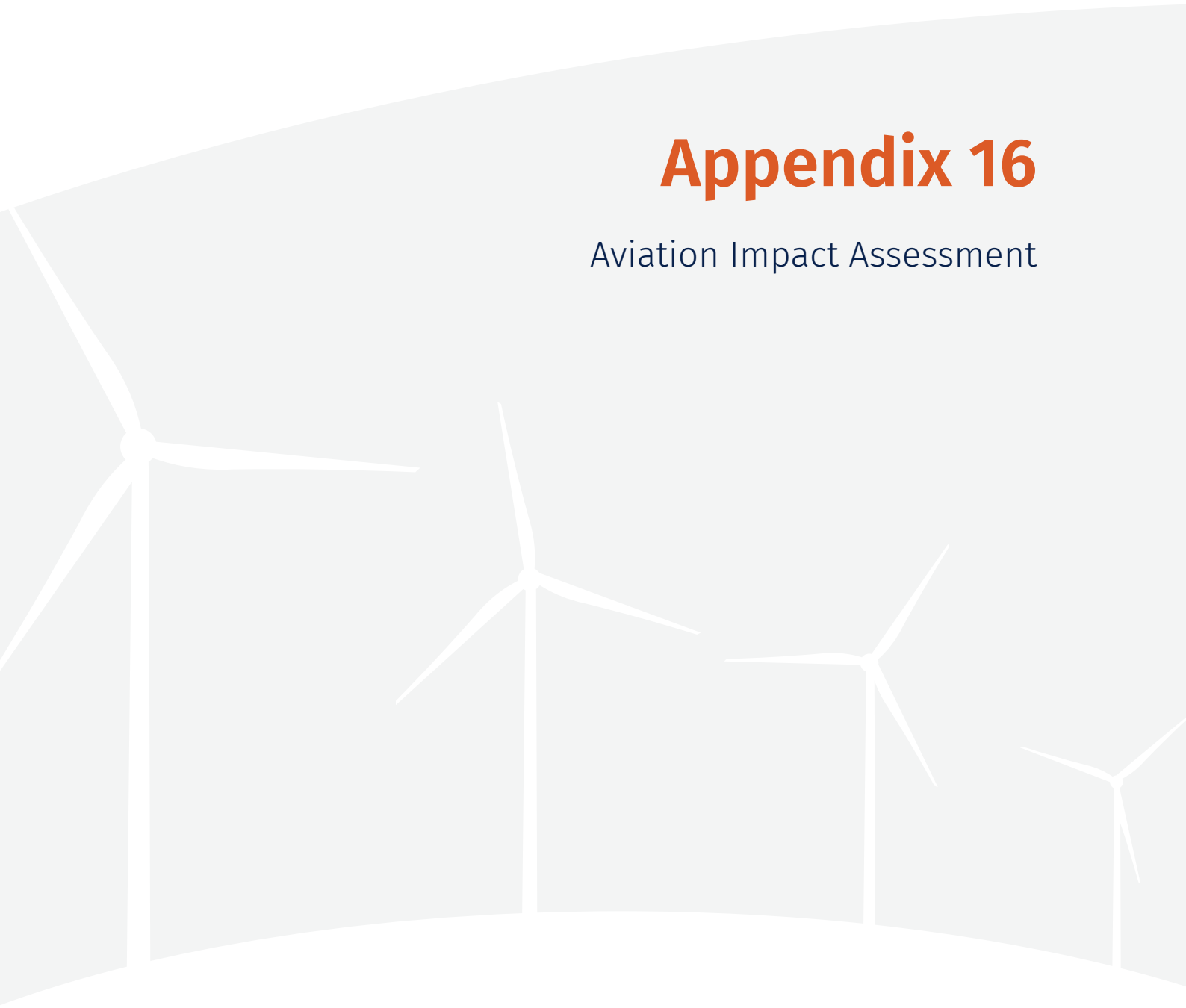
Appendix 16

Aviation Impact Assessment



November 2021

AVIATION IMPACT ASSESSMENT

THUNDERBOLT WIND FARM

Prepared for Umwelt Australia Pty Ltd

AVIATION PROJECTS

AVIATION PROJECTS

DOCUMENT CONTROL

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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
BESS	battery energy storage system
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
ERC-H	en-route chart high
ERC-L	en-route chart low

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

UNITS OF MEASUREMENT

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

DEFINITIONS

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

NOTES

A 5 m error budget has been applied for assessment of wind turbine generator (WTG) and wind monitoring tower (WMT) maximum height.

EXECUTIVE SUMMARY

Introduction

Neoen Australia is proposing to develop a wind farm, known as Thunderbolt Energy Hub – Stage 1 (the Project), located approximately 50 km north-east of Tamworth adjacent to the New England Highway, in New South Wales (NSW).

The Project Area is approximately 5,918 ha and includes 2 separate private landholdings. The Project includes the construction, operation, and maintenance of approximately 32 wind turbine generators (WTGs).

Umwelt Australia Pty Ltd (Umwelt) has been engaged by Neoen Australia (Neoen) to manage and prepare the Environmental Impact Statement (EIS) in accordance with the NSW Department of Planning, Industry and Environment. (DPIE) requirements.

Aviation Projects have prepared this aviation impact assessment (AIA) for the Project. The AIA will review potential impacts and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

The Project requires an aviation assessment undertaken in accordance with the Environmental Planning and Assessment Act 1979, relevant regulations, and in consideration of the NSW Wind Energy Guideline for State significant wind energy development 2016 and other relevant guidance and regulatory requirements such as the National Airports Safeguarding Framework (NASF) Guideline D: Managing the Risk to aviation safety of WTG installations (wind farms)/Wind Monitoring Towers and specific requirements as advised by Airservices Australia.

The AIA and supporting technical data will provide evidence and analysis for the Project to demonstrate that appropriate risk mitigation strategies have been identified. This AIA assesses the potential aviation impacts associated with the Project and 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 includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and marking for client review and acceptance before submission to external aviation regulators.

Project description

The Thunderbolt Wind Farm is now progressing as two separate stages, with the Stage 1 Project Area (the subject of this assessment) forming approximately 5,918 ha located to the north of the New England Highway. Stage 2 of the wind farm and the solar farm and battery store will be subject to separate development approval processes.

The Thunderbolt Wind Farm – Stage 1 (the Project) will include approximately 32 turbines with a maximum tip height of approximately 260 m and a capacity of approximately 198 MW. The Project also includes the construction and operation of associated infrastructure including operation and maintenance buildings, roads, civil works and electrical infrastructure (including one new substation) required to connect to the existing electricity transmission network.

Each WTG will have a generating capacity of approximately 6 MW and each WTG site will consist of a foundation and tower, nacelle, rotor hub and blades. To achieve visual consistency through the landscape, the

WTGs will feature uniform colour, design, height and rotor diameter, a matt-white finish and non-reflective material to reduce visibility, and no unnecessary signage or lighting.

A total construction period of approximately 18-24 months is expected. To facilitate construction, a range of temporary buildings and facilities will be required including a construction compound (including site offices, car parking and amenities for construction personnel), mobile concrete batching plants, laydown and storage areas for the temporary storage of plant, equipment, materials and WTG components.

Conclusions

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

Planning considerations

1. The Project as proposed satisfies the planning provisions of Tamworth Regional Council regarding Tamworth Airport and Armidale Regional Council regarding Armidale Airport and will not impact current and planned airport operations. The Project also satisfies Uralla Shire Council planning provisions regarding aviation considerations.

Certified airports

2. The Project Area is located within 30 nm (55.56 km) of 2 Certified airports – Tamworth (YSTW) and Armidale Airport (YARM).
3. The Project Area is located inside the 25 nm (+5 nm buffer) minimum sector altitude (MSA) of Tamworth (YSTW) and Armidale (YARM) Airports.
4. WTG T18 is the highest WTG (overall height of 1302 m AHD with 5 m buffer (4272 ft AMSL)) located within the horizontal extent of the 25 nm MSA buffer area of Tamworth Airport and will be below the controlling altitude of the relevant sector by approximately 328 ft (100 m).
5. WTG T24 is the highest WTG (overall height of 1352 m AHD with 5 m buffer (4436 ft AMSL)) located within the horizontal extent of the 25 nm MSA buffer area of Armidale Airport and will be below the controlling altitude of the relevant sector by approximately 664 ft (203 m).
6. The Project is located beyond the horizontal extent of circling areas at Tamworth and Armidale Airports.

Aircraft Landing Areas (ALAs)

7. Landholder ALA 1 (host), Landholder ALA 2 and Landholder ALA 3 will be impacted by the Project. Para 6.12 provides detailed analysis.
    - ALA 1 (host landholder) may be restricted to landing towards the northwest and take-off towards the southeast and may be affected by downstream wake turbulence
    - ALA 2 may be restricted to northern circuit operations only and may be affected by downstream wake turbulence
    - ALA 3 may be affected by downstream wake turbulence.
8. All other validated ALAs are further than 3 nm from the Project Area and will not be adversely affected by any WTG of the Project.

Obstacle Limitation Surfaces

9. The obstacle limitation surfaces of Tamworth and Armidale Airports will not be impacted.

Air Routes and Lowest Safe Altitude

10. The Project will not impact any air routes or grid lowest safe altitudes.

Airspace

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

Aviation Facilities

12. The proposed WTGs will not penetrate any protection areas associated with aviation facilities.

Radar

13. The Project Area is located in Zone 4 (accepted zone) and outside the radar line of sight of Round Mountain RSR and is not anticipated to interfere with the serviceability of this aviation facility.

Aviation Impact Statement

14. Based on the Project layout and overall turbine blade tip height limit of 260 m AGL, the blade tip elevation of the highest WTG, which is WTG T24, will not exceed 1352 m AHD (4436 ft AMSL).

15. This AIS concludes that the Project:

    - will not penetrate any obstacle limitation surface (OLS) surfaces
    - will not penetrate Procedures for Air Navigation Services - Aircraft Operations PANS-OPS surfaces
    - will not impact any nearby designated air routes
    - will not have an impact on the grid lowest safe altitude (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
    - wake turbulence may affect aircraft operations in the circuit at Landholder ALA 1 (host), Landholder ALA 2 and Landholder ALA 3.

Overall, the Project will have no material impact on aviation activities.

Obstacle lighting risk assessment

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

Consultation

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

Summary of key recommendations

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

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

1. Overhead transmission lines and/or supporting poles associated with the Project 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 Part 139 Manual of Standards (MOS) Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8) where applicable.
2. To facilitate the flight planning of aerial application operators, the location and height of 'as constructed' WTGs and the WMTs should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.
3. 'As constructed' details of WTG and WMT coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
4. The Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project, noting that there is no statutory requirement to do so.
5. Details of the final 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.
6. The rotor blades, nacelles and towers of the WTGs should be painted in white, providing sufficient contrast with the surrounding environment and to maintain an acceptable level of safety.
7. Consideration should be made to marking the temporary and permanent WMTs according to the requirements set out in Manual of Standards (MOS) Part 139 Chapter 8 Division 10 (as modified by the guidance in NASF Guideline D).

1. INTRODUCTION

1.1. Situation

Neoen Australia is proposing to develop a wind farm, known as Thunderbolt Wind Hub – Stage 1 (the Project), located approximately 50 km north-east of Tamworth adjacent to the New England Highway, in New South Wales (NSW).

The Project Area (the subject of this assessment) forms approximately 5,918 ha located to the north of the New England Highway. The Project will include approximately 32 turbines with a maximum tip height of approximately 260 m and a capacity of approximately 198 MW. The Project also includes the construction and operation of associated infrastructure including operation and maintenance buildings, roads, civil works and electrical infrastructure (including one new substation) required to connect to the existing electricity transmission network.

Umwelt Australia Pty Ltd (Umwelt) has been engaged by Neoen Australia (Neoen) to manage and prepare the Environmental Impact Statement (EIS) in accordance with the NSW Department of Planning, Industry and Environment. (DPIE) requirements.

Aviation Projects have prepared this aviation impact assessment (AIA) for the Project. The AIA will review potential impacts and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

The Project Area requires an aviation assessment undertaken in accordance with the Environmental Planning and Assessment Act 1979, relevant regulations, and in consideration of the NSW Wind Energy Guideline for State significant wind energy development 2016 and other relevant guidance and regulatory requirements such as the National Airports Safeguarding Framework (NASF) Guideline D: Managing the Risk to aviation safety of WTG installations (wind farms)/Wind Monitoring Towers and specific requirements as advised by Airservices Australia.

The AIA and supporting technical data will provide evidence and analysis for the Project to demonstrate that appropriate risk mitigation strategies have been identified. This AIA assesses the potential aviation impacts associated with the Project and 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 includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and marking for client review and acceptance before submission to external aviation regulators.

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 support the EIS for the Project which requires approval under Division 4.7 of Part 4 of the Environmental Planning & Assessment Act 1979. The assessment specifically responds to the:

- NSW Government, Planning & Environment, Wind Energy Guideline, December 2016
- Tamworth Regional Council, Local Environmental Plan 2010, 14 July 2021
- Uralla Local Environmental Plan 2012, 14 July 2021
- Armidale Dumaresq Local Environmental Plan 2012, 14 July 2021
- Tamworth Airport Master Plan, 2015, 31 March 2017

- Armidale Airport Master Plan, June 2016
- CASA, Advisory Circular AC 139.E-05v1.0, *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome,* May 2021
- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Other specific requirements as advised by Airservices Australia.

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

1.3. Methodology

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

- Confirm the scope and deliverables with the Proponent (or representative)
- Review client material
- Review relevant regulatory requirements and information sources
- Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified
- Prepare an AIS and a qualitative risk assessment to determine need for obstacle lighting and marking
- Identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management –Guidelines*
- Consult with relevant Councils, 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)
- Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
- Finalise the AIA report for client acceptance when responses 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 2 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 the client for preparation of this assessment included:

- File - 7066_Revised Project Layout.zip (received 1 November 2021)
- File - Thunderbolt_Stage1_Turbines_mga56_rev1.shp (received 11 November 2021)
- File - Thunderbolt_Stage1_Turbines_mga56_rev1.txt.xlxs (received 11 November 2021)
- Issued SEARs – SSD-10807896
- 7066_AviationRFP_160720 (1).

.

2. BACKGROUND

2.1. Site overview

The Project Area is located in the Kentucky Area of NSW, approximately 50 km north-east of Tamworth and adjacent to the New England Highway.

An overview of the Project Area relative to localities of Armidale and Tamworth is provided in Figure 1 (source: Umwelt, Google Earth).

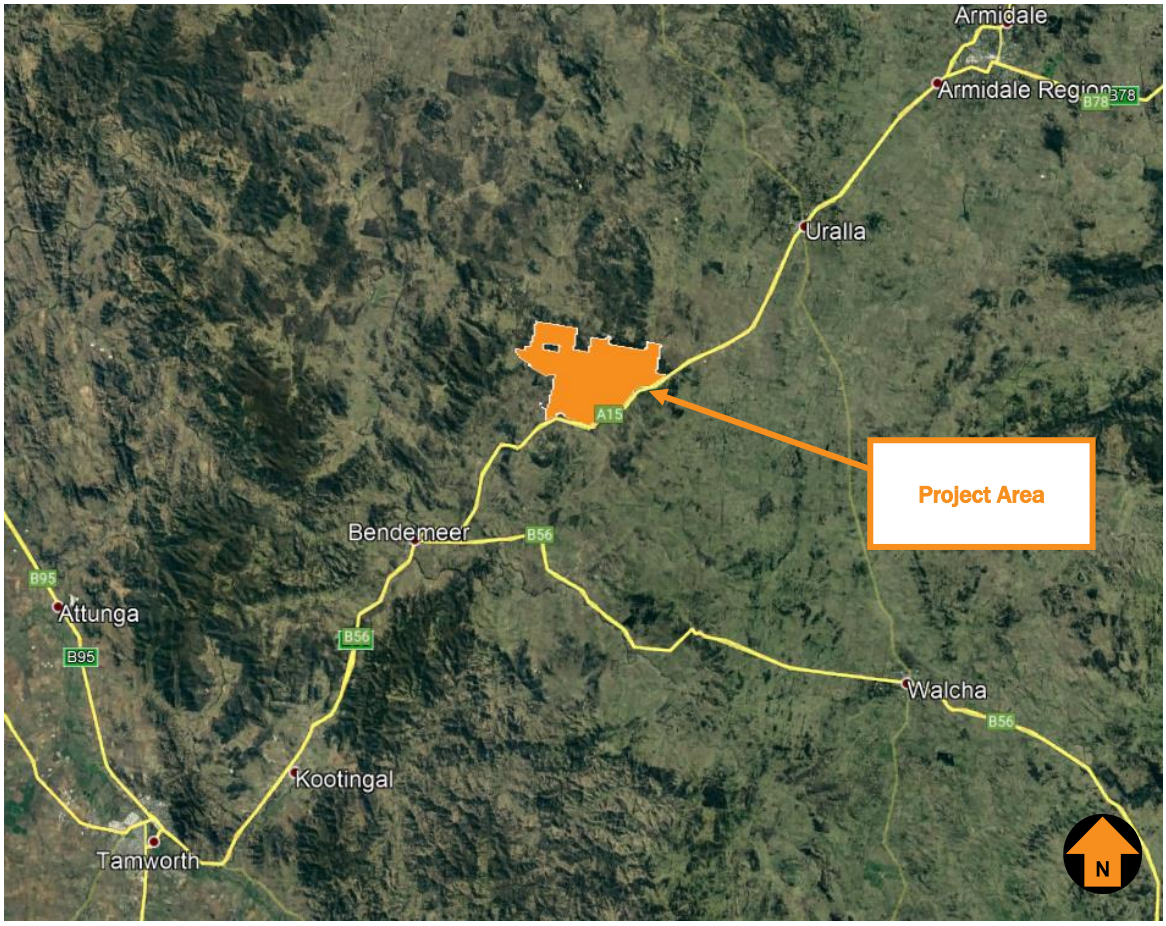

Figure 1 Project Area overview

2.2. Project description

The Thunderbolt Energy Hub is planned to include wind and solar electricity generation and battery storage. The Thunderbolt Wind Farm is now progressing as two separate stages, with the Stage 1 Project Area (the subject of this assessment) forming approximately 5,918 ha located to the north of the New England Highway. Stage 2 of the wind farm and the solar farm and battery storage system will be subject to separate development approval processes.

The Thunderbolt Wind Farm – Stage 1 (the Project) will include approximately 32 turbines with a maximum tip height of approximately 260 m and a capacity of approximately 198 MW. The Project also includes the construction and operation of associated infrastructure including operation and maintenance buildings, roads, civil works, and electrical infrastructure (including one new substation) required to connect to the existing electricity transmission network.

Each WTG will have a generating capacity of approximately 6 MW and each WTG site will consist of a foundation and tower, nacelle, rotor hub and blades. To achieve visual consistency through the landscape, the WTGs will feature uniform colour, design, height and rotor diameter, a matt-white finish and non-reflective material to reduce visibility, and no unnecessary signage or lighting.

A total construction period of approximately 18-24 months is expected. To facilitate construction, a range of temporary buildings and facilities will be required including a construction compound (including site offices, car parking and amenities for construction personnel), mobile concrete batching plants, laydown and storage areas for the temporary storage of plant, equipment, materials and WTG components.

An indicative layout of the proposed wind farm is provided in Figure 2 (source: Umwelt, Google Earth), including the 32 indicative WTG locations, and the Project relative to Local Government Areas. (LGAs).

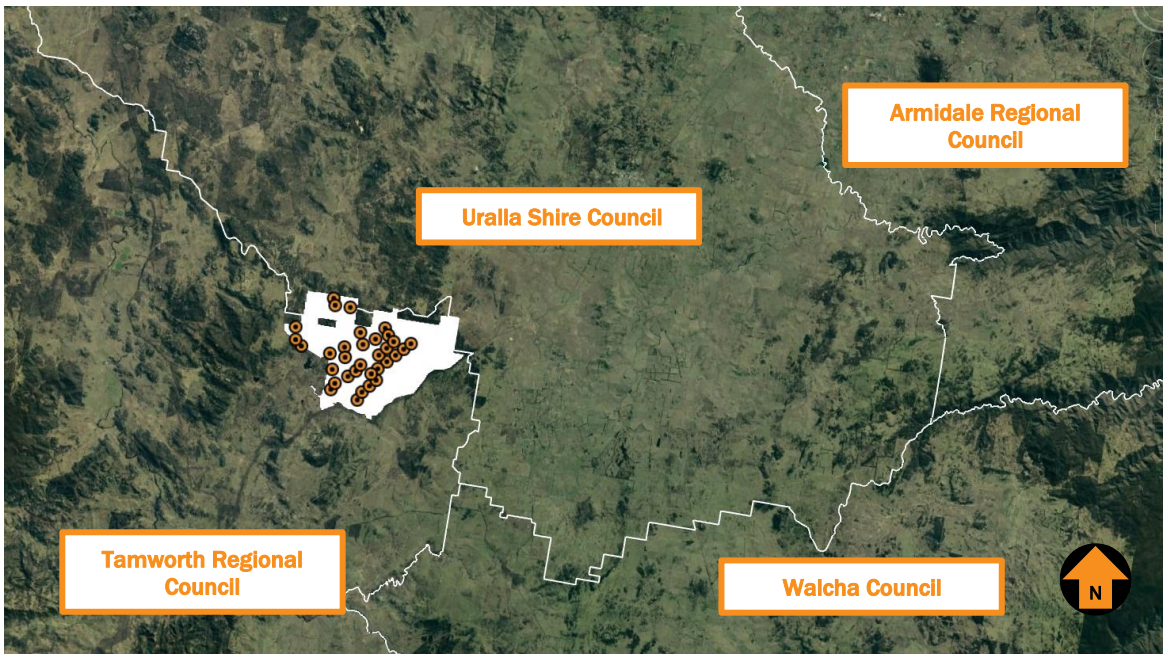

Figure 2 Project boundary and WTGs in relation to LGAs

3. EXTERNAL CONTEXT

This chapter explores the federal, state, and local planning context that may be relevant to the Project. Each section will explore and respond to the planning context to identify any conflict between the Project and applicable planning requirements.

3.1. New South Wales (NSW) planning context

The Project requires State Significant Development (SSD) consent under Division 4.7 of Part 4 of the Environmental Planning & Assessment Act 1979 (EP&A Act), which is the principal planning legislation for NSW.

The Project is deemed to be SSD due to capital investment value estimated to be greater than $30 million, as specified under the State Environmental Planning Policy.

The NSW Government Planning and Environment Department has produced the Wind Energy Guideline (December 2016) which aims to *provide the community, industry and regulators with guidance on the planning framework for the assessment of large-scale wind energy development proposals that are State significant development (SSD).*

Section 3 of the Wind Energy Guideline (Assessment issues for wind energy development) specifies the issues which will be assessed for Wind Farm projects, and lists hazards and risks associated with the project, including aviation safety, stating that *wind energy projects need to consider potential safety hazards for aircraft through intrusion of the wind turbines into the airspace; and potential effects on navigation instruments*.

The SSD assessment process includes preparation of a scoping report by the proponent, which then obtains project-specific Secretary's Environmental Assessment Requirements (SEARS). Aviation Safety considerations included in the SEARS applicable to the Project are included below:

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

3.2. Tamworth Regional Council

The Tamworth Regional Council has established the Environmental Plan 2010 under the Environmental Planning and Assessment Act 1979. The plan aims to make local environmental planning provisions for land in Tamworth Regional in accordance with the relevant standard environmental planning instrument under section 3.20 of the Act.

> *The particular aims of this Plan are as follows—*
>
> *(aa) to protect and promote the use and development of land for arts and cultural activity, including music and other performance arts,*
>
> *(a) to encourage the orderly management, development and conservation of natural and other resources within the Tamworth region by protecting, enhancing or conserving—*
>
> > *(i) important agricultural land, and*
> >
> > *(ii) timber, minerals, soil, water and other natural resources, and*
> >
> > *(iii) areas of significance for nature conservation, and*
> >
> > *(iv) places and buildings of archaeological or heritage significance,*
>
> *(b) to allow flexibility in the planning framework so as to encourage orderly, economic and equitable development while safeguarding the community's interests and residential amenity,*
>
> *(c) to manage and strengthen retail hierarchies and employment opportunities, promote appropriate tourism development, guide affordable urban form and provide for the protection of heritage items,*
>
> *(d) to promote ecologically sustainable urban and rural development and control the development of flood liable land, and*
>
> *(e) to secure a future for agriculture by expanding Tamworth's economic base and minimising the loss or fragmentation of productive agricultural land.*

The current version dated 01 February 2021 includes provision for the Development of Flight Path and Development in areas subject to aircraft noise as follows –

> ***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.

7.7 Development in areas subject to aircraft noise

(1) This clause applies to development that—

(a) is on land that—

(i) is near an airport, and

(ii) is in an ANEF contour of 20 or greater, and

(b) the consent authority considers is likely to be adversely affected by aircraft noise.

(2) Before determining a development application for development to which this clause applies, the consent authority—

(a) must consider whether the development will result in an increase in the number of dwellings or people affected by aircraft noise, and

(b) must consider the location of the development in relation to the criteria set out in Table 2.1 (Building Site Acceptability Based on ANEF Zones) in AS 2021—2000, Acoustics—Aircraft noise intrusion—Building siting and construction, and

(c) must be satisfied that the development will meet AS 2021—2000, Acoustics—Aircraft noise intrusion—Building siting and construction with respect to interior noise levels for the purposes of—

(i) if the development will be in an ANEF contour of 20 or greater—centre-based child care facilities, educational establishments, entertainment facilities, hospitals, places of public worship, public administration buildings or residential accommodation, and

(iii) if the development will be in an ANEF contour of 25 or greater—business premises, hostels, hotel or motel accommodation, office premises or retail premises.

(3) Before issuing a development consent to development on land identified as "Flight Training Path" on the Flight Training Path Map, the consent authority must consider measures for the insulation of any building on that land from aircraft noise

The Project will not impact the Limitation or Operations Surfaces of Tamworth Airport.

3.3. Tamworth Airport Master Plan

The *Tamworth Regional Airport Master Plan 2015* was prepared by Rehbein Airport Consulting in March 2015.

The Master Plan sets out short, medium and long-term proposals for aeronautical and non-aeronautical development within the airport land and identifies opportunities for adjacent airport related development consistent with the Tamworth Regional Local Environmental Plan (LEP) 2010.

The primary development objectives in the master plan, include -

Operations

- *Facilitate the safe and secure movement of aircraft, passengers and freight;*
- *Provide a clear and coherent plan to guide future airport infrastructure development, which meets the needs of all current and future airport users in a balanced and equitable fashion;*
- *Ensure the timely delivery of new and improved airport facilities;*
- *Protect the airport and its operations from incompatible development and activities external to the airport;*

Economic and Social

- *Support the existing airport activities as well as facilitating aviation infrastructure to accommodate and encourage growth of the airport's role as the training, business and tourist gateway;*
- *Encourage the expansion of aviation facilities to enhance and improve economic return from the existing airport asset;*
- *Incorporate Council land adjacent to the airport site for possible future aviation-related activity growth;*
- *Encourage the expansion of regional and domestic airline, charter and medical emergency services operations;*
- *Facilitate wider opportunities with respect to heavy aircraft maintenance and international freight operations; and*

Environment

- *Optimise the utilisation of the airport with minimum environmental impact.*

Section 4 of the master plan identifies economic and business development opportunities that were considered in estimating potential future aviation activity at the airport as well as in the land use planning to ensure aviation-related opportunities can be accommodated. Aviation opportunities included:

- Additional RPT Airlines and Destinations;
- Regional Charter Operations;
- Flying Training: Fixed-wing and Rotary;
- Aircraft Maintenance, Repair & Overhaul (MRO); and
- Direct International Freight.

The master plan includes provision for runway extension(s) as follows –

- *Extension of existing Runway 12L/30R to give total length to 3,000m with provision made for a 300m extension to the South East and 540m extension to the North West. Pavement widening to 60m with 7.5m shoulders, strengthening as required, and OLS based on 300m wide runway strip and Code 4F Precision Instrument. Runway extension to this length would be subject to detailed assessment of the impacts of the VOR/DME and obstacle limitation surfaces as well as engineering and environmental feasibility (extending the runway 540m to the North West is likely to impact not*

only the VOR/DME but also the affect the Grassy Box Tree line which runs along the Bolton Creek area and which is an Environmental sensitive area);

- *Extension of existing Runway 12R / 30L to give total length to 1,640m with provision made for a 530m extension to the North West, if required for pilot training activities. Pavement strengthening as required and widening to 23m total runway strip for OLS based on 90m wide runway strip and Code 2B Non-Precision Instrument;*
- *Runway 06 / 24 is retained with central section sealed west of RWY 18/36 for taxiway use by Code B aircraft. OLS based on 90m wide runway strip and Code 1 Non-Instrument; and*
- *Runway 18 / 36 is initially retained with central section 18m wide sealed south of Taxiway B for taxiway use by Code C aircraft. Ultimately, this runway would be converted to a taxiway to facilitate further development to the west of the terminal and redevelopment of the western GA area to accommodate larger charter aircraft.*

The Project will not impact the Limitation or Operations Surfaces associated with current and future Tamworth Airport plans.

3.4. Uralla Shire Council

The Uralla Shire Council has established the Local Environmental Plan 2012 under the Environmental Planning and Assessment Act 1979. The plan aims to make local environmental planning provisions for land in Uralla Shire in accordance with the relevant standard environmental planning instrument under section 3.20 of the Act.

The particular aims of this Plan are as follows—

(aa) to protect and promote the use and development of land for arts and cultural activity, including music and other performance arts,

(a) to encourage the orderly management, development and conservation of resources by protecting, enhancing and conserving—

(i) land of significance for agricultural production, and

(ii) timber, minerals, soils, water and other natural resources, and

(iii) areas of high scenic or recreational value, and

(iv) native plants and animals including threatened species, populations and ecological communities, and their habitats, and

(v) places and buildings of heritage significance,

(b) to provide a choice of living opportunities and types of settlements,

(c) to facilitate development for a range of business enterprise and employment opportunities,

(d) to ensure that development is sensitive to both the economic and social needs of the community, including the provision of community facilities and land for public purposes,

(e) to ensure that development has regard to the principles of ecologically sustainable development and has regard to areas subject to environmental hazards and development constraints,

(f) to provide for flexibility in applying certain development standards, where compliance with such standards may be unreasonable or unnecessary in the circumstances of a particular development, and there is sufficient justification for varying the standards on environmental planning grounds.

The current version dated 01 February 2021 does not include any provisions for aviation.

3.5. Armidale Regional Council

Although the Project Area is outside the Armidale Regional Council area, Armidale Airport resides within 30 nm of the Project Area.

The Armidale Regional Council has established the Local Environmental Plan 2012 under the Environmental Planning and Assessment Act 1979. The plan aims to make local environmental planning provisions for land in Armidale Dumaresq in accordance with the relevant standard environmental planning instrument under section 3.20 of the Act.

(2) The particular aims of this Plan are as follows:

(a) to encourage the orderly management, development and conservation of resources by protecting, enhancing and conserving:

(i) land of significance for agricultural production, and

(ii) timber, minerals, soils, water and other natural resources, and

(iii) areas of high scenic or recreational value, and

(iv) native plants and animals, including threatened species, populations and ecological communities, and their habitats, and

(v) places and buildings of heritage significance,

(b) to provide a choice of living opportunities and types of settlements,

(c) to facilitate development for a range of business enterprises and employment opportunities,

(d) to ensure that development is sensitive to both the economic and social needs of the community, including the provision of community facilities and land for public purposes,

(e) to ensure that development has regard to the principles of ecologically sustainable development and to areas subject to environmental hazards and development constraints,

(f) to provide for flexibility in applying certain development standards, where compliance with such standards may be unreasonable or unnecessary in the circumstances of a particular development, and there is sufficient justification for varying the standards on environmental planning grounds.

The current version dated 01 February 2021 includes the following aviation provisions -

6.3 Airspace operations

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

(a) to provide for the effective and on-going operation of the Armidale Regional 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.

*6.4 **Development in areas subject to aircraft noise***

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

(a) to prevent certain noise sensitive developments from being located near the Armidale Regional Airport and its flight paths,

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

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

(2) This clause applies to development that—

(a) is on land that—

(i) is near the Armidale Regional Airport, and

(ii) is in an ANEF contour of 20 or greater, and

(b) the consent authority considers is likely to be adversely affected by aircraft noise.

(3) Before determining a development application for development to which this clause applies, the consent authority—

(a) must consider whether the development will result in an increase in the number of dwellings or people affected by aircraft noise, and

(b) must consider the location of the development in relation to the criteria set out in Table 2.1 (Building Site Acceptability Based on ANEF Zones) in AS 2021—2000, and

(c) must be satisfied the development will meet the indoor design sound levels shown in Table 3.3 (Indoor Design Sound Levels for Determination of Aircraft Noise Reduction) in AS 2021—2000.

*6.5 **Development within a designated buffer***

(1) The objective of this clause is to maintain a safe and effective operational environment around the Armidale Regional Airport and Armidale Sewage Treatment Plant.

(2) This clause applies to land identified as "ARA" on the Airport Buffer Map and "STP" on the Sewage Treatment Plant Buffer Map.

(3) Before granting development consent for development on land to which this clause applies, the consent authority must consider the following matters—

(a) the impact that any noise or other emissions associated with existing land uses would have on the proposed development,

(b) any proposed measures incorporated into the development that would limit the impact of such noise and other emissions associated with the existing land use,

(c) any opportunities to relocate the proposed development outside the land to which this clause applies,

(d) whether the proposed development would adversely affect the safe and effective operational environment of the Armidale Regional Airport and Armidale Sewage Treatment Plant and any existing development that forms part of those facilities.

The Project will not impact the Limitation or Operations Surfaces of Armidale Airport.

3.6. Armidale Airport Master Plan

The Armidale Regional Airport Master Plan 2016 was prepared by Armidale Regional Council in June 2016.

The key aims of this master plan are to:

- *Position Armidale Regional Airport as a growing hub for RPT services*
- *Support and grow existing general aviation and aviation related business activity*
- *Diversify current airport income through expansion of the airport's property portfolio and*
- *Upgrade and expand current airport infrastructure, capabilities and services.*

The master plan includes provision for runway extension(s) as follows –

New 45M wide 05/23 Runway

...is to plan and construct a new runway to be located northwest of the existing 05/23 strip and at the minimum separation distance required for construction. The new runway will be a minimum of 2,120m in length, 45m in width and accommodate aircraft including the Dash 8-400 (Q400) and current B737-800, A320 and B717-200 jet aircraft.

Precision Approach

It is proposed that a 'precision approach' be installed at or before the time of construction of the new runway. A precision approach is an instrument approach and landing system that uses precise lateral and vertical guidance with a minimal clearance distance above the ground. A CAT-IIIA approach allows a pilot to fly 'blind' to within 30m of the ground before requiring visual sight of the runway and 200m visibility along the runway. Such an approach would greatly assist current RPT carriers and GA operators and avoid the expensive and disruptive diversions to an alternate airport at times of poor weather/visibility. The type of aircraft that would use the proposed new runway would expect such navigation aids and the availability of a precision approach would greatly enhance Armidale Airport's attractiveness as a training airfield. Such facilities are limited throughout this region and training operations at Glen Innes and Tamworth would regularly use such an approach for training.

The Project will not impact the Limitation or Operations Surfaces associated with current and future Armidale Airport plans as the development remains outside the 15 km OLS boundary.

3.7. 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 WMTs.

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 Area 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.

3.8. Aircraft operations at non-controlled aerodromes

There are several uncontrolled aerodromes in the vicinity of the Project Area. 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 3 and Figure 4

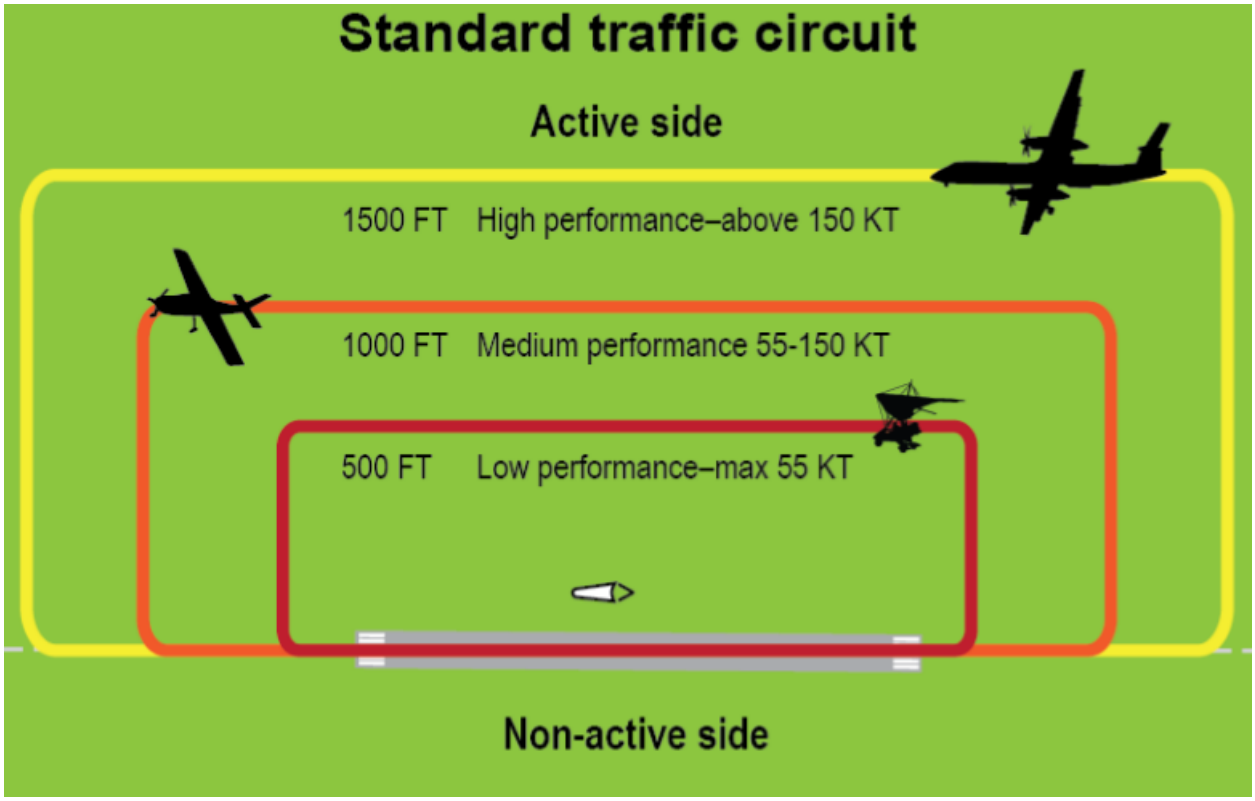

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

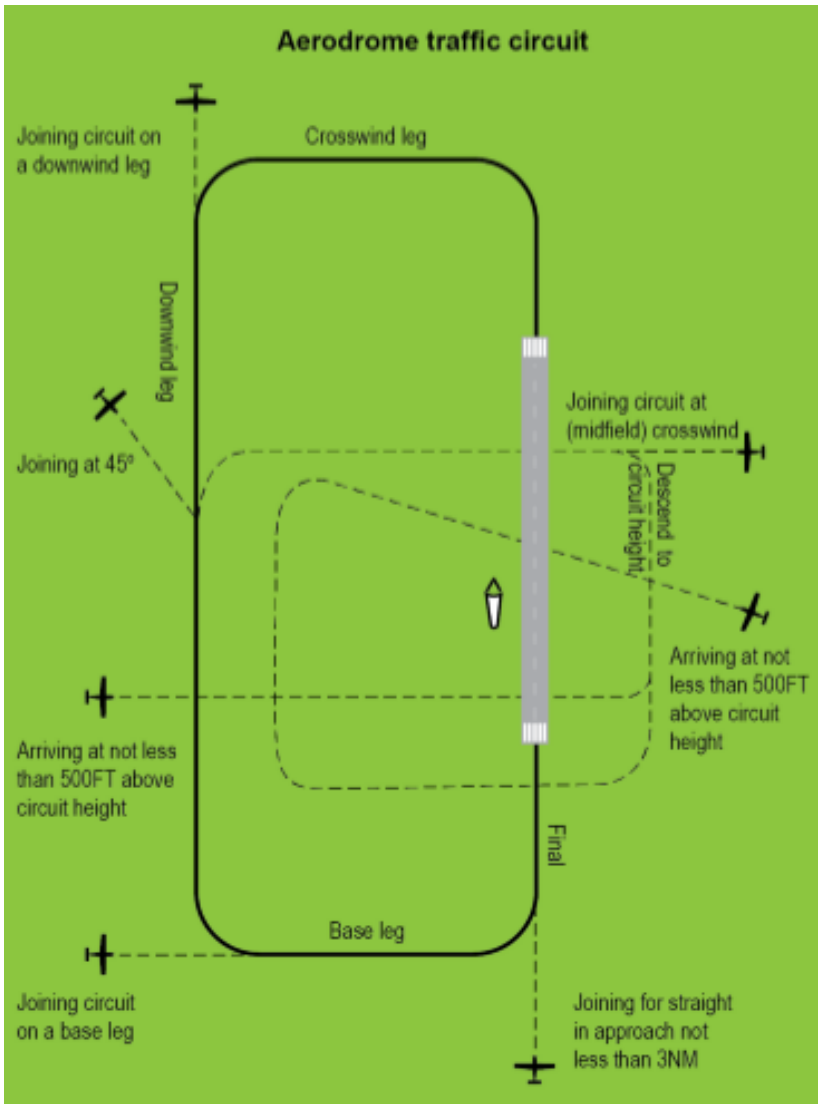

Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures

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.

3.9. Rules of flight

3.9.1. 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.

3.9.2. 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.

3.9.3. 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.

3.10. 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 WTGs) and clear of the highest point of the terrain by 500 ft vertical distance and 600 m horizontal distance. In VMC, the WTGs 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 WTGs 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 proposed WTGs will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project Area 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.

3.11. Passenger transport operations

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

3.12. 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.

3.13. Military operations

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

Refer to Section 5 for a detailed response from Department of Defence.

3.14. 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 WTGs on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the Project Area was assessed.

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

3.15. 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 includes consideration 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.

This Aviation Impact Assessment has been prepared in consideration of the National Windfarm Operating Protocols.

3.16. 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 Area and neighbouring the Project site, by implementing recommendations provided in this report.

As a consideration, 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 'as constructed' location and height information of WTGs, WMTs 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.

3.17. 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) has developed a national position on wind farms, their development and operations in relation to bushfire prevention, preparedness, response and recovery, set out in the document titled *Wind Farms and Bushfire Operations*, version 3.0, dated 25 October 2018.

Of specific interest in this document is the section extracted from under the 'Response' heading, copied below:

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

Refer to Section 5 for detailed responses from aerial firefighting stakeholders including NSW RFS.

3.18. Emergency services - Royal Flying Doctor Service/Air Ambulance

Royal Flying Doctor Service (RFDS)/Air Ambulance 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 location

The Project Area is located approximately 36 km south-west of Armidale town and 50 km north-east of Tamworth township.

The closest wind farm project (in planning stage) is Winterbourne Wind Farm which is 75 km north-east of Tamworth and 35 km south-west of Armidale (approximately 40 km south-east of the Project Area) and the closest solar farms are the New England and Salisbury Solar Farms (approximately 28 km northeast and east, respectfully, of the Project Area. Source: energy NSW – Indicative New England Renewable Energy Zone.

Figure 5 provides a photograph from within the Project Area.

Figure 5 Photo from Project Area April 2021

4.2. WTG description

The maximum blade tip height of the proposed WTGs will be up to 260 m AGL.

The highest ground elevation of any of the proposed WTGs (WTG T24) is 1087 m AHD, which, with a 5 m error budget, results in a maximum overall height of 1352 m AHD (4436 ft AMSL).

Figure 6 illustrates the Project layout identifying the highest WTG T24 (source: Umwelt, Google Earth).

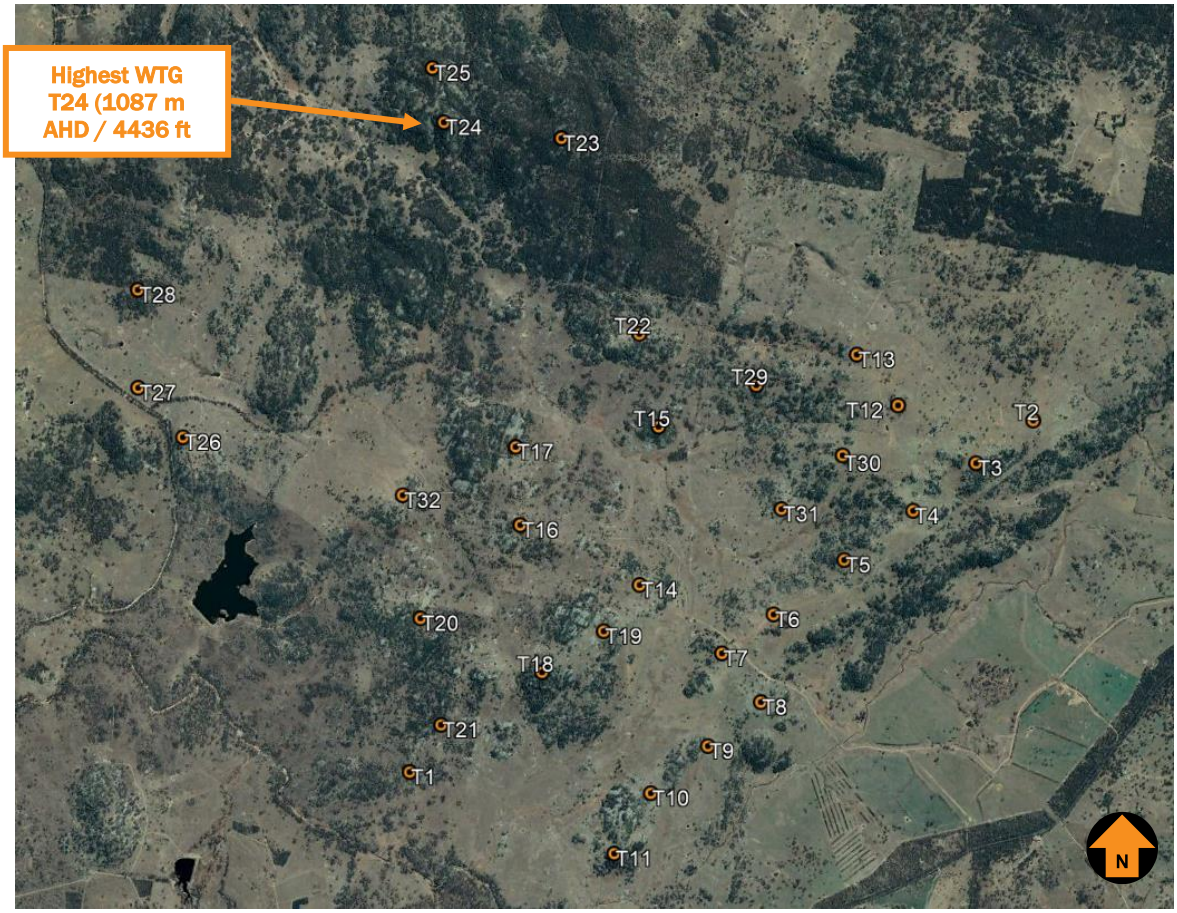

Figure 6 Project layout and highest WTG

The coordinates and ground elevations of the proposed WTGs analysed are listed in **Annexure 3.**

4.3. Wind Monitoring Tower description

There is currently 1 existing temporary WMT and it is proposed to install up to 6 permanent WMTs, each up to 170m tall. These additional WMTs would all be located in close proximity to WTGs with final positions to be determined in consultation with the WTG manufacturer. The single temporary WMT will be removed during the Project construction phase.

The existing WMTs location is provided in Figure 7 (Source: Umwelt, Google Earth)

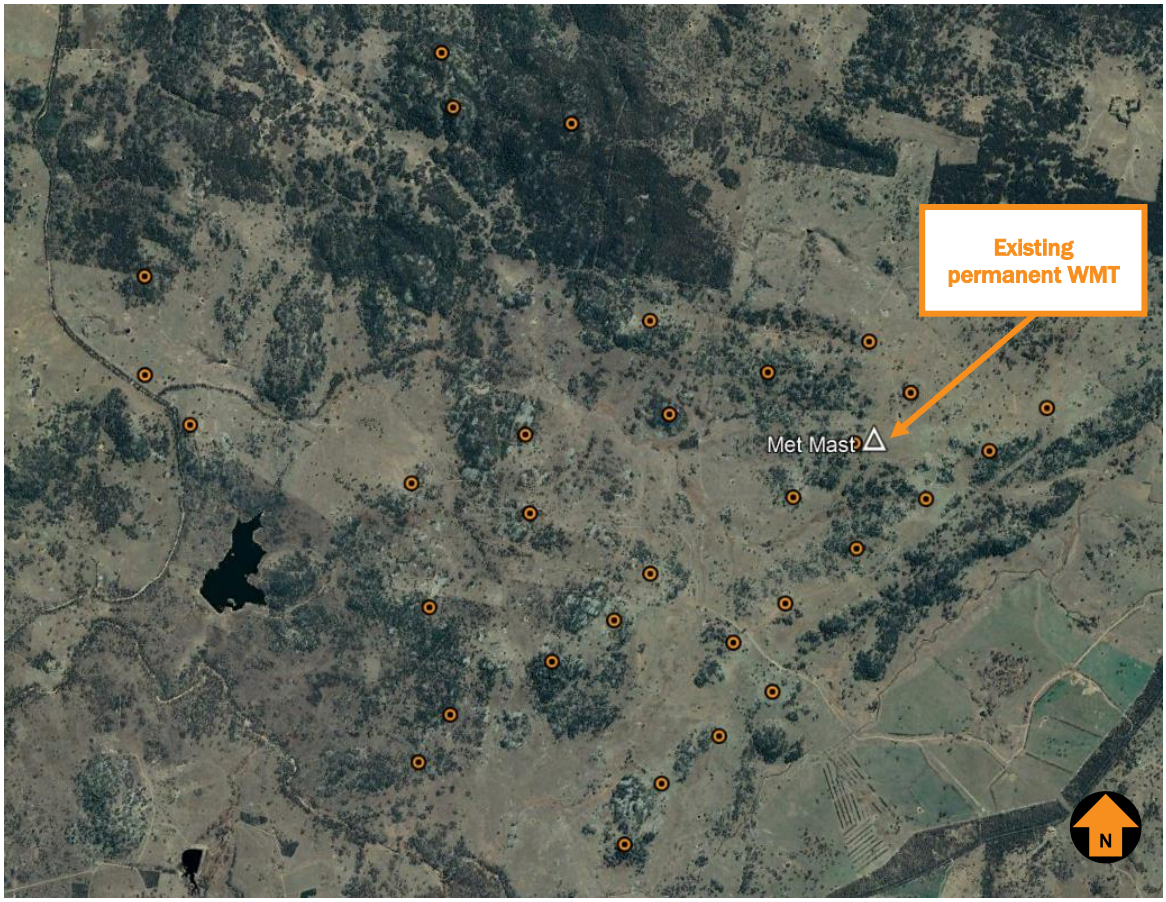

Figure 7 Existing permanent WMT location within Project Area

4.4. Nearby wind farms

The closest wind farm in planning is the Winterbourne Wind Farm approximately 40 km to the south-east. Winterbourne Wind Farm lies within the Walcha Regional Council Area and construction is expected to begin early 2023.

Figure 8 demonstrates the location of the Project Area in relation to representative project extents of the (proposed) Winterbourne Wind Farm (Source: Umwelt, ERM, Google Earth). The closest aircraft landing areas are displayed for reference.

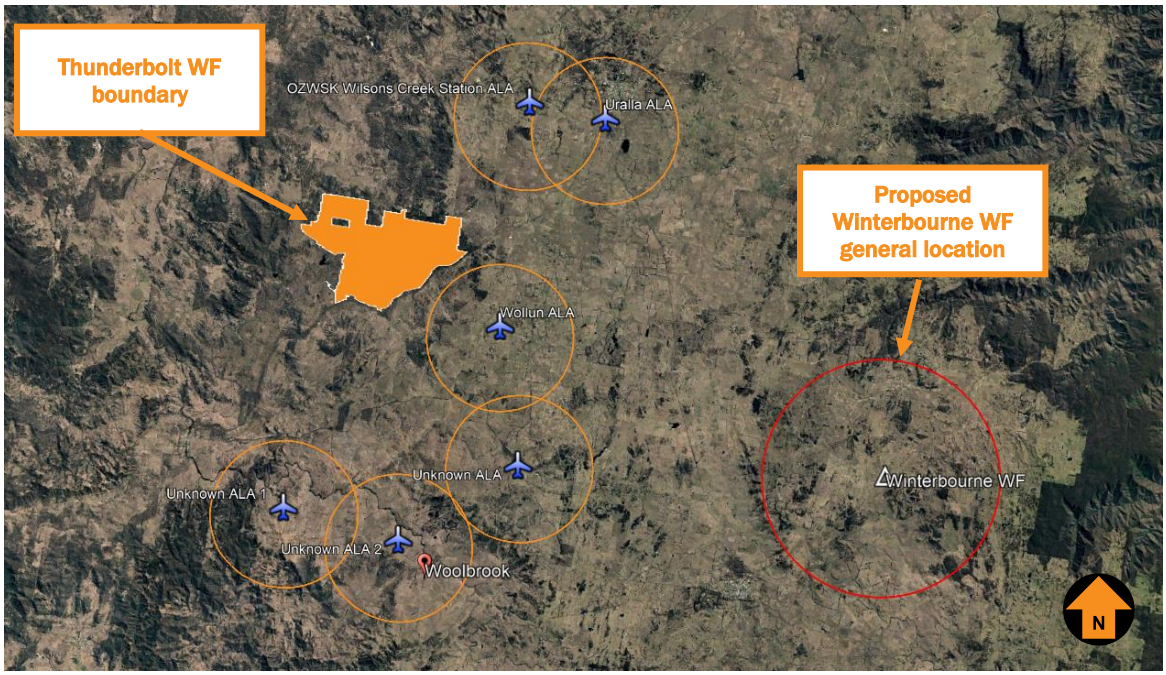

Figure 8 Project Area in relation to nearby Wind Farm projects

The location of the Project Area should not introduce additional constraints to the operation of aircraft to and from nearby ALAs in relation to cumulative impacts of those nearby Projects.

5. CONSULTATION

The stakeholders consulted include:

- Aerial Application Association of Australia
- Airservices Australia
- Armidale Regional Council (aerodrome operator)
- Department of Defence
- Royal Flying Doctor Service
- NSW Rural Fire Service
- Tamworth Regional Council (aerodrome operator)
- Landholder ALA1, ALA2 and ALA3

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

Table 1 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response / Date*	*Issues Raised During Consultation*	*Action Proposed*
Aerial Application Association of Australia	Consultation email sent 20 September 2021	Email received 20 September 2021 from Phil Hurst (CEO AAAA)	*As you have correctly identified in the draft report - AAAA is opposed to all windfarm developments – including related infrastructure such as wind monitoring towers – in agricultural areas. They represent a direct threat to aviation safety and a direct economic impact on our industry and the farmers we service.* *AAAA does not have the resources to provide detailed responses to windfarm development proposals. However, having had a brief look at your draft, I suggest you also include reference to the following:* • *Australian Standard AS 3891 Part 1 and 2 – as recently amended – to better understand marking requirements in addition to CASR Part 139 + MOS* • *Refer to CASR Part 137 that governs all aerial application fixed wing operations which in some ways overrides the CAAP.* *I also suggest that any location information regarding the turbines or existing wind towers is provided in lats and longs which is more compatible with the system in use – in addition to a lay reference eg xx miles south of <town> name.* *The windfarm issue is covered in some detail in our policy on windfarms that you can find at www.aerialag.com.au – under resources / policies.* *From that policy you will see we are opposed to all wind towers in agricultural areas and their associated infrastructure. In particular, we have identified wind monitoring towers as a safety threat to legitimate low level aviation. I also refer you to my evidence to the Senate Windfarm*	No further action required

			inquiry and the death of an agricultural pilot in the US from hitting an unmarked, un-notified tower. *http://www.aph.gov.au/hansard/senate/commttee/S13670.pdf* *In terms of windfarm and related infrastructure safety, AAAA fully supports the whole of government approach encapsulated in the NASAG National Guidelines and particularly Guideline D that relates to windfarms and wind monitoring towers. You can find more information on the NASAG approach at http://www.infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/* *If the windfarm comes into operation, I suggest a positive way forward is to engage with local aerial applicators in accordance with our National Windfarm Operating Protocols which are also available on our website – http://www.aerialag.com.au/ResourceCenter/Policies.aspx*	
Airservices Australia	Consultation email sent 20 September 2021	Response received 28 October 2021 from William Zhao (Advisor Customer Engagement)	*Airspace Procedures* *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at the various heights provided the wind farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Armidale aerodrome.* *The wind farm will not affect any air route lowest safe altitude.* *Note: Procedures not designed by Airservices at Armidale aerodrome were not considered in this assessment* *Communications/Navigation/Surveillance (CNS) Facilities* *Radar* *Note that Mt Sandon is one of the site for Airservices transportable radar to be deployed which is currently not in operation. The closet Airservices active radar facility to this wind farm is at the Round Mountain site. Please amend your report accordingly with this information.* *We have assessed the proposal to a maximum height of 1352m (4436 ft) AHD for any impacts to Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF*	*1. Report updated (28 October 2021) to reflect Airservices Mt Sandon radar not in operation.* *2. Proponent to complete the Vertical Obstacle Notification Form for tall structures and submits it to VOD@airservicesaustralia.com as soon as the development reaches the maximum height.*

			Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links and have no objections to it proceeding. *Summary* *Based on the above assessment, our view is that the proposed wind farm would not have an impact on any Airservices designed instrument procedures, CNS facilities or ATC operations at Armidale Airport.* *Vertical Obstacle Notification* *We request that the proponent completes the Vertical Obstacle Notification Form for tall structures and submits it to VOD@airservicesaustralia.com as soon as the development reaches the maximum height.* *For further information regarding the reporting of tall structures, please contact (02) 6268 5622, email VOD@airservicesaustralia.com or refer to the web links below:* *Civil Aviation Safety Regulation Part 175 — Airservices and You - Airservices (airservicesaustralia.com)* *Vertical Obstacle Notification Form:* *https://www.airservicesaustralia.com/wp-content/uploads/Tall-Structure-Vertical-Obstacle-Form.pdf*	
Armidale Regional Council	Consultation email sent 20 September 2021	Email received 23 September 2021 from Wes Summers	*...the Armidale Regional Airport has conducted an assessment of the current proposal and found that it does not impact the PAN-OPS, OLS etc for the Armidale Regional Airport.* *This data provided has been inputted into the ARC mapping program (Enlighten) for ARC/Airport future reference. I concur with the AIS in its current form...*	No further action required

		(Manager)		
Department of Defence	Consultation email sent 20 September 2021	Email received 10 October 2021 from Adam Murray (Estate Strategic Planner) on behalf of Charles Mangion (Director)	*…The proposed structures will meet the above definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com.* *Defence understands this assessment is yet to be considered by CASA. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons 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.*	1. Report tall structure to voda@airservicesaustralia.com 2. Comply with NASF marking requirements and note frequency range of lighting should they need to be installed.
NSW RFS	Consultation email sent 20 September 2021	Response received 30 October 2021 from Inspector Bernie O'Rourke	*The NSW RFS has no further comments on the **Thunderbolt Wind Farm**. Wind Farms are treated like any other potential hazard to aircraft operations.* *Aerial firefighting strategies and tactics will be selected based on the fire location, what the fire is threatening and hazard in the area.*	No further action required

RFDS	Consultation email sent 20 September 2021	Reminder email sent 28 October 2021	Nil response received	No further action required
Tamworth Regional Council	Consultation email sent 20 September 2021	Reminder email sent 28 October 2021	Nil response received	No further action required
Landholder ALA 1	Consultation at various times – presentation and written	Response received 17 Sep 2021	Written response received from Landholder ALA 1 to Aviation Projects questionnaire regarding operational use at ALA 1. Operations conducted once or twice per year in light wind conditions. Details of the physical dimensions of the ALA were given. Ongoing consultation will be undertaken with the Landholder directly by Neoen. A tailored letter for the landholder is being developed and will be supplied detailing operational use of the ALA.	Supply tailored aviation letter for ALA 1
Landholder ALA 2	Consultation at various times – presentation, verbal and written	Response received 29 Sep 2021	Telephone call between Landholder and Aviation Projects. Aviation Projects offered pertinent questions to understand the type of operations (plus future operations) conducted at ALA 2. ALA 2 operator is a relatively new landowner and intends to conduct super spread spreading at some point in the future. Ongoing consultation will be undertaken with the Landholder directly by Neoen. A tailored letter for the Landholder is being development and will be supplied detailing operational use of the ALA.	Supply tailored aviation letter for ALA 2
Landholder ALA 3	Consultation at various times – presentation and written	Response received 25 Sep 2021	Written response received from Landholder ALA 3 to Aviation Projects questionnaire regarding operational use at ALA 3. ALA 3 is used once per year for 2 days and in light wind conditions. Ongoing consultation will be undertaken with the Landholder directly by Neoen. A tailored	Supply tailored aviation letter for ALA 3

			letter for the Landholder is being development and will be supplied detailing operational use of the ALA.	

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The Project Area is located within 30 nm (55.56 km) of 2 certified airports – Tamworth (YSTW) and Armidale (YARM).

The location of the Project Area relative to Tamworth (YSTW), Armidale (YARM), Inverell (YIVL), Quirindi (YQDI) and Gunnedah (YGDH) Airports is shown in Figure 9. The orange circle around each airport represents a distance of 30 nm from the Aerodrome reference point of each airport (source: Umwelt, Google Earth).

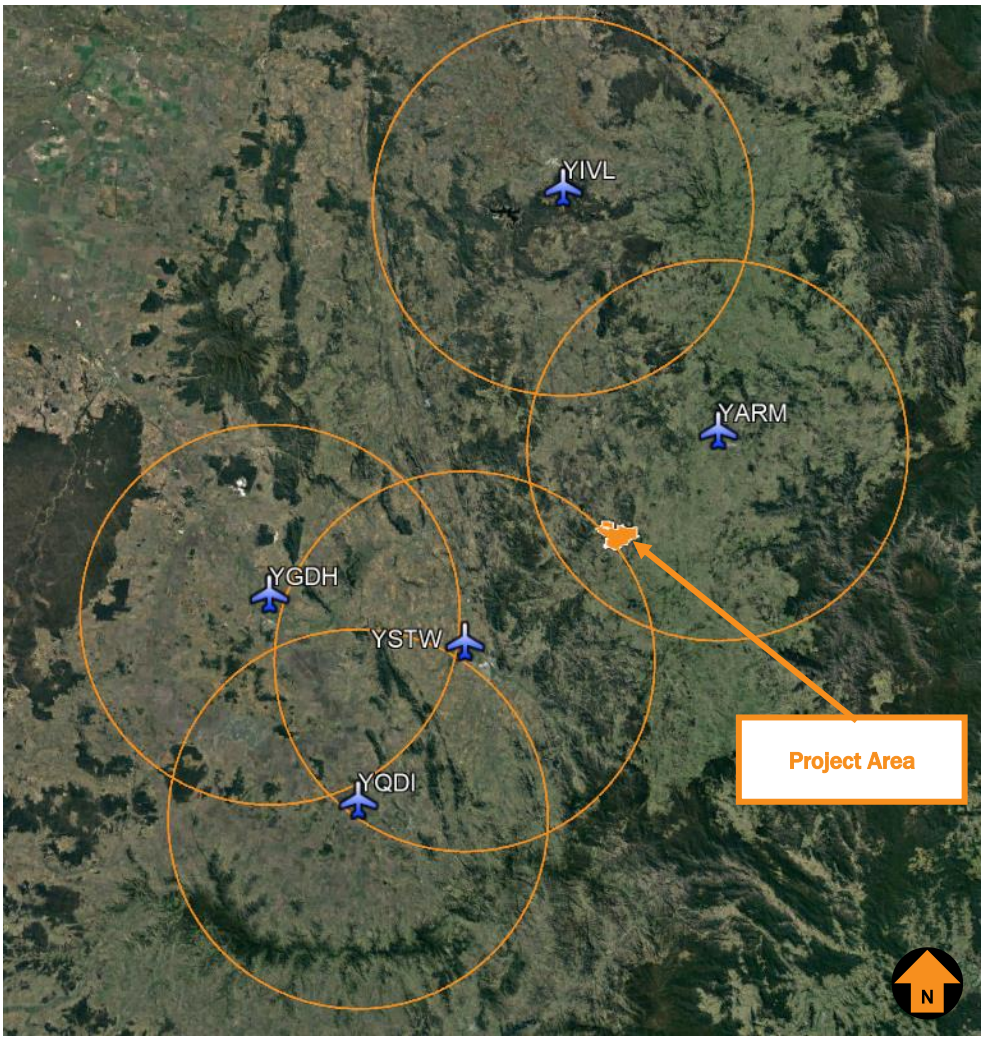

Figure 9 Location of Certified Airports in relation to Project Area

6.2. Tamworth Airport

Tamworth Airport (YSTW) is a certified aerodrome operated by Tamworth Regional Council, with a published aerodrome elevation of 407 m AHD (1335 ft AMSL) (source: Airservices Australia, Aerodrome Chart YSTW).

Tamworth Airport has 4 runways:

- Runway 12L/30R sealed, 2200 m length, width 30 m
- Runway 12R/30L sealed, 1110 m length, width 18 m
- Runway 06/24 grass brown clay, 842 m length, width 30 m
- Runway 18/36 grass brown clay, 1020 m length, width 30 m.

Figure 10 shows the Tamworth Airport (YSTW) runway layout (source: AsA, Aerodrome Chart, dated 17 June 2021).

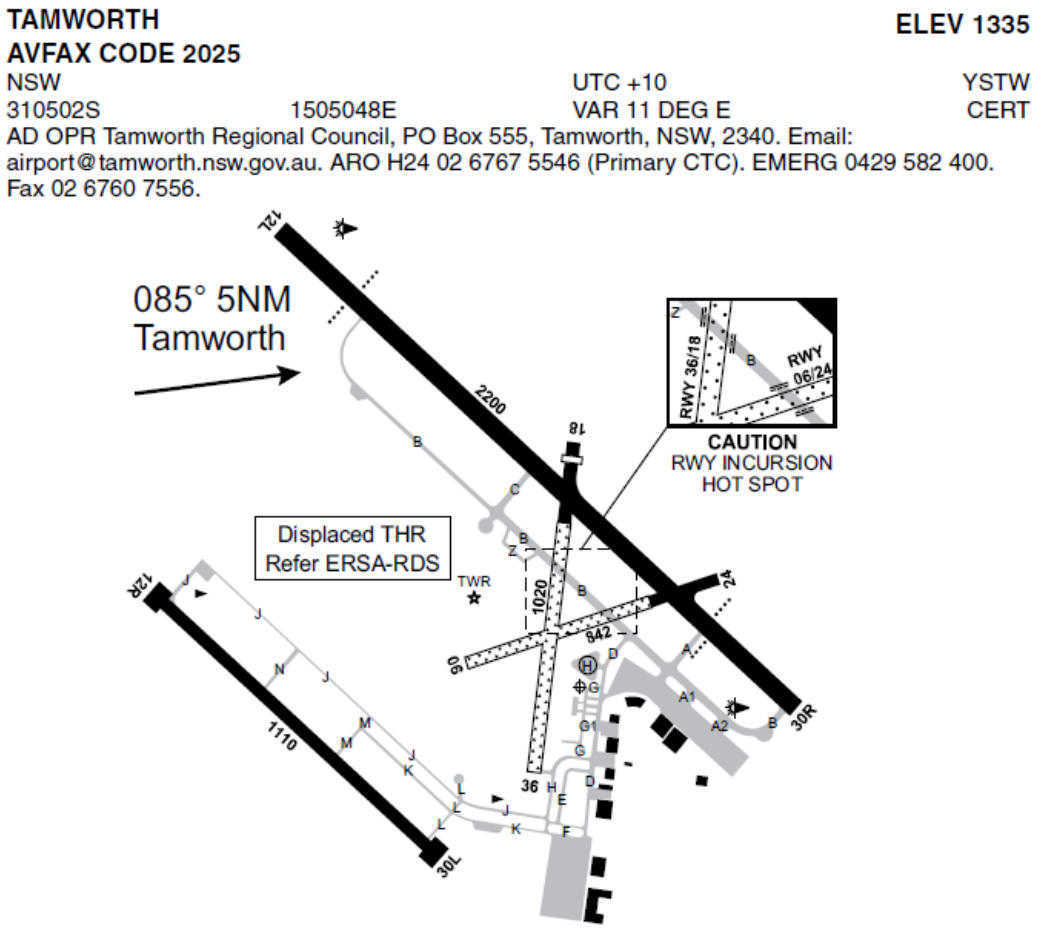

Figure 10 Tamworth Airport runway layout

Tamworth Airport's Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's ERSA are Latitude 31°05'02"S and Longitude 150°50'48"E.

6.3. Instrument procedures – Tamworth Airport

A check of the AIP via the Airservices Australia website showed Tamworth Airport is served by non-precision terminal instrument flight procedures, as per Table 2 (source: Airservices Australia June 2021).

Procedure charts for Tamworth Airport are designed by Airservices Australia.

Table 2 Tamworth Airport (YSTW) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART PAGE 1	07-Nov-2019 (Am-161)
AERODROME CHART PAGE 2	23-May-2019 (Am 159)
DME OR GNSS ARRIVAL PAGE 1	26-May-2016 (Am 147)
DME OR GNSS ARRIVAL PAGE 2	3-Mar-2016 (Am 146)
VOR RWY 12L	23-May-2019 (Am 159)
ILS-Z OR LOC-Z RWY 30R	7-Nov-2019 (Am 161)
VOR RWY 30R	26-May-2016 (Am 147)
NDB-A OR VOR-A	26-May-2016 (Am 147)
RNAV (GNSS) RWY 12L	5-Nov-2020 (Am 165)
RNAV (GNSS) RWY 30R	5-Nov-2020 (Am 165)

6.4. PANS-OPS surfaces – Tamworth Airport

An image of the MSA published for Tamworth Airport is shown in Figure 11. (Source Airservices Australia)

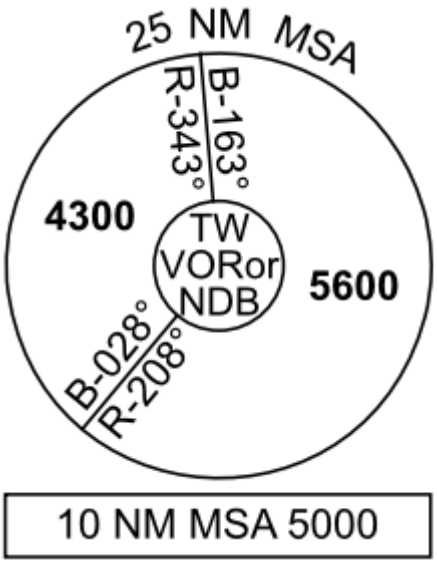

Figure 11 MSA established for Tamworth Airport (VOR or NDB)

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 Tamworth Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm when flying the respective approach procedures.

The Project Area is located inside the 25 nm (+5nm buffer) MSA of Tamworth Airport, in the eastern sector between B-163°M and B-028°M. The applicable MSA is 5600 ft AMSL (1707 m AHD) and MOC 4600ft AMSL (1402 m AHD).

Figure 12 shows the 10 nm (+ 5 nm buffer) and 25 nm (+ 5 nm buffer) MSAs of Tamworth Airport from the aerodrome reference point relative to the Project Area (source: Umwelt, Google Earth).

WTG T18 is the highest WTG located inside of the horizontal extent of the 25 nm MSA (+ 5 nm buffer) of Tamworth Airport with a tip height of 4272 ft AMSL (1302 m AHD). An impact analysis of Tamworth Airport's MSA is provided in Table 3.

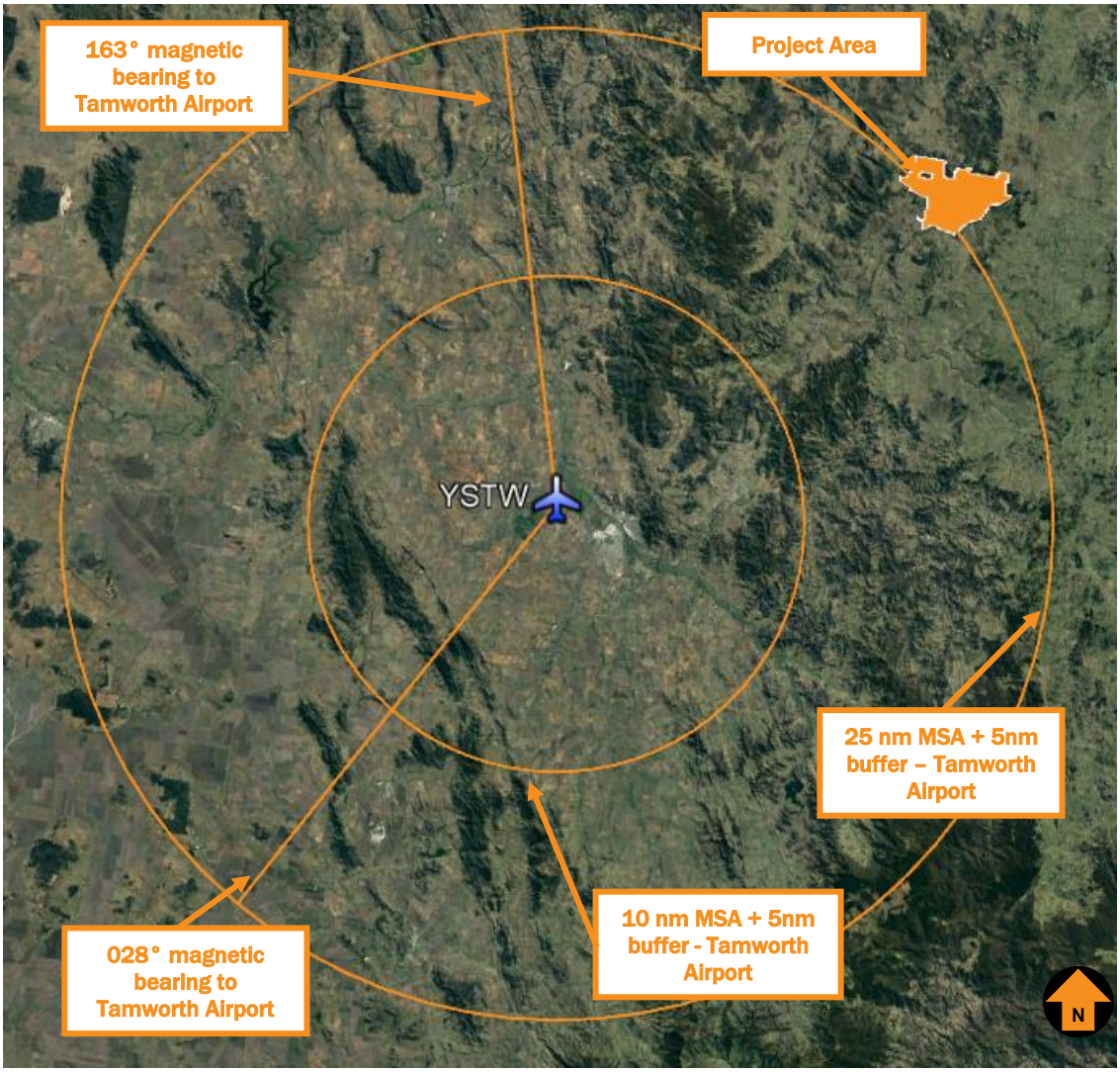

Figure 12 Tamworth Airport (YSTW) 10nm (+ 5nm buffer) and 25nm (+ 5nm buffer) MSA with sectors

Table 3 Tamworth Airport MSA impact analysis

MSA	Minimum altitude	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	5000ft AMSL	4000 ft AMSL	Nil – outside the horizontal extent of the 10nm MSA	N/A	N/A
25 nm east (sector B163° and B028°)	5600 ft AMSL	4600 ft AMSL	Nil – below controlling surface MOC by 328 ft (100 m)	N/A	N/A
25 nm west (sector B163° and B028°)	4300 ft AMSL	3300ft AMSL	Nil – outside the B110° and B245° sector	N/A	N/A

The Project will not impact instrument flight procedures at Tamworth Airport.

6.5. Circling areas – Tamworth Airport

The maximum horizontal distance that category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.78 km) from the threshold of each usable runway.

All turbines are located beyond the horizontal extent of category A, category B and category C circling areas at Tamworth Airport.

6.6. Obstacle limitation surfaces – Tamworth 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 WTG in the Project Area to Tamworth Airport is located approximately 28 km to the north-east of the aerodrome reference point, and beyond the horizontal extent of the obstacle limitation surfaces of Tamworth Airport.

6.7. Armidale Airport

Armidale Airport (YMDG) is a certified aerodrome operated by Armidale Regional Council, with a published aerodrome elevation of 1084 m AHD (3556 ft AMSL) (source: Airservices Australia, Armidale Aerodrome Chart).

Armidale Airport has 2 runways:

- Runway 05/23 sealed runway with a length of 1738 m, width 30 m
- Runway 09/27 grass runway with a length of 1116 m, width 30 m .

Figure 13 shows the Armidale Airport (YARM) runway layout (source: AsA, Aerodrome Chart, dated 17 Jun 2021).

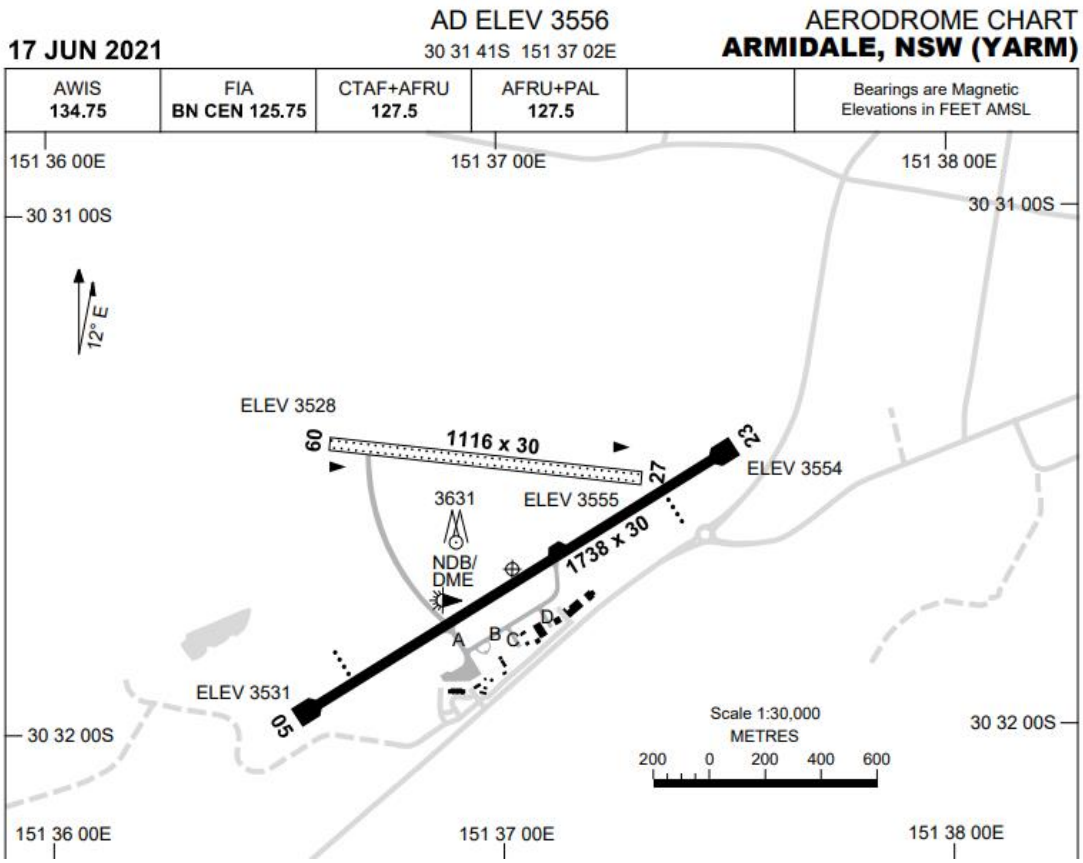

Figure 13 Armidale Airport Aeodrome Chart

Armidale Airport's Aerodrome Reference Point (ARP) coordinates published in Airservices Australia's ERSA are Latitude 30°31'41"S and Longitude 151°37'02"E.

6.8. Instrument procedures – Armidale Airport

A check of the AIP via the Airservices Australia website showed Armidale Airport is served by non-precision terminal instrument flight procedures, as per Table 2 (source: Airservices Australia June 2021).

Procedure charts for Armidale Airport are designed by Airservices Australia.

Table 4 Tamworth Airport (YSTW) aerodrome and procedure charts

Chart name	*Effective date*
AERODROME CHART	17-Jun-2021 (Am 167)
DME OR GNSS ARRIVAL	17-Jun-2021 (Am 167)
NDB RWY 05	17-Jun-2021 (Am 167)
NDB RWY 23	17-Jun-2021 (Am 167)
RNAV (GNSS) RWY 05	17-Jun-2021 (Am 167)
RNAV (GNSS) RWY 23	17-Jun-2021 (Am 167)

6.9. PANS-OPS surfaces – Armidale Airport

An image of the MSA published for Armidale Airport is shown in Figure 11. (Source Airservices Australia)

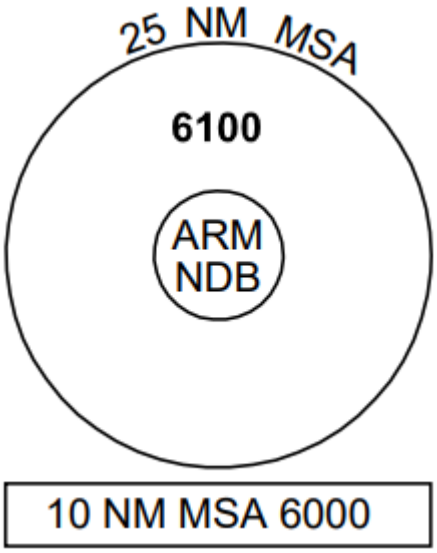

Figure 14 MSA established for Armidale Airport (NDB)

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 Tamworth Airport's ARP define the height at which an aircraft can fly when within 10 nm and 25 nm when flying the respective approach procedures.

The Project Area is located inside the 25 nm (+5 nm buffer) MSA of Armidale Airport, and outside the 10nm (+5 nm buffer). The applicable MSA is 6100 ft AMSL (1859 m AHD) and MOC 5100 ft AMSL (1555 m AHD).

Figure 15 shows the 10 nm (+ 5 nm buffer) and 25 nm (+ 5 nm buffer) MSAs of Armidale Airport from the aerodrome reference point relative to the Project Area (source: Umwelt, Google Earth).

WTG T24 is the highest WTG located inside of the horizontal extent of the 25 nm MSA (+ 5 nm buffer) of Armidale Airport with a tip height of 4436 ft AMSL (1352 m AHD). An impact analysis of Armidale Airport's MSA is provided in Table 5 Armidale Airport MSA impact analysis.

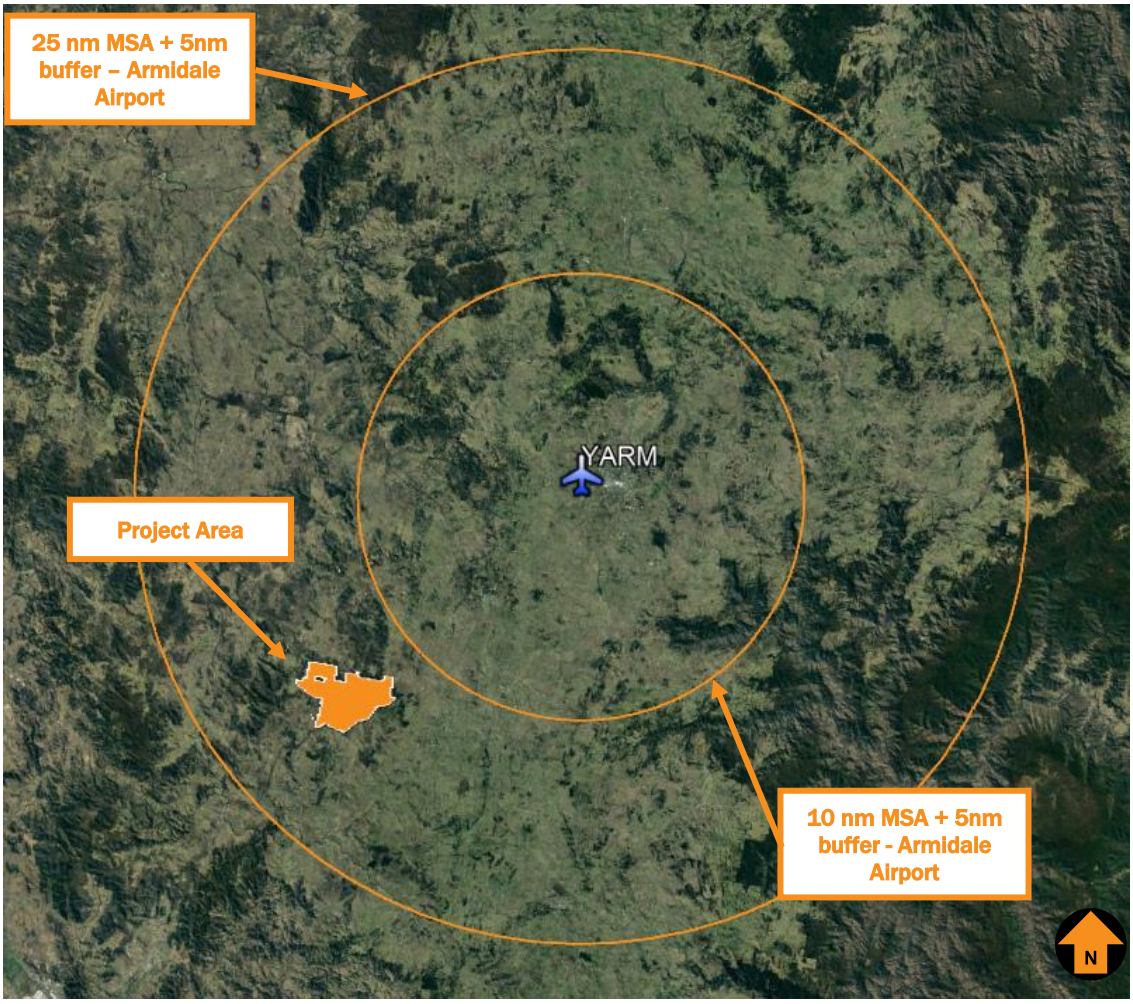

Figure 15 Armidale Airport (YARM) 10nm (+ 5nm buffer) and 25nm (+ 5nm buffer) MSA

Table 5 Armidale Airport MSA impact analysis

MSA	Minimum altitude	MOC	Impact on airspace design	Potential solution	Impact on aircraft ops
10 nm	6000ft AMSL	5000 ft AMSL	Nil – outside the horizontal extent of the 10nm MSA	N/A	N/A
25 nm	6100 ft AMSL	5100 ft AMSL	Nil – below controlling surface MOC by 664 ft (203 m)	N/A	N/A

The Project will not impact instrument flight procedures at Armidale Airport.

6.10. Circling areas – Armidale Airport

The maximum horizontal distance that category C circling area may extend for an aerodrome in Australia is 4.2 nm (7.78 km) from the threshold of each usable runway.

All turbines are located beyond the horizontal extent of category A, category B and category C circling areas at Tamworth Airport.

6.11. Obstacle limitation surfaces – Armidale 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 WTG in the Project Area to Armidale Airport is located approximately 36 km to the south-west of the aerodrome reference point, and beyond the horizontal extent of the obstacle limitation surfaces of Armidale 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), did not identify any unregulated aerodromes in close proximity to the Project Area. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

During early landowner consultation however, 3 private ALAs were identified as being within 3nm and have been included in this report. These are labelled Landholder ALA 1 (host landholder), Landholder ALA 2 and Landholder ALA 3 respectively.

A review of NationalMap (an online map-based tool allowing access to spatial data from Australian government agencies) was also undertaken as well as a search of landing areas identified on Google Earth Transportation (Airports) layer. Figure 16 shows the location of identified ALAs in relation to the Project Area.

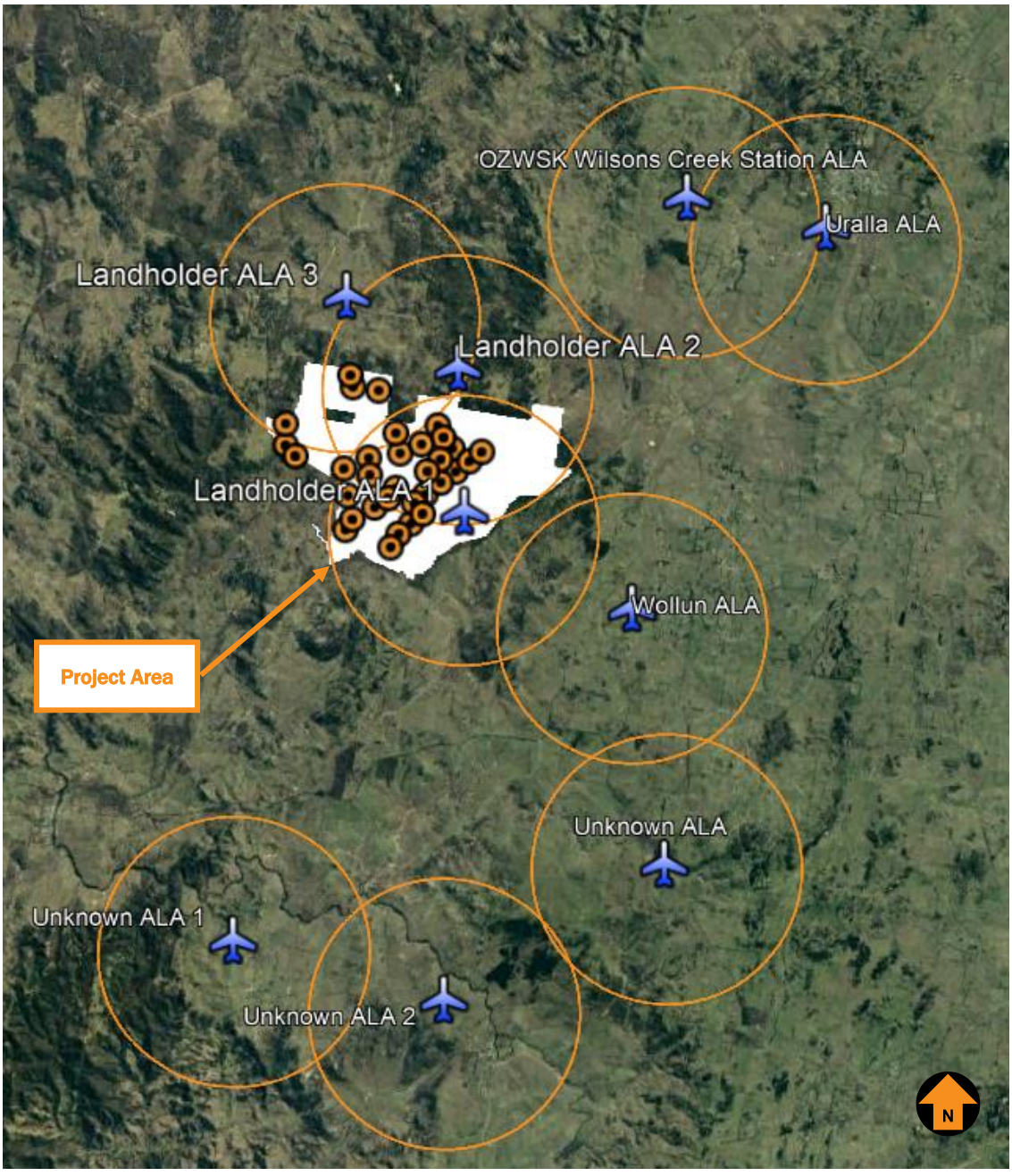

Figure 16 Project Area in relation to identified ALAs.

Landholder ALA 1, 2 and 3 are the closest in relation to the project area and the next closest is Wollun ALA. Wollun ALA is located approximately 8 km south-east of the Project Area.

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

Approach and take off surfaces

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

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

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

A copy of CAAP 92-1(1) Figure 2A – *Single engine and Centre-Line Thrust Aeroplanes not exceeding 2000 kg MTOW (day operations),* which shows the physical characteristics that may be applicable to the circumstances, is provided in Figure 17 (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

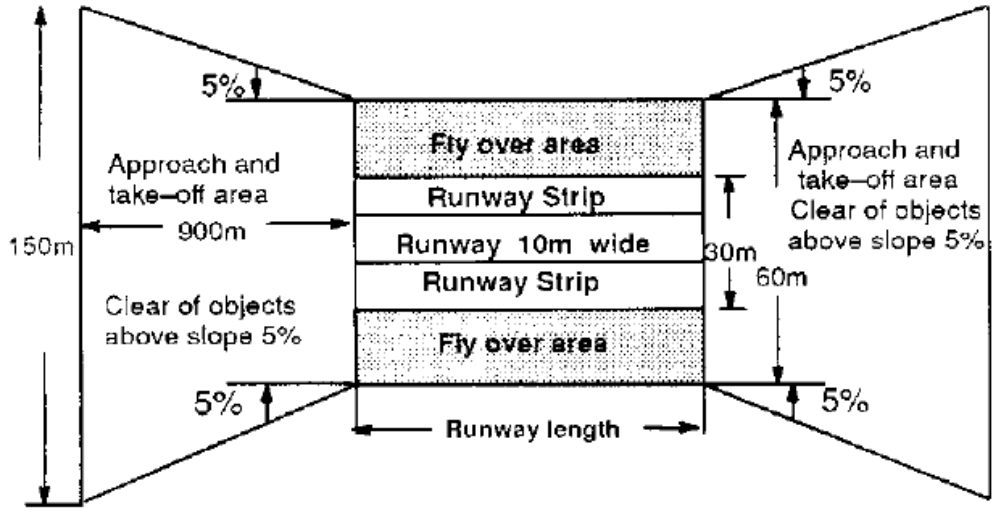

Figure 17 CAAP 92-1(1) Figure 2A

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

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

A copy of CAAP 92-1(1) Figure 4 – *Dimensions – agricultural day,* which shows the physical characteristics applicable to aerial application operations, is provided in Figure 18 CAAP 92-1(1) Figure 4 (source: CAAP 92-1(1) Guidelines for aeroplane landing areas).

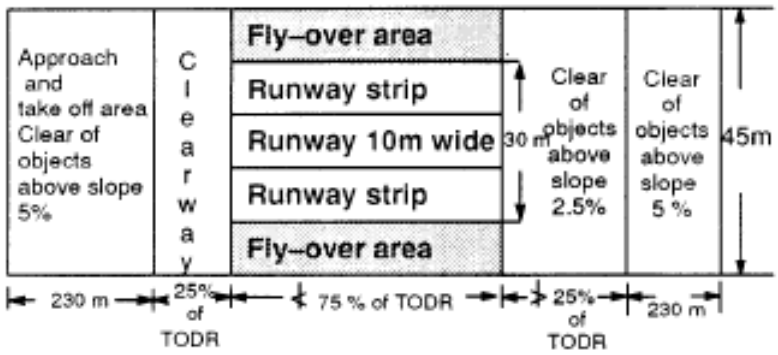

Figure 4 - Dimensions - agricultural day operations

Figure 18 CAAP 92-1(1) Figure 4

The proposed WTGs are located outside the horizontal extent of Figure 2A approach and take-off surfaces at Landholders ALA 1 (host), ALA 2, ALA 3 and Wollun ALA. Therefore, the Project will not impact Figure 2A approach and take-off surfaces at these ALAs.

Aerodrome circuits

For the purpose of this AIA the WTGs located in proximity to Landholder ALA 1 (host landholder), ALA 2, ALA 3 and Wollun ALA have been analysed to identify any potential impacts on the aerodrome's circuit operations.

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

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

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

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

Figure 19 shows a close up of the nearest WTGs relative to Landholders ALA 1 (host), ALA 2 and ALA 3 showing the indicative flight circuits (in red colour) and 3 nm radii of these ALAs (source: Umwelt, Google Earth).

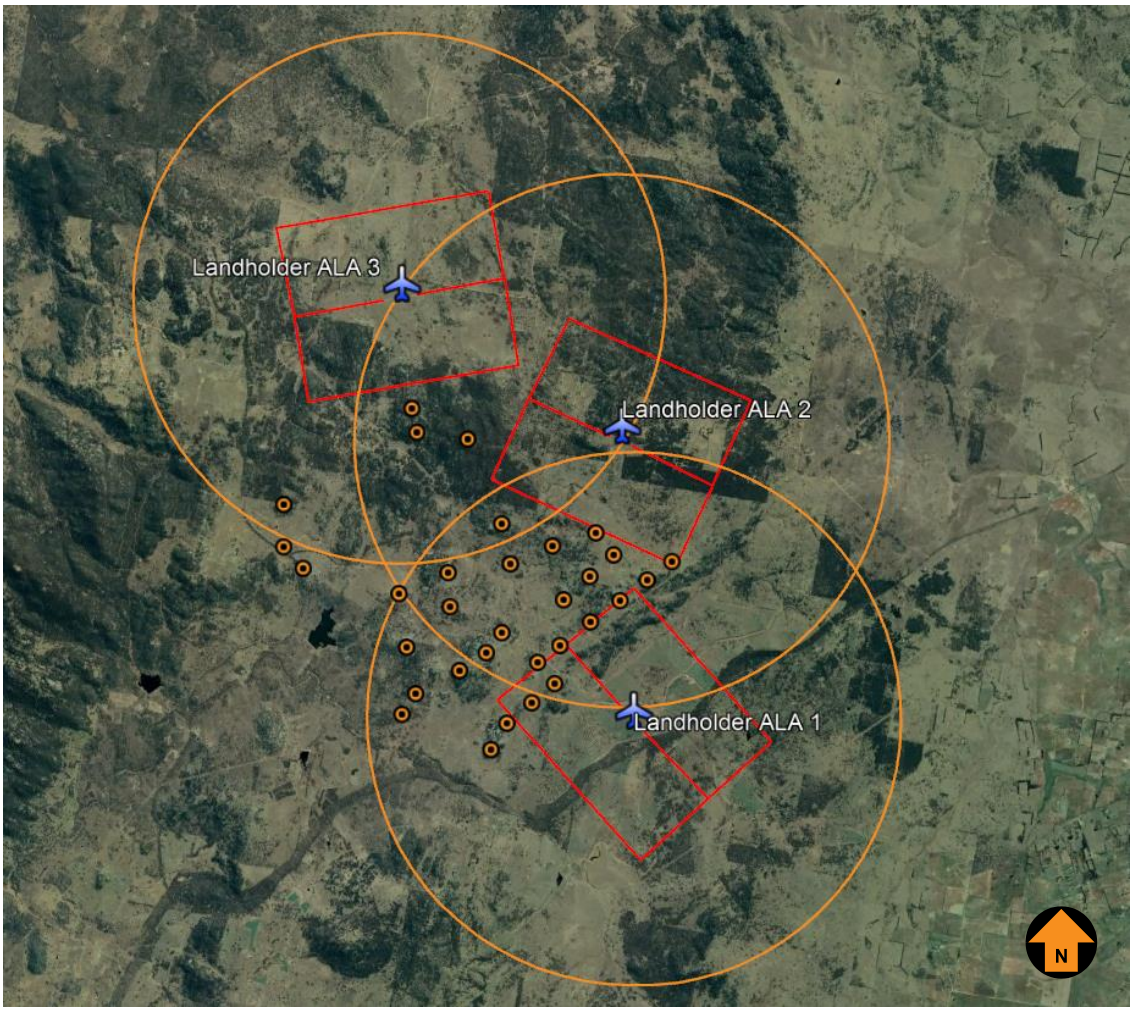

Figure 19 Landholders ALA 1 (host), ALA 2 and ALA 3 circuits in relation to the Project area.

Figure 20 shows the location of Wollun ALA (and 3 nm radius) in relation to the Project Area. A nominal circuit pattern (with 1 nm upwind, base and crosswind legs) is shown in red. (Source Umwelt, Google Earth)

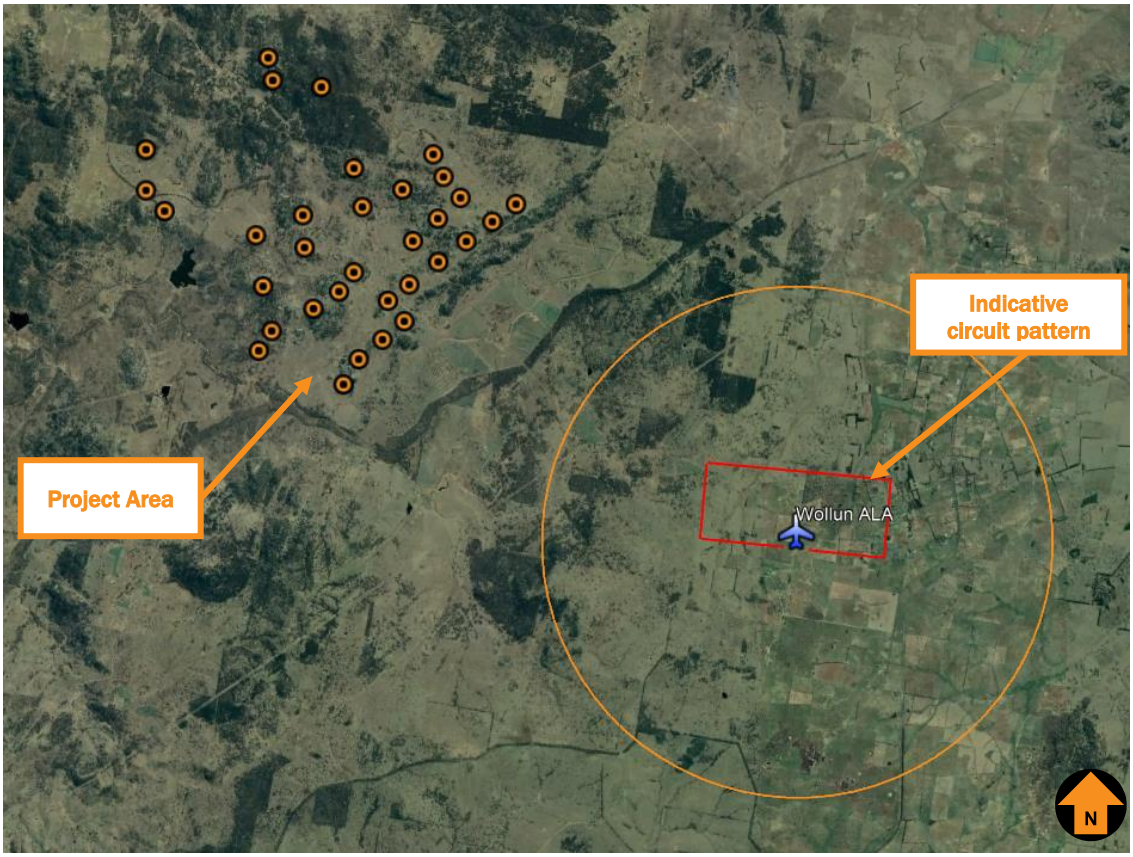

Figure 20 Wollun ALA in relation to the Project area

Wollun circuit area is approximately 6.9km from the closest WTG. The proposed WTGs are located outside the horizontal extent of indicative flight circuits of Wollun ALA.

It is unlikely aerodromes circuit operations of Wollun ALA will be affected by the Project.

Landholder ALA 1 – Circuit Operations

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

Individual consultation has taken place with each ALA Landholder in this report. Refer to Section 5.

A close-up of Landholder ALA 1 (host landholder), highlighting the indicative flight circuit and a 3 nm radius of this ALA is shown in Figure 21

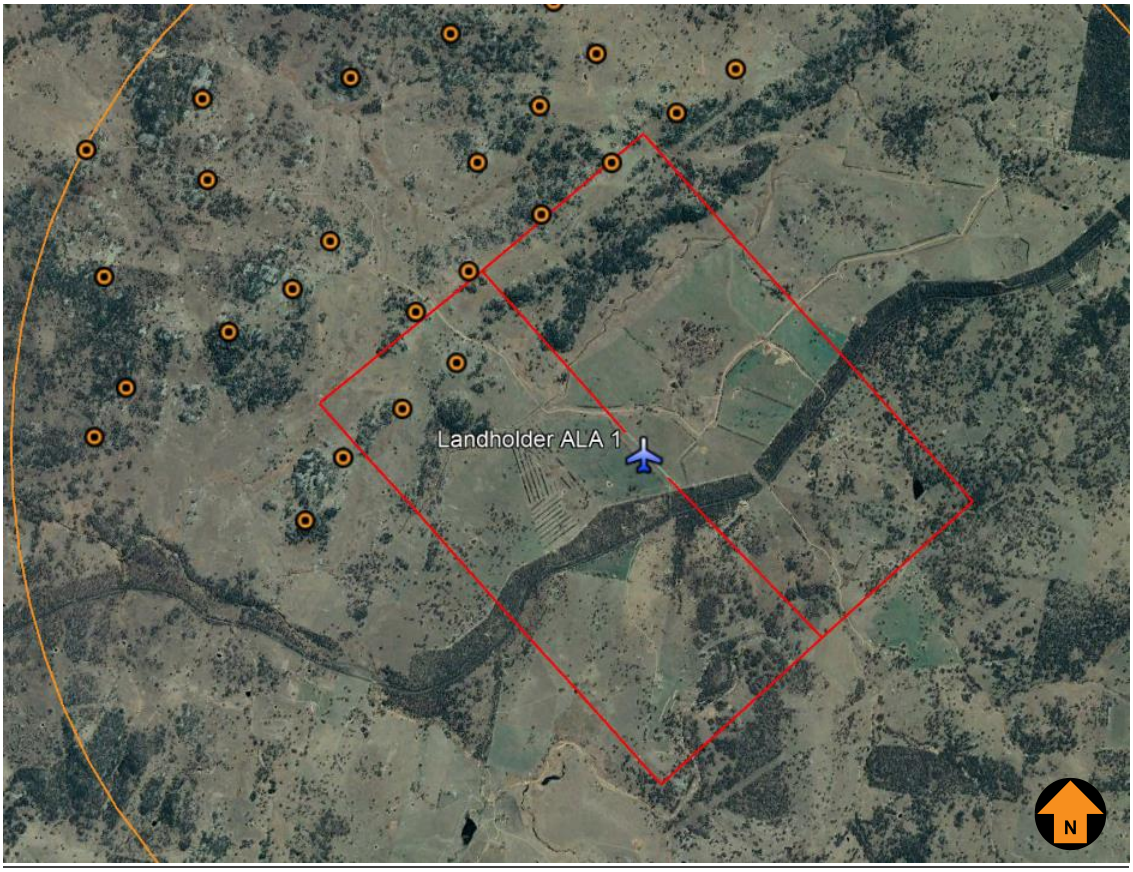

Figure 21 Proposed WTGs within a 3 nm radius of Landholder ALA 1 (host landholder), and indicative flight circuits

The approach and take-off surfaces for each runway commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The closest WTG to Landholder 1 ALA is WTG T8 and is located approximately 1.5 km (0.8 nm) from the end of the runway.

Whilst the WTGs do not impact the approach and take-off surface on the northern side of Landholder ALA 1, the circuit areas are impacted. Mitigations are as follows:

- Taking off to the north-west may be restricted by the turbine proximity
- Landing toward the south-east may be restricted by the turbine proximity
- Land towards the north-west and take-off towards the south-east
- There may be wake turbulence from the turbines in west and north-west winds
- The turbines are outside of the take-off and approach surfaces for the ALA.
- Essentially, Landholder ALA 1 (host landholder), is a one-way runway – Figure 22 refers.

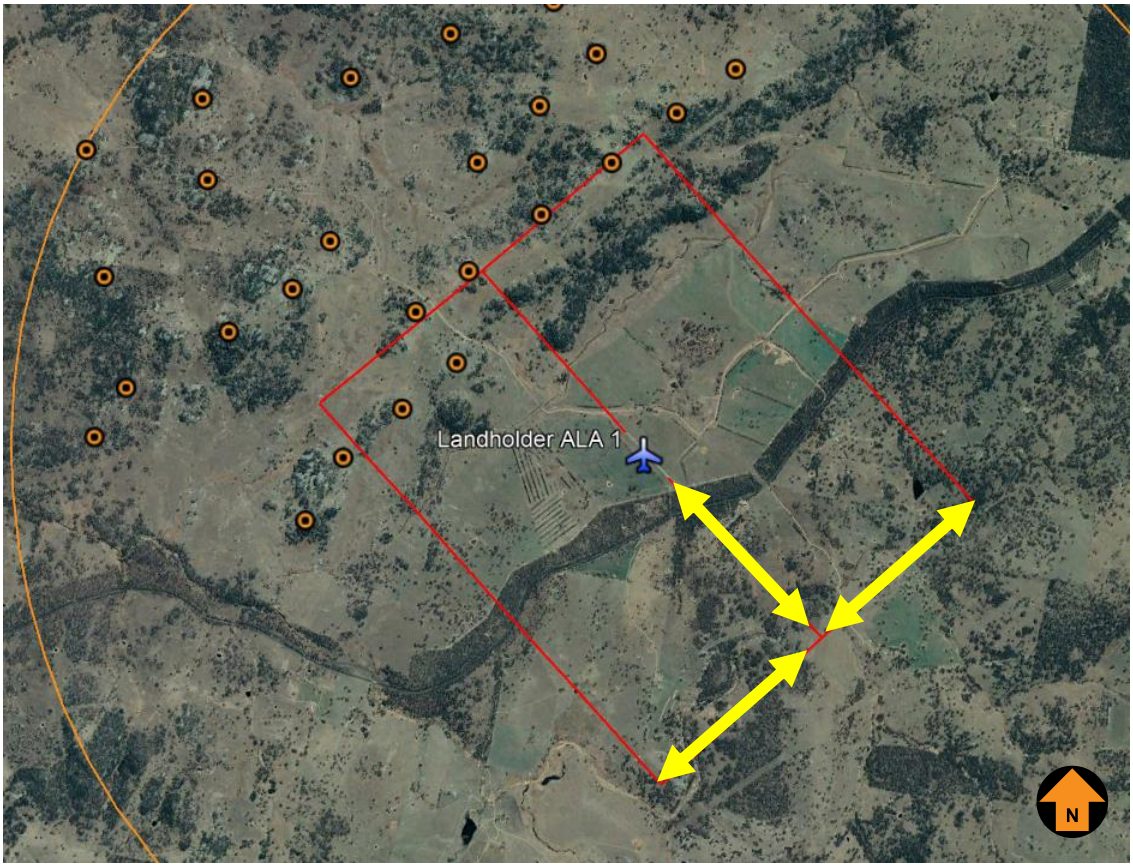

Figure 22 one-way take-off and landing to avoid WTG to the north-west

Landholder ALA 2

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

Individual consultation has taken place with each ALA Landholder in this report. Refer to Section 5.

A close-up of Landholder ALA 2 highlighting the indicative flight circuit and a 3 nm radius of this ALA is shown in Figure 23

Figure 23 Proposed WTGs within a 3 nm radius of Landholder ALA 2 and indicative flight circuits

The approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The closest WTG to of Landholder ALA 2 is WTG T13 and is located approximately 1.95 km (1.05 nm) to the south of the runway.

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

Based on the analysis conducted above and the information gathered, it is recommended circuit directions are kept to the north side of the ALA – Figure 24 refers. Approach and take-off surfaces at Landholder ALA 2 are not affected.

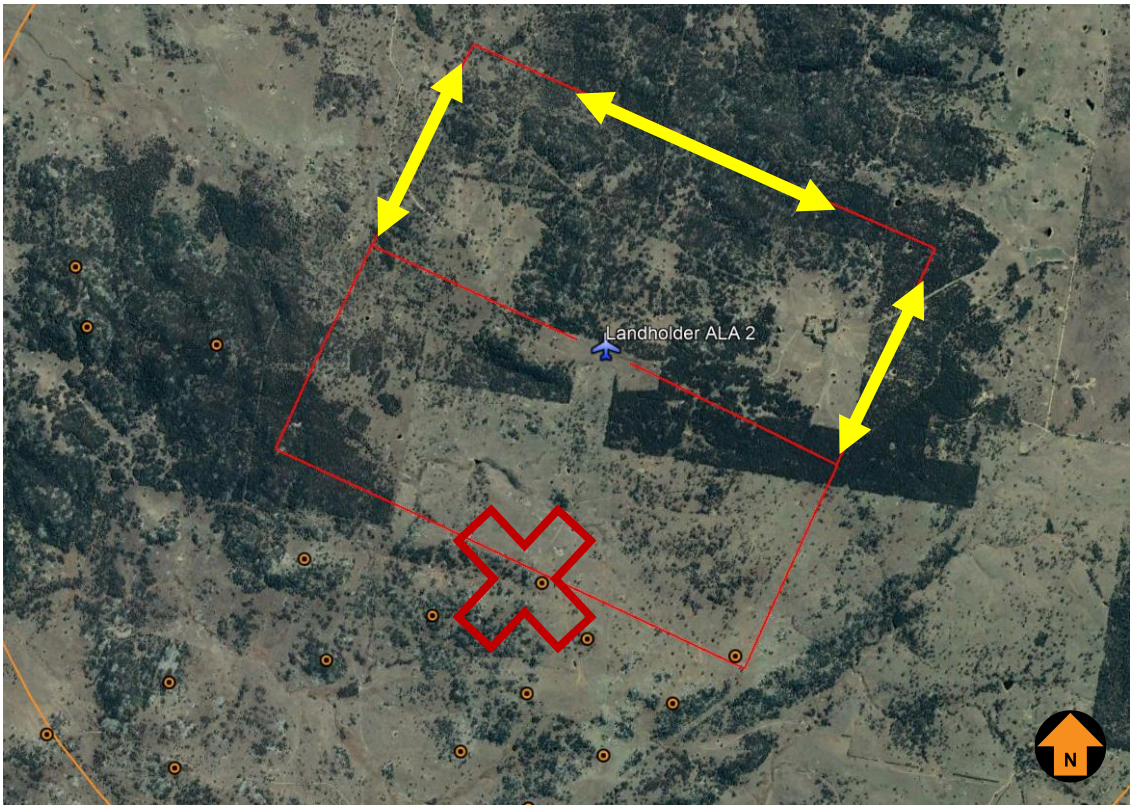

Figure 24 Landholder ALA 2 circuits conducted to the north only

Landholder ALA 3

As there is no published data available for Landholder 3 ALA, a conservative approach of a runway length of 500 m, with a runway width of 10 m as per *CAAP 92-1(1) Figure 2A* was used as a basis for analysis.

Individual consultation has taken place with each ALA Landholder in this report. Refer to Section 5.

A close-up of Landholder ALA 3 highlighting the indicative flight circuit and a 3 nm radius of this ALA is shown in Figure 25.

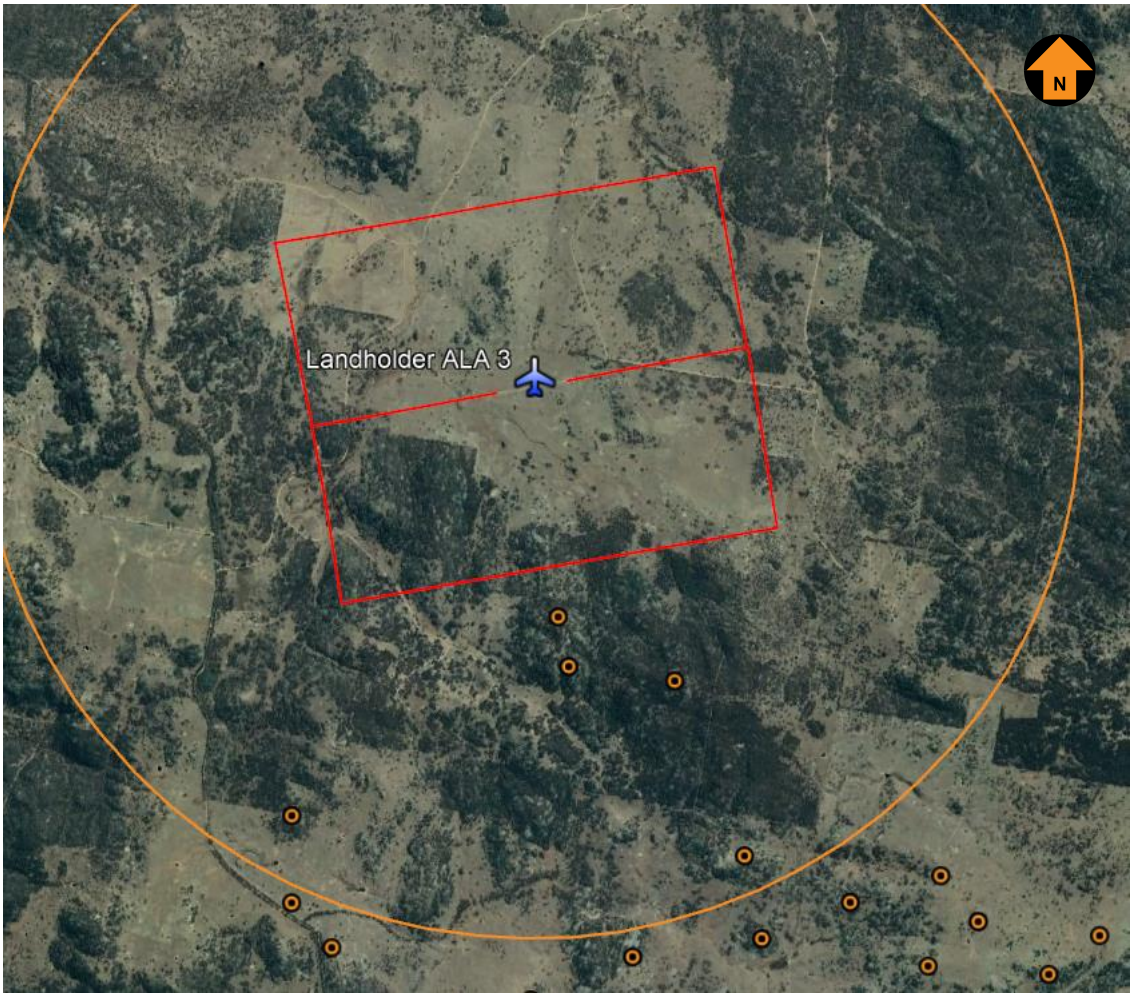

Figure 25 Proposed WTGs within a 3 nm radius of Landholder ALA 3 and indicative flight circuits

The approach and take-off surfaces for each runway end commence at the runway end (threshold) at a distance of 30 m either side of the runway centreline and diverge at a rate of 5% to a distance of 900 m. The closest WTG to of Landholder ALA 3 is WTG T25 and is located approximately 2.3 km (1.2 nm) to the south of the runway. Figure 25 refers.

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

Based on the analysis conducted above and the information gathered, it is unlikely that the Project will impact on circuit operations and approach and take-off surfaces at of Landholder ALA 3.

6.13. Potential Impacts from Wake Turbulence

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

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

Guidance regarding WTG wake turbulence states:

> *Wind farm operators should be aware that wind turbines may create turbulence which noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 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.*

With a proposed rotor diameter of 180 m, the wake turbulence affects could be noticeable at a distance of 2,880 m (16 times 180 m) downwind of the nearest WTG. Figure 26 demonstrates a 2880 m radius from the WTGs located nearest ALAs.

Aircraft operating at Landholder ALAs 1, 2 and 3 may be impacted by wake turbulence effects from the Project Area based on NASF guidance of 16 times rotor diameter. Figure 26 refers.

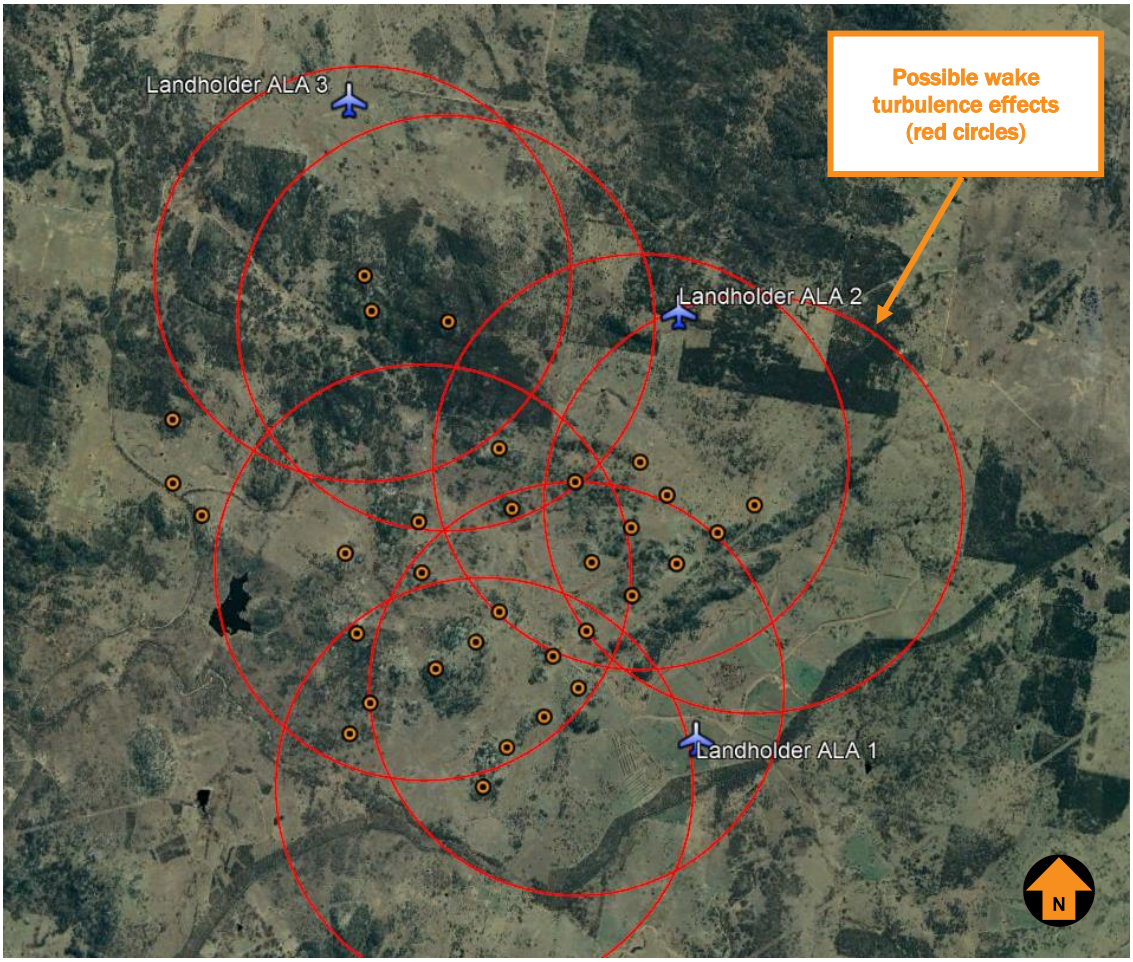

Figure 26 Wake turbulence effects (2880 m) to nearest ALAs

6.14. Summary of ALA analysis

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

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

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

The proponent has contacted the landowners and aerial operators for the identified airport and ALAs to inform them of potential impacts on the operation. Refer to Consultation Section 5.

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

The details of all identified ALAs are provided in Table 6.

Table 6 Nearby aircraft landing areas

ALA Name	*ICAO code*	*Registration status*	*Distance from the Project site*	*Nearest WTG*	*Impact on the OLS*	*Impact on flight circuit(s)*	*Potential wake turbulence from WTGs*
Landholder ALA 1 (host landholder)	Nil	uncertified	1.8 km east	T8	NIL	YES, to both flight circuits	YES
Landholder ALA 2	Nil	uncertified	1.6 km north-east	T13	NIL	YES, to one flight circuit	YES
Landholder ALA 3	Nil	uncertified	2.3 km north	T25	NIL	NO	YES
Wollun ALA	Nil	uncertified	9.7 km east	T8	NIL	NO	NO

6.15. Air routes and LSALT

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

The Project Area is located in the vicinity of 7 air routes. It is located in a grid identified in the EnRoute Chart – Low (ERC Low National) with a grid LSALT of 6400 ft AMSL. (MOC 5400 ft AMSL).

The highest WTG is WTG T24 with a maximum overall height of 1352 m AHD (4436 ft AMSL) with 5 m buffer applied and is below the grid LSALT MOC of 5400 ft AMSL by 294 m (964 ft AMSL). Therefore, the Project will not affect the grid LSALT.

Figure 27 provides the grid LSALT and low-level air routes in proximity to the Project Area (source: Umwelt, Airservices ERC Low National Chart, 17 June 2021).

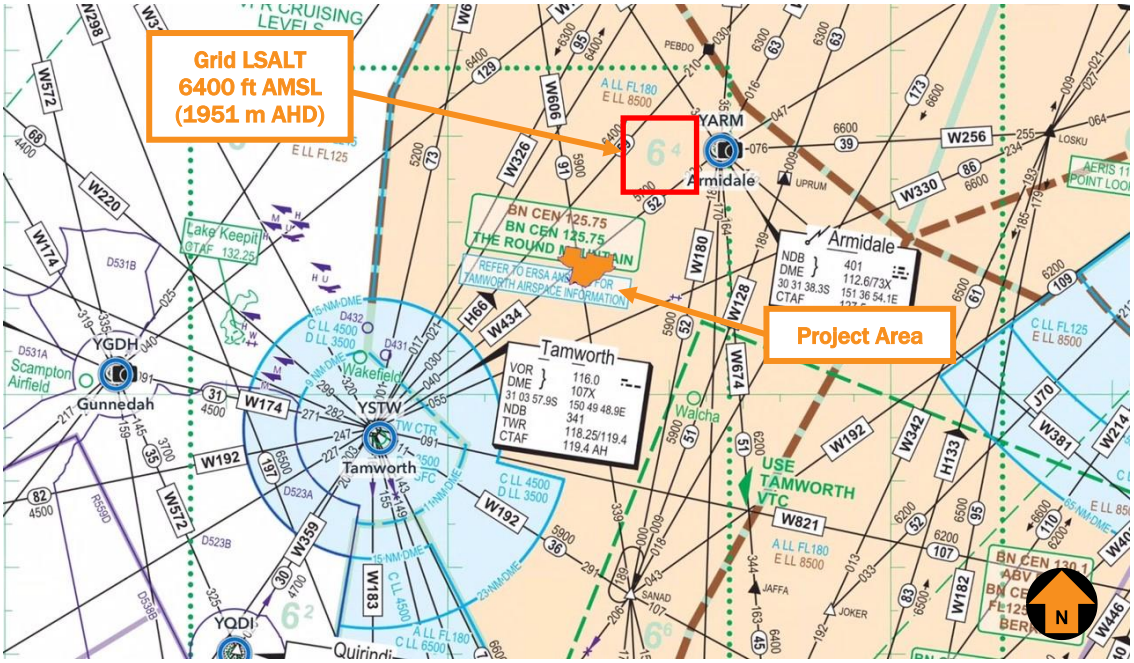

Figure 27 Grid LSALT and air routes in proximity to the proposed Project (ERC Low National)

The Project Area is also shown in relation to air routes located in EnRoute Chart – High (ERC High National) in Figure 28 (Source Umwelt, Airservices ERC High National Chart, 17 June 2021)

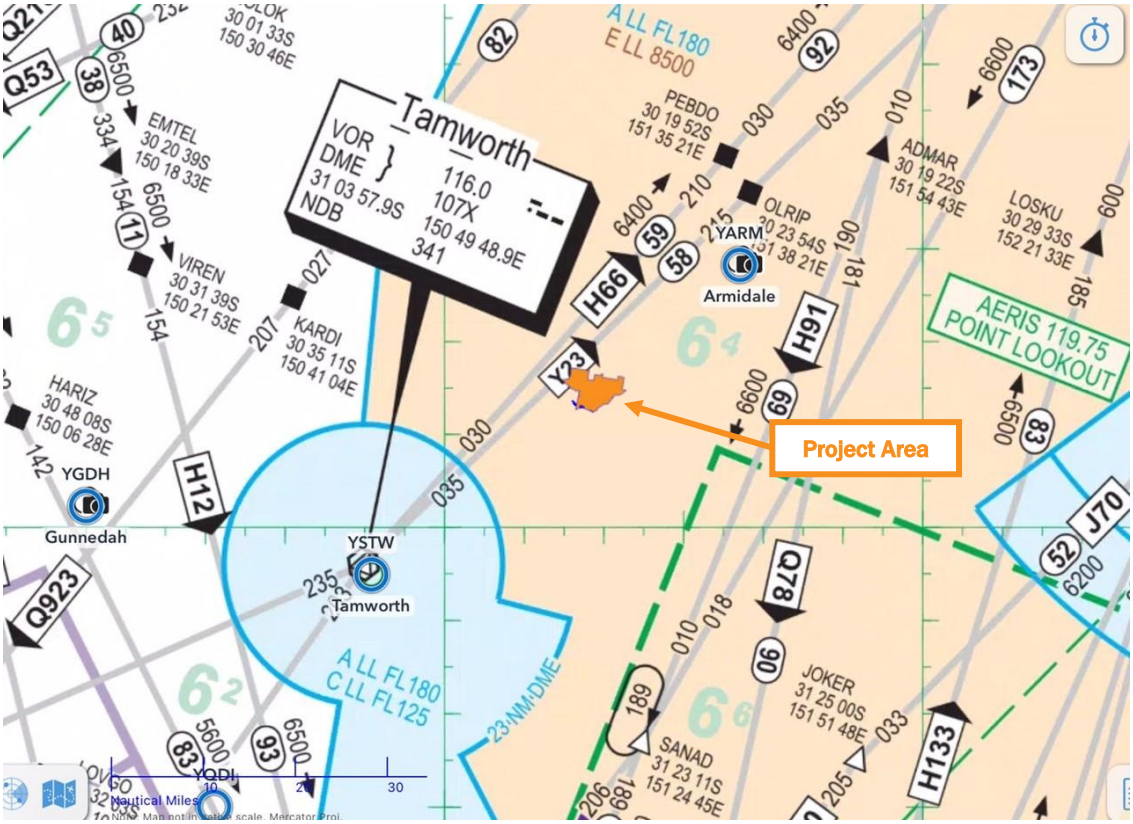

Figure 28 Project Area shown on ERC High National

An impact analysis of the surrounding air routes is provided in Table 7 in relation to the tallest object in the Project Area (WTG T24 – 1352 m AHD, 4436 ft AMSL).

Table 7 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
W434	YSTW-YARM	5700 ft AMSL	4700 ft AMSL	Nil	N/A	N/A
W606	SANAD – YIVL	5900 ft AMSL	4900 ft AMSL	Nil	N/A	N/A
W330	YSTW – LOSKU	6600 ft AMSL	5600 ft AMSL	Nil	N/A	N/A
W180	YARM – SANAD	5900 ft AMSL	4900 ft AMSL	Nil	N/A	N/A
H66	YSTW – PEBDO	6400 ft AMSL	5400 ft AMSL	Nil	N/A	N/A
W326	YSTW – YGLI	6300 ft AMSL	5300 ft AMSL	Nil	N/A	N/A
W169	YSTW - HUUGO	6400 ft AMSL	5400 ft AMSL	Nil	N/A	N/A
Y23	YSTW - OLRIP	N/A High Air Route	N/A High Air Route	Nil	N/A	N/A

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

The Project will not an impact on the grid LSALT or route LSALT.

6.16. Airspace

The 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.

6.17. 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:

- Armidale Airport - Airservices Australia NDB located approximately 23 nm (43 km) north-east of the Project
- Tamworth Airport Airservices Australia ILS/LLZ/VOR/DME/NDB located approximately 27 nm (49 km) south-west of the Project.

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

6.18. Radar

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

With respect to aviation radar facilities, the closest radar is the Mt Sandon Secondary Surveillance Radar (SSR) which is located approximately 36 nm (67 km) south of the Project Area. Mt Sandon is a transportable radar site and is not in operation as advised by Airservices Australia (28 October 2021).

The closest functional radar is Round Mountain RSR which is approximately 93 km north-east of the project site.

The Project Area is located in Zone 4 and outside the radar line of sight of the Secondary Surveillance Radar (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 Round Mountain RSR.

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

6.19. 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.

6.20. AIS summary

Based on the Project layout and overall turbine blade tip height limit of 260 m AGL, the blade tip elevation of the highest WTG, which is WTG T24, will not exceed 1352 m AHD (4436 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate PANS-OPS surfaces
- will not impact any nearby designated air routes

- 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
- wake turbulence may affect aircraft operations in the circuit at Landholder ALAs 1, 2 and 3

The list of WTGs (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 there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WTGs or WMTs, without obstacle lighting on the WTGs and WMTs of the Project.

For completeness, lighting standards and guidelines are summarized in **Annexure 5.**

7.1. Wind monitoring tower

In terms of obstacle marking and lighting requirements, relevant requirements set out in Part 139 MOS 2019 and NASF are provided below.

Consideration should be given to marking any WMTs according to the requirements set out in Part 139 MOS 2019 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 4.3 for additional information regarding the temporary WMT.

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 considered.

8.1. General aviation operations

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

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

8.2. ATSB occurrence taxonomy

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

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

8.3. National aviation occurrence statistics 2010-2019

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

According to the report, there were no fatalities in high or low capacity RPT operations during the period 2010-2019. In 2019, 220 aircraft were involved in accidents in Australia, with a further 154 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there was 35 fatalities from 22 fatal accidents. There have been no fatalities in scheduled commercial air transport in Australia since 2005.

Of the 326 fatalities recorded in the 10-year period, over 50% (175 or 53.68%) occurred in the general aviation segment. On average, there were 1.51 fatalities per aircraft associated with a fatality in this segment. The fatalities to aircraft ratio ranges from 1.09 to 177:1. Whilst it can be inferred from the data that the majority of fatal accidents are single person fatalities, it is reasonable to assert that the worst credible effect of an aircraft accident in the general aviation category will be multiple fatalities.

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 8 (source: ATSB).

Table 8 Number of fatalities by GA sub-category – 2010 to 2019

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

Figure 29 refers to Fatal Accident Rate by operation type per million departures over the 6-year period 2014 - 2019 (source: ATSB).

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

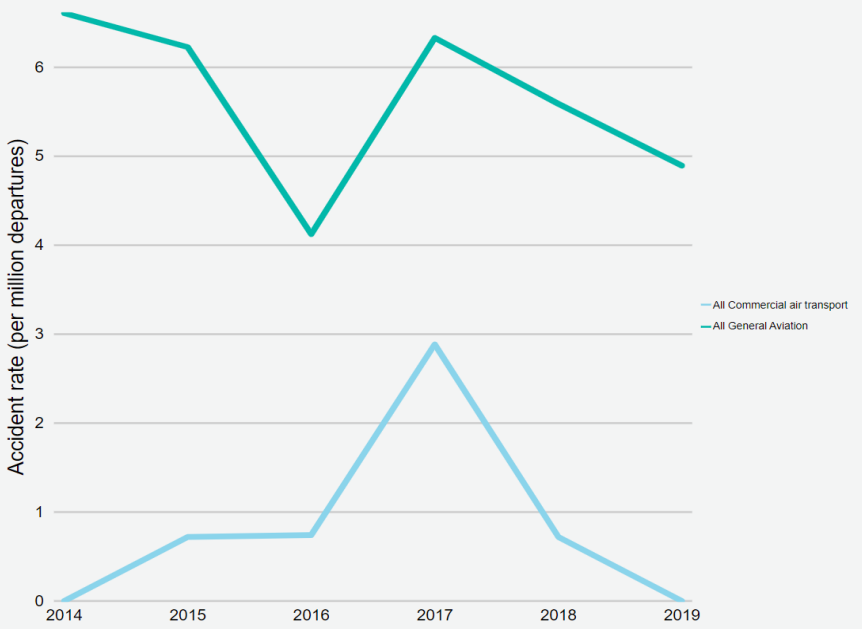

Figure 29 Fatal Accident Rate (per million departures) by Operation Type

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

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 9 (source: ATSB).

Table 9 Fatal accidents by GA sub-category – 2010 -2019

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

Sub-category	Fatal accidents	Fatalities
Instructional flying	11	19
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	115	174

Over the 10-year period, no aircraft collided with a WTG or a WMT.

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

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

8.4. Worldwide accidents involving wind farms

To provide some perspective on the likelihood of a VFR aircraft colliding with a WTG, a summary of the 4 accidents that involved an aircraft colliding with a WTG, and the relevant factors applicable to this assessment, is incorporated in this section.

Based on the statistic of the Global Wind Energy Council (GWEC) report 2019, there were 341,320 WTGs operating around the world at the end of 2016. In 2019, approximately 60.4 GW of wind power had been installed worldwide.

According to the Australian Renewable Energy Agency (ARENA), at the end of 2018 there were 94 wind farms operating in Australia. Clean Energy Council data indicates another 8 projects were commissioned in 2019 and there were 30 were under construction or financially committed, producing a total of 132 wind farms nationally.

Aviation Projects has researched public sources of information, accessible via the internet, 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 4 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 WTG on its descent. This accident is not applicable to the circumstances under consideration.

There have been 2 accidents involving collision with a WTG during the day.

Only one of these (Melle, Germany 2017) resulted in a single fatality, as the result of a collision with a WTG 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 2 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 WTG near Baraboo, Wisconsin, on 29 July 2000. The NTSB database record 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 WTGs or a wind farm.

A summary of the 4 accidents is provided in Table 10.

Table 10 Summary of accidents involving collision with a WTG

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 WTG 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 WTG tower, at night in IMC. The wind 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 WTG 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 WTG. Contributing to the accident was the inoperative obstruction light on the WTG, which prevented the pilot from visually identifying the WTG.	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 WTGs. 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 WTGs 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 WTG 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 WTGs and WMTs of the Project.

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

1. potential for an aircraft to collide with a WTG, controlled flight into terrain (CFIT);
2. potential for an aircraft to collide with a WMT (CFIT);
3. potential for a pilot to initiate manoeuvring to avoid colliding with a WTG 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 5 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 Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 11 to Table 15 below.

Table 11 Aircraft collision with WTG

Risk ID:	1. Aircraft collision with WTG (CFIT)
Discussion An aircraft collision with a WTG would result in harm to people and damage to property. Property could include the aircraft itself, as well as the WTG. There have been 4 reported occurrences worldwide of aircraft collisions with a component of a WTG 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 WTG: • 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 WTG. 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 WTG, 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 4 reports of aircraft collisions with WTGs 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 2 relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG 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 260 m (853 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 108 m (354 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 WTGs.
- 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 WTGs are typically coloured white so they should be visible during the day.
- The ‘as constructed’ details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Because the turbines are above 100 m AGL, there is a statutory requirement to report the towers to CASA.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

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

Recommended Treatments
The following treatments which can be implemented at little cost will provide an acceptable level of safety:
• Details of the Project should be communicated to local and regional aircraft operators prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:
  ○ Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG rotor blades prior to the commencement of the subject aircraft operations within the Project Area (Figure 16 refers)
  ○ Arrangements should encourage applicable aerodrome operators 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 WTG 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). Considering obstacle lighting will not reduce the residual risk number, obstacle lighting 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 WTG, without obstacle lighting on the turbines of the Project.**
Residual Risk | 7 - Tolerable

Table 12 Aircraft collision with WMT

Risk ID:	**2. Aircraft collision with a WMT (CFIT)**
Discussion An aircraft collision with a WMT would result in harm to people and damage to property. There is currently 1 existing permanent WMT and it is proposed to install up to 6 permanent WMTs, each up to 170m tall. These additional WMTs would all be located in close proximity to WTGs with final positions to be determined in consultation with the WTG manufacturer. The final location of the WMTs 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. There are known helicopter aerial agriculture operations conducted in the region. 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 WMT 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 location of the WMT will be determined as part of the final construction design and the 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 WMT will be at a maximum height of 80 m	

(263 ft) AGL, which will be approximately 72 m (236 ft) below the minimum height of 500 ft AGL for an aircraft flying at this height.

- In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The WMT will be constructed from grey steel.
- The WMTs will be reported 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:

- The location of the WMTs will be determined as part of the final construction design and the details should be reported to Airservices Australia, local and regional aerodrome and aircraft operators before, during and following construction.
- The WMT should be marked with aviation marker balls and consideration should be made to Part 139 MOS 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.

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 WTG would obstacle lighting be considered necessary. 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 13 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 WTG 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 260 m (853 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 108 m (354 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 WTGs. 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 WTGs are typically coloured white so they should be visible during the day • The 'as constructed' details of WTGs 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 WTG 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.
- WTGs will be a maximum of 260 m (853 ft) AGL at the top of the blade tip, so the rotor blade at its maximum height will be approximately 108 m (354 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 WTGs.
- 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 WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Level of Risk

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

Current Level of Risk	8 – Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments

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

• Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, The Proponent 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 WTG 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 WTG, without obstacle lighting on the turbines of the Project.**
Residual Risk | 7 - Tolerable

Table 14 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 Area 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. • WTGs will be a maximum of 260 m (853 ft) at the top of the blade tip, so the rotor blade at its maximum height will be approximately 108 m (354 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 WTGs. • 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 WTGs. • 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 WTGs are typically coloured white so they should be visible during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the turbines will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Level of Risk

The level of risk associated with a Possible likelihood of a Minor consequence is 5.

Current Level of Risk	5 - Tolerable

Risk Decision

A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.

Risk Decision	Accept, conduct cost benefit analysis

Proposed Treatments

Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a WTG.

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, The Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project.
- Placement of any additional WMTs in close proximity to the WTGs.

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 15 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 WTGs 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 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Consequence

The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be:

- Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences.

This would be a Moderate consequence.

Consequence	Moderate

Untreated Likelihood

The likelihood of moderate site impact, minimal local impact is Almost certain - the event is likely to occur many times (has occurred frequently).

Untreated Likelihood	Almost certain

Current Treatments

If the WTGs or WMTs are higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. For objects outside an OLS and above 100 m obstacle lighting is required, 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 WTGs 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 32 WTGs with a maximum overall height (tip height) of up to 260 m AGL
- the highest WTG is WTG T24 with a ground elevation of 1092 m AHD (with 5 m buffer) and overall height of 1352 m AHD (4436 ft AMSL)
- One permanent WMT is proposed with a height of 80 m AGL (263 ft)
- Associated high voltage equipment and transmission infrastructure.

10.2. Regulatory requirements

The following regulatory requirements apply:

- With respect to Part 139 MOS 2019 Chapter 8 Division 10 8.109, the proposed WTGs and WMTs must be reported to CASA if they are considered a hazardous obstacle
- WTGs and WMTs must be marked in accordance with respect to Part 139 MOS 2019 Chapter 8 Division 10 8.110
- WTGs must be lit in accordance with Part 139 MOS 2019 Chapter 9 Division 4 9.30 and 9.31, unless an aeronautical study assesses they are of no operational significance.

10.3. Planning considerations

The Project as proposed satisfies the planning provisions of Tamworth Regional Council regarding Tamworth Airport, and Armidale Regional Council regarding Armidale Airport and will not impact current and planned airport operations. The Project also satisfies Uralla Shire Council planning provisions regarding aviation aspects.

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 blade tip height limit of 260m AGL, the blade tip elevation of the highest WTG, which is WTG T24, will not exceed 1352 m AHD (4436 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate PANS-OPS surfaces

- will not impact any nearby designated air routes
- 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
- wake turbulence may affect aircraft operations in the circuit at Landholder ALA 1 (host), Landholder ALA 2 and Landholder ALA 3

Refer to **Section 5** for a detailed summary of the consultation.

10.6. ALA analysis summary

Landholder ALA 1 (host), Landholder ALA 2 and Landholder ALA 3 will be impacted by the Project. Para 6.12 provides detailed analysis.

- ALA 1 (host landholder) may be restricted to landing towards the NW and take-off towards the SE and may be affected by downstream wake turbulence. Landholder ALA 1 has been consulted – refer to Section 5 for details.
- ALA 2 may be restricted to northern circuit operations only and may be affected by downstream wake turbulence. Landholder ALA 2 has been consulted – refer to Section 5 for details.
- ALA 3 may be affected by downstream wake turbulence. Landholder ALA 3 has been consulted – refer to Section 5 for details.

All other validated ALAs are further than 3 nm from the Project Area and will not be adversely affected by any WTGs of the Project.

10.7. Aircraft operator characteristics

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

The Proponent has engaged with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG rotor blades prior to the commencement of the subject aircraft operations within the Project Area.

WTGs 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.

10.8. Hazard lighting and marking

The following conclusions apply to hazard marking and lighting:

- With respect to Part 139 MOS 2019 Chapter 8 Division 10 8.109, the proposed WTGs and WMTs must be reported to CASA if they are considered a hazardous obstacle. WTGs and WMTs must be marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110.
- WTGs must be lit in accordance with Part 139 MOS 2019 Chapter 9 Division 4 9.30 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.

10.9. 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 16.

Table 16 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with WTG	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the Project to local and regional operators and encourage applicable aerodrome operators to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with WMT	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Although there is no obligation to do so, consideration should be made for marking the WMT according to the requirements set out in Part 139 MOS 2019 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Details of WMTs should be 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 encourage applicable aerodrome operators 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 encourage applicable aerodrome operators 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 WTG and WMT coordinates and elevation should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
3. 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.
4. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMT 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

5. Whilst not a statutory requirement, the Proponent 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 Area.

Marking of turbines

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

Lighting of turbines

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

Marking of WMTs

8. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). Specifically:
    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires
    b. paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast

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

d. a flashing strobe light during daylight hours.

Micrositing

9. The potential micrositing of the turbines and WMT 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 WMT positions. Providing the micrositing is within 100 m of the turbines and WMTs 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.

Overhead transmission line

10. 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 Part 139 MOS 2019 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

Triggers for review

11. 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:

- Armidale Regional Council, *Armidale Airport Master Plan 2016*
- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 17 June 2021
- Airservices Australia, Designated Airspace Handbook, effective 17 June 2021
- Civil Aviation Safety Authority, Civil Aviation Regulations 1988 (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
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.0 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome
- 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
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, aeronautical navigation charts extracts, dated 17 Jun 2021
- Rehbein Airport Consulting, *Tamworth Regional Airport Master Plan 2015*
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- NSW Government, Planning and Environment Department, *Wind Energy Guideline (December 2016)*

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: Umwelt, BDG_turbines and MM_locations (Received 13 August 2021)

Note: the heights include a 5 m allowance for variation in site elevation. The WTG with largest overall height is highlighted.

WTG ID	*Easting*	*Northing*	*Type*	*Height (m AGL)*	*Ground mAH*	*Overall height (m AHD)*
T2	341225	6597378	Turbine	260	1341.589	1081.58865
T3	340719	6596988	Turbine	260	1347.026	1087.025884
T4	340162	6596552	Turbine	260	1340.56	1080.560135
T5	339556	6596100	Turbine	260	1301.499	1041.498839
T6	338931	6595599	Turbine	260	1291.077	1031.077145
T7	338473	6595240	Turbine	260	1276.34	1016.34024
T9	338364.6	6594397	Turbine	260	1251.674	991.6738502
T10	337854	6593964	Turbine	260	1232.356	972.3556934
T11	337532	6593412	Turbine	260	1249.51	989.5097483
T12	340014	6597494	Turbine	260	1323.507	1063.507227
T13	339635	6597942	Turbine	260	1320.588	1060.588331
T14	337718	6595842	Turbine	260	1279.546	1019.546275
T15	337867	6597269	Turbine	260	1246.296	986.2963981

WTG ID	Easting	Northing	Type	Height (m AGL)	Ground mAH	Overall height (m AHD)
T16	336629	6596361	Turbine	260	1241.268	981.2678882
T17	336574	6597065	Turbine	260	1242.348	982.3478492
T18	336850	6595039	Turbine	260	1297.219	1037.219174
T19	337401	6595420	Turbine	260	1317.27	1057.270036
T20	335739	6595504	Turbine	260	1241.599	981.5987316
T21	335940	6594542	Turbine	260	1219.644	959.6442745
T22	337676	6598098	Turbine	260	1269.641	1009.640522
T23	336942	6599833	Turbine	260	1330.077	1070.077357
T24	335882.9	6599958	Turbine	260	1347.176	1087.176084
T25	335768.3	6600449	Turbine	260	1314.017	1054.016539
T26	333549	6597099	Turbine	260	1220.444	960.4436288
T27	333137.2	6597539	Turbine	260	1212.04	952.0404772
T28	333131	6598418	Turbine	260	1261.811	1001.811142
T29	338740.1	6597656	Turbine	260	1291.137	1031.136642
T30	339527	6597038	Turbine	260	1310.223	1050.223193
T31	338989	6596546	Turbine	260	1277.55	1017.549755

WTG ID	Easting	Northing	Type	Height (m AGL)	Ground mAH	Overall height (m AHD)
T32	335555	6596610	Turbine	260	1210.434	950.4336438
T1	335660.7	6594107	Turbine	260	1198.078	938.0779723
	339685.9	6597063	Met Mast	80	1127.634	1047.633558

ANNEXURE 4 - RISK ASSESSMENT FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

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

Actions required

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

Table 4 Actions Required

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

ANNEXURE 5 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed time-frame for construction. 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 WTGs 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 WTGs, 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 Part 139 MOS 2019.

The characteristics of low and medium intensity obstacle lights specified in Part 139 MOS 2019, Chapter 9, are provided below.

Part 139 MOS 2019 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.*

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.33 outlines Characteristics of Medium Intensity Obstacle Lights.

1. *Medium-intensity obstacle lights must:*

   a. *be visible in all directions in azimuth; and*

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

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

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

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

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

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

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

Visual impact of night lighting

Annex 14 Section 6.2.4 and Part 139 MOS 2019 Chapter 9 are specifically intended for WTGs 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 WTGs 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 WMT were introduced in **Section 0** of this report.

Consideration could be given to marking any WMTs according to the requirements set out in Part 139 MOS 2019 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 WMTs 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 Part 139 MOS 2019 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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