UPDATED AVIATION IMPACT ASSESSMENT

Submissions Report – Appendix 8

Amendment Report – Appendix 13

May 2023

AVIATION IMPACT ASSESSMENT

LIVERPOOL RANGE WIND FARM

Prepared for Tilt Renewables Australia Pty Ltd as trustee for Liverpool Range Wind Farm Project

AVIATION PROJECTS

AVIATION PROJECTS

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

ERC-L	en-route chart low
ERSA	En Route Supplement Australia
GA	general aviation
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
LGA	local government area
LRWF	Liverpool Range Windfarm
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
PSR	primary surveillance radar
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RPT	regular public transport
RSR	route surveillance radar
SARPs	standards and recommended practices
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development
SSP	State Safety Programme
SSR	secondary surveillance radar
VFR	visual flight rules
VFRG	visual flight rules guide

VMC	visual meteorological conditions
WMTs	wind monitoring towers
WTGs	wind turbine generators

UNITS OF MEASUREMENT

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

DEFINITIONS

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

NOTES

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

EXECUTIVE SUMMARY

Introduction

Tilt Renewables Australia Pty Ltd as trustee for Liverpool Range Wind Farm Project (Tilt Renewables or Proponent), is seeking to modify the existing State Significant Development (SSD) approval (SSD 6696) for the Liverpool Range Wind Farm Project (the Project or LRWF).

The Project is located approximately 6 km east of Coolah township, 110 km south-west of Tamworth, and within the Warrumbungle Shire, Upper Hunter Shire, and Mid-Western Regional Council local government areas (LGA/s), New South Wales (NSW). The Proponent has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) to assess the potential aviation safety impacts associated with the Project to support the RTS Project application and formally consult with aviation agencies. The modification application will be submitted to the Department of Planning and Environment (DPE) for approval.

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

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting.

Project description

LRWF project was approved as a State Significant Development (SSD 6696) by the Minister of Planning on 27 March 2018. The approved LRWF project consists of up to 267 wind turbine generators (WTGs) with a maximum blade tip height of 165 m above ground level (AGL) and associated infrastructure (the Approved Project). The Approved Project includes an approximately 82 km long (30 km internal to wind farm site and 52 km external) 330 kilovolt (kV) transmission line from the wind farm to the proposed switching station at Ulan located within the Mid-Western Regional LGA.

In September 2022 Tilt Renewables made an application to DPE to modify the Project. The modification application sought approval for the construction and operation of 220 WTGs at a maximum height of 267m (Modified Project). The modification application was placed on public exhibition between 20 September to 17 October 2022, during which time 208 submissions were received from government agencies, stakeholder groups and individuals,

To address matters raised in submissions, further amendments have been made to Project design. The proposed changes include a decrease in the maximum blade tip height to 215 m AGL, a reduction in the maximum number of WTGs to 185, and various changes to the layout of the wind turbines and ancillary infrastructure (Response to Submissions (RTS) Project)).

In summary the RTS Project will comprise the following;

- up to a maximum of 185 WTGs
- maximum blade tip height of the WTGs of up to 215 m AGL
- highest elevation WTG is C18 with ground elevation of 1,092 m Australian Height Datum (AHD) and overall height of 1,311 m (4,301 ft above mean sea level (AMSL)), assuming a 215 m AGL maximum blade tip height plus a 5 m error buffer)

- up to 11 permanent wind monitoring towers (WMTs) with a maximum height of up to 169 m (554 ft) AGL, which will be reported to Airservices Australia once the final locations are confirmed prior to construction; and
- approximately 96 km x 330 kV transmission line, within the wind farm, and between the wind farm and Ulan switching station. The transmission poles or towers will be up to 60m AGL.

The Proponent has progressed planning approvals for 2 proposed temporary WMTs (one 140 m (459 ft) AGL tall and the other 110 m (361 ft) AGL tall). Both WMTs will be reported to Airservices Australia once the final locations are confirmed prior to construction.

Conclusions

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

Certified airports

1. The LRWF site is located within 30 nautical miles (nm) (55.56 km) (area used to identify possible constraints) from one certified airport – Coolah Airport (YCAH).
2. Coolah Airport (YCAH) is a certified, code 2, non-instrument approach runway, operated by Warrumbungle Shire Council.
3. For a Code 2 non-instrument runway the obstacle limitation surfaces extend up to 2,500 m, in this case, generally as a radius from the ends of the runways joined by tangents. Coolah Airport is located approximately 18 km (9.6 nm) west of the nearest RTS Project WTG (A1). Therefore, the RTS Project will not impact Coolah Airport's obstacle limitation surfaces (OLS).
4. Coolah Airport is not served by instrument or non-precision approach procedures therefore there are no procedures for air navigation services – aircraft operations (PANS-OPS) surfaces.
5. The Project is located beyond 30 nm from Coonabarabran Airport (YCBB), Dubbo Airport (YSDU), Mudgee Airport (YMDG), Quirindi Airport (YQDI), Scone Airport (YSCO) and Tamworth Airport (YSTW). Therefore, the Project will not impact on the operational airspace of these airports.

Aircraft Landing Areas (ALAs)

1. There are approximately 48 unregulated (i.e. not certified) aircraft landing areas (ALAs) within proximity to the proposed LRWF site. As a guide, an area of interest within a 3 nm radius of an ALA is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.
2. Further analysis based on a review of aerial imagery and OzRunways data identified that the majority of the ALAs were likely to be non-operational or located more than 3 nm from a WTG.
3. Additional searches on OzRunways, which sources its data from Airservices Australia, returned three uncertified aerodromes (YADU, OZDAK Dalkeith and OZTON Dalkeith) within close proximity to the LRWF site. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

4. Therefore, the ALA analysis is based on 11 ALAs located nearby the proposed RTS Project WTGs, including ALA 1, ALA 2, ALA 3, ALA 4, ALA 5, ALA 6, ALA 7, ALA 8, ALA 9, ALA OZDAK and ALA YADU. The key findings are:

    a. The Project will not impact ALA 5, ALA 6, ALA 7, ALA 8 and YADU approach and departure paths or the aerodromes' circuit operations. However, some of the proposed RTS Project WTGs are located within a 3 nm radius of ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA.

    b. It is unlikely aerodromes circuit operations and approach and take-off surfaces of ALA 1, ALA 3, ALA 4 and OZDAK ALA will be affected by the RTS Project.

    c. Circuit operations for ALA 2 and ALA 9 will be affected by the RTS Project. WTGs within 3 nm of ALA 2 would be considered as potentially hazardous obstacles for circuit operations

    d. According to National Airport Safeguarding Framework NASF (NASF) Guideline D - *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* guidance, the effects of wake turbulence could be noticeable at a distance of 16 times rotor diameter, or 2752 m from the proposed wind turbines. For the purpose of the wake turbulence analysis, a 172 m rotor diameter has been used. In this case, the effects of wake turbulence could potentially be noticeable at ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA, in the following circumstances:

        - while performing the southern right hand circuits at ALA 1
        - while departing to the south-east at ALA 2
        - when operating in the southern circuit at ALA 3
        - while departing to the north-west at ALA 4
        - while operating in the vicinity of ALA 9
        - when operating in the northern circuit at OZDAK ALA.

Air Routes and Lowest Safe Altitude

1. The LRWF site is located within 3 grid LSALTs. The grid LSALT where the highest RTS Project WTG (C18) is located is 1,646 m AHD (5,400 ft AMSL) with a minimum obstacle clearance (MOC) surface of 1,341 m AHD (4,400 ft AMSL). Therefore the grid LSALT will not be impacted by the highest RTS Project WTG C18.

Military operations

2. The LRWF site is located outside controlled airspace (wholly within Class G airspace), within the Restricted Area R559B, adjacent to the Restricted Area R559D and within the Danger Area D538B associated with Royal Australian Air Force (RAAF) Base Williamtown military restricted airspace.

3. All RTS Project WTGs within the Restricted Area R559B and adjacent to the Restricted Area R559D will be below the applicable vertical restriction limits (from 10,000 ft AMSL up to flight level 260). However, the proposed RTS Project WTGs are located within the Danger Area D538B, which is operated between surface and 10,000 ft AMSL. Low level military flight operations within Danger Area D538B will need to be conducted in consideration of the RTS Project WTGs.

Aviation Facilities

4. The RTS Project WTGs will not penetrate any protection areas associated with aviation facilities. The protection areas for the applicable aviation facilities (non-directional radio beacons – NDB) extend to a distance of 300 m.

Radar

5. The LRWF site is located in Zone 4 (accepted zone) and outside the radar line of sight of Mt Sandon secondary surveillance radar (SSR), Mt Boyce route surveillance radar (RSR), Williamtown tactical air command, Cecil Park SSR and primary surveillance radar (PSR), Sydney SSR and PSR, and the Round Mountain RSR, and will not interfere with the serviceability of these aviation facilities.

6. It is unlikely that the RTS Project will impact the Newcastle weather radar as the LRWF site is located beyond 100 km and will not impact the performance of this radar.

Aviation Impact Statement (AIS)

7. Based on the proposed RTS Project WTG layout and maximum blade tip height of 215 m AGL, the blade tip elevation of the highest wind turbine, which is C18, will not exceed 1,347 m (4,418 ft (AMSL) (allowing for an additional 5 m error buffer).

8. This AIS concludes that the RTS Project:

    a. will not penetrate any OLS surfaces

    b. will not penetrate any PANS-OPS surfaces (Coolah Airport is not served by instrument procedures)

    c. will not have an impact on nearby designated air routes

    d. will not have an impact on the grid LSALT..

    e. will not have an impact on operational airspace

    f. is wholly contained within Class G airspace, but within lateral extent of the Danger Area D538B. Low level military flight operations within Danger Area D538B will need to be conducted in consideration of the RTS Project WTGs.

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

Obstacle lighting risk assessment

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

10. Over the 10-year period between 2010-2019, no aircraft collided with a WTG or a WMT in Australia.

11. There is no regulatory requirement to mark or light power poles or overhead transmission lines.

12. Following consultation with local aerial application operators, if a risk assessment is required, the Proponent should follow standards outlined in the Australian Standards (AS) 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations*.

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.

Comparative assessment - Approved Project and RTS Project

1. An Aviation Impact Assessment (dated 9 February 2017) was prepared by REHBEIN Airport Consulting that assessed the potential aviation impacts related to the Approved Project. The REHBEIN Airport Consulting report assessed the potential aviation impacts associated with a 282 wind turbine layout and maximum blade tip height of 165 m AGL.
2. To understand the extent of change in potential aviation impacts associated with the Approved Project and the RTS Project, Aviation Projects completed a comparative assessment of the key findings of the REHBEIN Airport Consulting report and those set out this AIA.
3. The findings of this AIA are consistent with those of the REHBEIN Airport Consulting report.

Summary of key recommendations

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

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

1. Department of Defence should be consulted if there is any subsequent increase in the wind turbine height or scale of development to identify any potential impacts of this on military flying training within the Danger Area D538B.
2. To facilitate the flight planning of aerial application operators, the location and height of WTGs, WMTs 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.
3. 'As constructed' details of the coordinates and elevations of the WTGs and WMTs 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 LRWF site, particularly at ALAs 1, 2, 3, 4, 9 and OZDAK ALA, 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 so they can plan their operations accordingly.

6. The rotor blades, nacelles and towers of the WTGs should be painted in white, typical of most wind turbines operational in Australia to ensure they are visible to pilots during the day.

7. Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in Manual of Standards (MOS) Part 139 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8). Aviation marker balls and painting the top 1/3 of WMTs structures in red and white bands is considered to be an acceptable mitigation strategy.

1. INTRODUCTION

1.1. Situation

Tilt Renewables Australia Pty Ltd as trustee for Liverpool Range Wind Farm Project (Tilt Renewables or Proponent), is seeking to modify the existing State Significant Development (SSD) approval (SSD 6696) for the Liverpool Range Wind Farm Project (the Project or LRWF).

The Project is located approximately 6 km east of Coolah township, 110 km south-west of Tamworth, and within the Warrumbungle Shire, Upper Hunter Shire, and Mid-Western Regional Council local government areas (LGA/s), New South Wales (NSW).

The LRWF project was approved as a State Significant Development (SSD 6696) by the Minister of Planning on 27 March 2018 for the construction and operation of up to 267 wind turbine generators (WTGs) with a maximum blade tip height of 165 m above ground level (AGL) (the Approved Project).

Following a detailed layout review and design optimisation process the Proponent applied to modify the Approved Project in September 2022. The proposed modification sought to increase the maximum blade tip height to 250 m AGL (increase of 85 m), reduce the maximum number of wind turbines to 220 (reduction of 47) and various changes to the layout of the wind turbines and ancillary infrastructure (Mod-1 Project). The modification application was placed on public exhibition between 20 September to 17 October 2022, during which time 208 submissions were received from government agencies, stakeholder groups and individuals,

To address matters raised in submissions, the Proponent made further amendments to Project design. The main modification involves a reduction in the maximum number of wind turbines to 185 (further reduction of 35), reduction of the maximum blade tip height from 250 m AGL to 215 m AGL (reduction of 35 m) and various changes to the WTG layout (RTS Project).

The Proponent has engaged Aviation Projects to prepare an AIA for the RTS Project to support the modification application and formally consult with aviation agencies, before submitting the modification application to the Department of Planning and Environment (DPE) for approval.

Aviation Projects prepared a Phase 1 Preliminary Aviation Assessment for the Mod-1Project in April 2020.

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

The initial AIA that supported the original development application for the LRWF Project was prepared by REHBEIN Airport Consultancy dated 9 February 2017. This AIA provides a comparative assessment of the potential aviation impacts associated with the Approved Project and the RTS Project.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by the Civil Aviation Safety Authority (CASA), Airservices Australia and Department of Defence, and to progress any ongoing consultation through the modification application process.

The AIA specifically responds to the following key legislation, approvals, and guidance material:

- *Environmental Planning and Assessment Act 1979*

- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Conditions/sections of Development Consent SSD 6696, Director General's Requirements (DGRs), and Determination Assessment Report (Department of Planning and Environment, 2018)
- CASA, Advisory Circular AC 139.E-01v1.0, *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome, December* 2021
- NSW Government, Planning & Environment, Wind Energy Guideline, December 2016
- DPE Planning Secretary's Environmental Assessment Requirements (SEARS), SSD-24106966, issued 14 September 2021.

1.3. Methodology

Aviation Projects undertook this scope of works in accordance with the following methodology:

1. Confirmed the scope and deliverables.
2. Conducted a site visit on 9 June 2020 to properly investigate aviation safety aspects of the proposed LRWF site.
3. Included all relevant findings from the Phase 1 Preliminary Aviation Assessment (prepared for the Mod-1 Project).
4. Prepared a draft AIA and supporting technical data that provides evidence and analysis in support of the proposed modification application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators.
5. Assessed the following matters:
    a) the impacts of wind turbines and wind monitoring masts on flight procedures and aviation communications, navigation and surveillance (CNS) facilities, and radar operations
    b) departure and approach procedures for airfields
    c) the requirements for obstacle lights and markings on wind turbines and wind monitoring masts
    d) Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-05 v1.0 Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome
    e) Civil Aviation Safety Authority (CASA) MOS Part 139 Chapter 7 (Obstacle Restriction and Limitation) and Section 9.4 (Obstacle Lighting)
    f) PANS-OPS and OLS, and the ability to evaluate proposals with respect to these surfaces
    g) published air routes and way points
    h) EUROCONTROL guidelines on how to assess the potential impact of wind turbines on surveillance sensors.

6. Identified all potential adverse impacts to aviation services including all relevant flight activities and defence radar, communication and navigation facilities, and how these risks will be mitigated or managed through the siting and design of the wind farm, and avoidance/mitigation measures to be implemented during construction and operation phases.
7. The detailed aviation risk assessment addressed all potential aviation activities within the vicinity of the proposed wind farm including recreation, commercial, civil (including for agricultural purposes) and military operations.
8. Considered the potential impacts identified in Section 14.1 of the Environmental Assessment prepared by Epuron Pty Ltd and the Aviation Impact Assessment dated 9 February 2017 prepared by REHBEIN Airport Consulting and completed a comparative assessment of the potential aviation impacts associated with the Approved Project and the RTS Project.
9. Identified any additional approvals that are required for the LRWF project, if relevant and required
10. Consulted with Airservices Australia and the Department of Defence. CASA was not consulted in accordance with its stated position that it normally only responds to requests for review from planning authorities.
11. Consulted with Mid-Western Regional Council, Upper Hunter Shire Council and Warrumbungle Shire Council
12. Detailed any other matters relevant to the project
13. Finalised the AIA report upon receipt of responses from stakeholder consultation.

1.4. Aviation Impact Statement (AIS)

The AIS included in this report (see Section 7) 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 site
- 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 site and review potential impacts of Project operations on aircraft using those air routes
- Specify two waypoint names located on the routes which are located before and after the obstacles

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by the Proponent for preparation of this assessment include:

- Australian Bureau of Statistics, Local Government Areas, *ABS_Regional__Boundaries_LGA_shp*, dated April 2020
- Department of the Environment and Energy, EPBC Approval.pdf, received 2 April 2020
- NSW Government, *Department of Planning and Environment,* Assessment Report, 01. LRWF Assessment Report & Determination.pdf, dated March 2018
- NSW Government, *Department of Planning and Environment,* Development Consent, 08. Liverpool Range Wind - Assessment Report - Appendix G Conditions of Consent.pdf, dated 27 March 2018
- REHBEIN Airport Consulting, Liverpool Range Wind Farm Aviation Impact Assessment, Appendix F - Aviation Impact Assessment.pdf, dated 9 February 2017
- Tilt Renewables, LRWF Modified Turbine Layout_20220118.shp, received 21 January 2022
- Tilt Renewables, Transmission Line Route (Transmittal 16), *330kV Transmission Line Route - Primary Option_line.shp*, received 18 June 2020
- Tilt Renewables, Transmission Line Route, LRWF_330 kV OHL_20220119.shp, received 24 January 2022
- Tilt Renewables, Wind Monitoring Towers, LRWF - Engineering drawing - proposed 140 m Metmast.pdf, received 27 April 2020
- Tilt Renewables, *WMT Layout, LRWF_12_Indicative_Mast_Locations.shp*, received 18 June 2020
- Tilt Renewables, WMT Layout, LRWF - 110m Metmast.shp, received 27 April 2020
- Tilt Renewables, WMT Layout, LRWF 140m metmast point.shp, received 27 April 2020
- Tilt Renewables, WMT Layout, LRWF_Monitoring_PCV_Mast_20211201.shp, received 21 January 2022
- Tilt Renewables, Airstrips Lines, LRWF_*Airstrips_6Dec18_LINES_MGA55.shp*, received 2 April 2020
- Tilt Renewables, *Airstrips Points, LRWF_Airstrips_6Dec18_POINTS_MGA55.shp*, received 2 April 2020
- Tilt Renewables, LRWF Cadastre, *LRWF_Cadastre_191118_AREAS_MGA55.shp*, dated 18 November 2019
- Tilt Renewables, LRWF_Modified Development Corridor Wind Farm_20220118.shp, received 21 January 2022
- Tilt Renewables, Project boundary, *LRWF_Site_Boundary_APPROVED_27Mar18_MGA55.shp*, dated 27 March 2018.
- Tilt Renewables, Project boundary, LRWF_Modified_Site_Boundary_20220118.shp, received 21 January 2022
- Tilt Renewables, Turbine Coordinates and Elevations (Transmittal 23), LRWF_DT23_Turbine_coordinates_20201201.xlsx, received 09 December 2020

- Tilt Renewables, *20210507 LRWF Turbine Layout.xslx*, received 01 June 2021
- Tilt Renewables, LRWF_Modified Turbine Layout_20220118.xlxs, received 21 January 2022
- Tilt Renewables, LRWF_RTS_L8_185WTG_Elevation_20230303.shp, received 16 March 2023
- Tilt Renewables: LRWF_Modified_Site_Boundary_RTS_20230427.shp, received 2 May 2023
- Tilt Renewables: LRWF_Internal_330kV_Transmission_Line_20230501.shp, received 4 May 2023
- Tilt Renewables: LRWF_Internal_330kV_Transmission_Line_Structure_Point_20230501.shp, received 4 May 2023
- Tilt Renewables: LRWF_Modified Turbine Layout_L8_185WTG_20230501.shp, received 4 May 2023
- Tilt Renewables: LRWF_RTS_Modified Turbine Layout_L8_185WTG_Spreadsheet_20230501.xlsx, received 4 May 2023

2. BACKGROUND

2.1. Site overview

The LRWF site is located to the east of the rural town Coolah and approximately 198 km (107 nm) north-west of Newcastle, within the Central West and Orana region, New South Wales. The LRWF site, which includes the proposed 330 kV transmission line to Ulan, extends across the Warrumbungle Shire, Upper Hunter Shire, and Mid-Western Regional local government areas (LGAs).

An overview of the LRWF site and the RTS Project WTG layout relative to nearby townships and LGAs is provided in Figure 1 (source: Tilt Renewables, Google Earth).

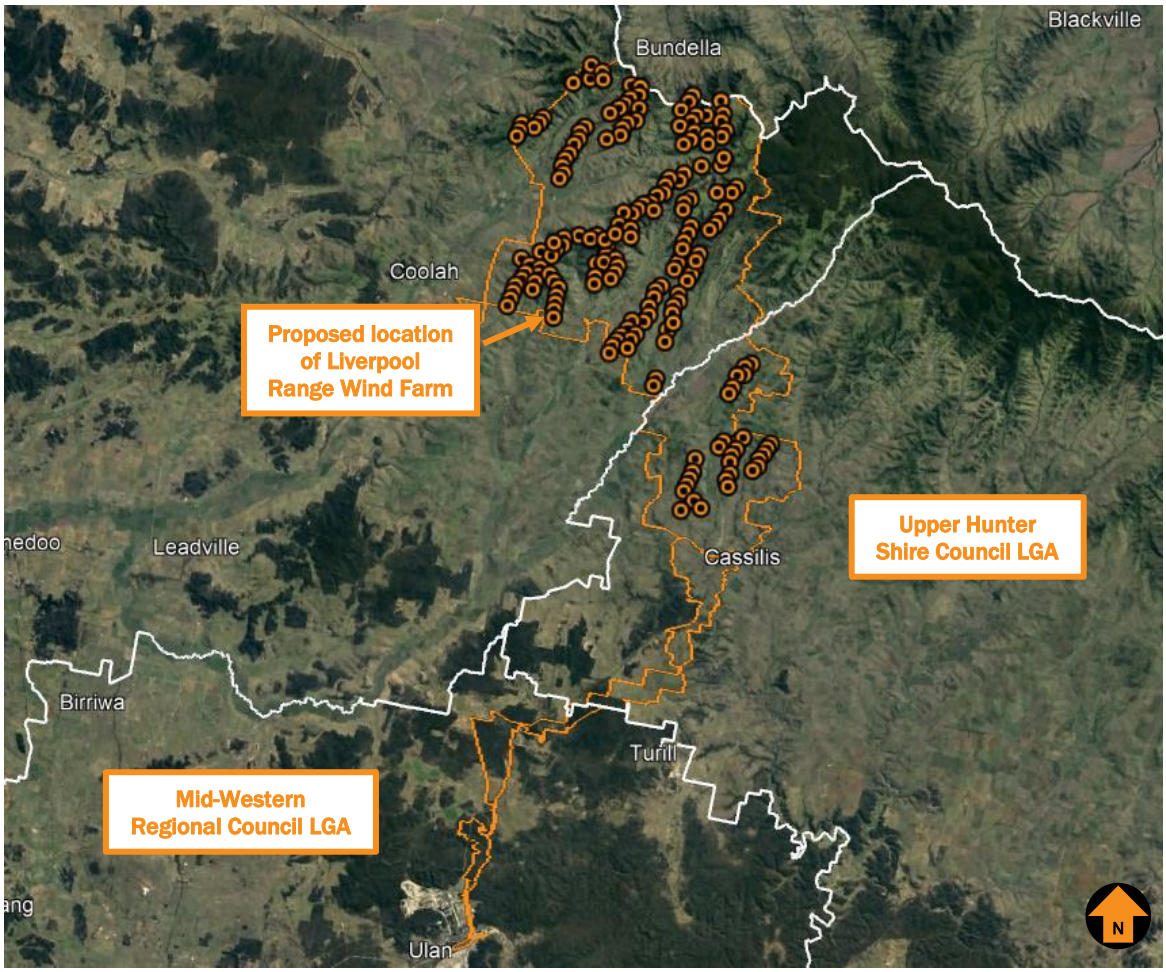

Figure 1 Overview of the LRWF site and RTS Project WTG layout

2.2. Project chronology

On 27 March 2018 the LRWF project was granted development approval as SSD ((SSD 6696) for the construction and operation of up to 267 turbines with a maximum blade tip height of 165 m AGL, under Section 4.38 of *the Environmental Planning & Assessment Act 1979*. The relevant conditions of consent specified in Development Consent SSD 6696 (Schedule 3) are as follows:

AVIATION

Mitigation of Aviation-Related Impacts

32. The Applicant must carry out the development in accordance with the National Airports Safeguarding Framework Guideline D: Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers, or its latest version.

Notification of Aviation Authorities

33. Prior to the construction of any wind turbine or wind monitoring mast, the Applicant must provide the following information to CASA, Airservices Australia, and the RAAF (together the authorities):

(a) co-ordinates in latitude and longitude of each wind turbine and mast;

(b) the final height of each wind turbine and mast in Australian Height Datum;

(c) ground level at the base of each wind turbine and mast in Australian Height Datum;

(d) confirmation of compliance with any OLS; and

(e) details of any proposed aviation hazard lighting.

34. Within 30 days of the practical completion of any wind turbine or mast, the Applicant must:

(a) provide confirmation to the authorities that the information that was previously provided remains accurate; or

(b) update the information previously provided.

Aerial agricultural activities

35. The owner of any property immediately adjacent to the site may ask the Applicant, to implement mitigation measures for situations where pre-existing aerial agricultural activities are affected by the erection and/or operation of wind turbines.

These mitigation measures must be reasonable and feasible, aimed at reducing the impacts to aerial agricultural activities, and commensurate with the level of impact on the owner. This could include funding the cost difference between the pre-development aerial agricultural activities and a reasonable alternative method and/or stopping wind turbines during aerial agricultural activities and aligning them as required by the aerial operator.

If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

2.3. Comparative assessment of the Approved Project and RTS Project

To support the original development application REHBEIN Airport Consulting prepared the *Liverpool Range Wind Farm Aviation Impact Assessment, Appendix F - Aviation Impact Assessment*, dated 9 February 2017. The REHBEIN Airport Consulting report assessed the potential aviation impacts associated with a 282 wind turbine layout with a maximum blade tip height of 165 m AGL.

To support the modification application and to understand the extent of change in potential aviation impacts associated with the Approved Project and RTSProject, Aviation Projects has completed a comparative assessment of the key findings of the REHBEIN Airport Consulting report and those set out this AIA.

The key findings of the REHBEIN Airport Consulting assessment are reproduced below, verbatim:

> *...on the basis of this preliminary investigation, to pose a hazard to aviation. REHBEIN Airport Consulting have assessed that aviation obstacle lighting on the wind turbines is unlikely to be required however CASA will ultimately make a determination in relation to lighting requirements.*
>
> *The proposed wind farm will not impact upon aircraft operations to and from nearby registered and certified aerodromes such as Coolah, Mudgee, Quirindi or Tamworth airports. Nor will it interfere with airborne radio, Radar or navigation aid performance.*
>
> *Analysis undertaken by REHBEIN Airport Consulting indicates that there will be no impact upon IFR traffic transiting the area on routes W619, W326, V316, H66, W359 and W627. Traffic operating under the VFR should not be affected by the proposed wind farm as the structures will be sufficiently conspicuous by day, and en-route LSALTs will provide adequate clearance from the turbines for Night VFR operations.*
>
> *Investigation undertaken by REHBEIN Airport Consulting suggests the impact of the proposed wind farm upon radar and radio performance in the region, if any, will not be of operational significance.*
>
> *Analysis suggests that there will be no adverse impact upon aerial agricultural operations further than 1km from any wind turbines.*
>
> *Low level flying operations, such as aerial agricultural operations, will be affected within the wind farm site and in the immediate vicinity (1km) of the wind turbine locations.*
>
> *The wind farm development is not likely to adversely affect hang gliding operations within the vicinity of Tamworth, as hang gliding is conducted during daylight hours when turbines are clearly visible and are not conducted when winds in the area are from the north east, as these conditions are unsuitable for hang gliding.*

As detailed in **Section 6** the findings of this AIA are for the most part consistent with those of the REHBEIN Airport Consulting report, dated 9 February 2017.

3. EXTERNAL CONTEXT

3.1. Planning context

The Proponent seeks to increase wind power production while protecting individuals, communities and the environment from potential adverse impacts from wind farms by complying with the NSW *Wind Energy Guideline for State significant wind energy development* (DPE, 2016).

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

The project-specific Secretary's Environmental Assessment Requirements (SEARS) issued for the Project in relation to Aviation Safety considerations include:

> ***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. National Airports Safeguarding Framework

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

- the implementation of best-practice in relation to land use assessment and decision making in the vicinity of airports
- assurance of community safety and amenity near airports

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

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

3.3. Warrumbungle Shire Council

The *Warrumbungle Shire Local Environment Plan 2013* (Warrumbungle LEP, dated 9 May 2023) does not include provisions for airfields, aerodromes or airports.

The *Warrumbungle Shire Council Development Control Plan 2015* (amendment 16 February 2017) does not have any provisions nor protections for aerodromes, airports or airfields.

3.4. Upper Hunter Shire Council

The *Upper Hunter Local Environmental Plan 2013* (Upper Hunter LEP, dated 9 May 2023) includes provisions for airspace operations at Scone Airport (YSCO). Section 6.7 Airspace operations details the following:

> *(1) The objectives of this clause are as follows—*
>
> > *(a) to provide for the effective and ongoing operation of the Scone Memorial Aerodrome by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or Operations Surface for that airport,*
> > *(b) to protect the community from undue risk from that operation.*
>
> *(2) If a development application is received and the consent authority is satisfied that the proposed development will penetrate the Limitation or Operations Surface, the consent authority must not grant development consent unless it has consulted with the relevant Commonwealth body about the application.*
>
> *(3) The consent authority may grant development consent for the development if the relevant Commonwealth body advises that—*
>
> > *(a) the development will penetrate the Limitation or Operations Surface but it has no objection to its construction, or*
> >
> > *(b) the development will not penetrate the Limitation or Operations Surface.*
>
> *(4) The consent authority must not grant development consent for the development if the relevant Commonwealth body advises that the development will penetrate the Limitation or Operations Surface and should not be constructed.*

Refer to Figure 2 for a map depicting the obstacle limitation surface for Scone Airport.

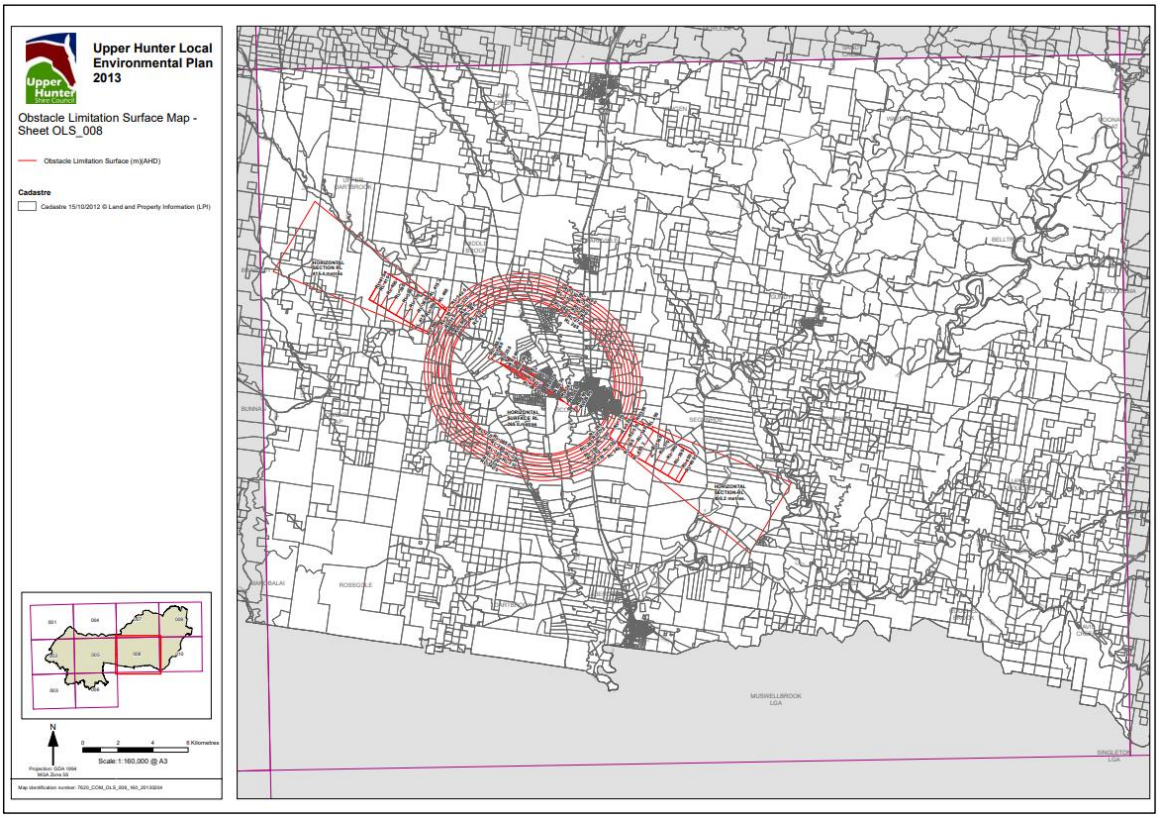

Figure 2 Scone Airport (YSCO) obstacle limitation surface

The LRWF site is located approximately 90 km north-west of Scone Airport, and as such is located outside of the 30 nm assessment area associated with Scone Airport. Therefore, the RTS Project will have no impact on the airspace associated with Scone Airport.

3.5. Mid-Western Regional Council

The *Mid-Western Regional Development Control Plan 2013* (amendment No 5, commencement 18 September 2020) addresses land adjacent to Mudgee Airport. The LRWF site is located approximately 90 km north-east of Mudgee Airport, and as such is located outside of the 30 nm assessment area associated with Mudgee Airport. The RTS Project will have no impact on the airspace associated with Mudgee Airport.

The *Mid-Western Regional Local Environmental Plan 2012* (Mid-Western LEP, dated 01 December 2021), includes provisions for the protection of airspace surrounding Mudgee Airport, including protections on the Obstacle Limitation Surfaces. Section 6.8 Airspace Operations – Mudgee Airport, details the following:

> *(1) The objectives of this clause are as follows—*
>
> > *(a) to provide for the effective and ongoing operation of the Mudgee Airport by ensuring that such operation is not compromised by proposed development that penetrates the Limitation or*

Operations Surface for that airport,
(b) to protect the community from undue risk from that operation.

(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.

(5) In this clause—

***Limitation or Operations Surface** means the Obstacle Limitation Surface or the Procedures for Air Navigation Services Operations Surface as shown on the Obstacle Limitation Surface Map or the Procedures for Air Navigation Services Operations Surface Map for the Mudgee Airport.*

***Relevant Commonwealth body** means the body, under Commonwealth legislation, that is responsible for development approvals for development that penetrates the Limitation or Operations Surface for the Mudgee Airport.*

The LRWF site is located approximately 90 km northeast of Mudgee Airport, and as such is located outside of the 30 nm assessment area associated with Mudgee Airport. Therefore, the RTS Project will have no impact on the airspace associated with Mudgee Airport.

3.6. Dark Sky Region in NSW

It is noted that the LRWF site is located approximately 100 km south-east of the Siding Springs Observatory within a Dark Sky Region in NSW, and subject to the local controls for lighting and consultation requirements set out in the NSW Dark Sky Planning Guideline: *Protecting the observing conditions at Siding Springs* (Department of Planning and Environment, June 2016).

3.7. Civil Aviation Safety Authority

The following CASA publications inform pilots of their obligations at non-certified ALAs in uncontrolled airspace.

3.7.1. Advisory Circular (AC) 91-02 V1.1, Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land, dated November 2021

This Advisory Circular (AC) provides guidance for pilots of:

- Aeroplanes with maximum take-off weight (MTOW) not exceeding 5 700 kg that are operated under Part 91 of CASR, including experimental aircraft, and

- Light sport aircraft (LSA) under Part 103 of CASR.

  "Purpose

  This AC provides guidance to assist pilots when making a determination about the suitability of a place for an aeroplane to safely take off and land. It provides an overview of the pilot's responsibilities and discusses some, but not all, circumstances, including prevailing weather conditions, that are recommended to be considered. It also provides general information and advice to enhance the safety of taking off and landing at any place.

  2 Introduction

  2.2 Use of Aerodromes

  2.2.1 Regulation 91.410 authorises a place for use as an aerodrome if: (i) it is suitable for the landing and taking-off of aircraft; and (ii) an aircraft can land at or take off from the place safely, having regard to all the circumstances of the proposed landing or take-off (including the prevailing weather conditions).

  3.3 Performance Information

  3.3.1 The AFM, POH, owner's manual or placarding should provide relevant performance information, but presentations are not standardised. Learning how to find and interpret a particular aircraft's performance information should be part of a pilot's familiarisation with the aeroplane.

  4 Information about aerodrome publications

  4.1.3 There are no standards for aerodromes that are not certified (listed in the En Route Supplement Australia (ERSA) as an uncertified aerodrome), but noting regulation 91.410 requires the aerodrome to be suitable. CASA has published recommended criteria for landowners or operators of these aerodromes, but these recommendations are guidelines only.

  The ERSA only provides limited information for uncertified aerodromes and these aerodromes are not subject to NOTAM action, except in certain circumstances (refer to the ERSA for further details).

  Take-off and landing guides are also commercially available which provide information for pilots about many aerodromes not included in the ERSA. Pilots should note that the information in these guides may not be subject to regular updating, and these aerodromes are not supported with NOTAM information. Pilots should therefore consider ways of mitigating the risk of such a document's information being out of date or inaccurate.

  The examples below are two of many possible considerations:

  – the obstacles surrounding the aerodrome have been accurately described and are still current (e.g. have the trees on final grown taller since last reported), and

  – the information provided enables the pilot to judge whether or not a landing approach can be made from both runway directions.

  Pilots and operators must consider ownership and management requirements for aircraft operations into any aerodrome. Unless a landing place is unambiguously open for public use for aviation purposes, the pilot should assume that permission is required from the land owner or occupier before using land or water for take-off and landing."

3.7.2. AC 91-10 v1.1, Operations in the vicinity of non-controlled aerodromes, date November 2021

This AC provides guidance on procedures that, when followed, will improve situational awareness and safety for all pilots when flying at, or in the vicinity of, non-controlled aerodromes.

> *"2 Introduction*
>
> *2.1.3 This AC provides guidance on procedures that, when followed, will improve situational awareness and safety for all pilots when flying at, or in the vicinity of, non-controlled aerodromes.*
>
> *4 Related safety actions at non-controlled aerodromes*
>
> *4.1.1 Subdivision D.4.6 of CASR Part 91 (prescribes the requirements for operating in the vicinity of a non-controlled aerodrome. Prior to flight, pilots should consult the current ERSA and NOTAMs to ascertain whether carriage of radio is required, special circuit procedures apply or, in the case of NOTAMs, whether the information contained within the ERSA has been modified.*
>
> *4.1.5 Prior to operating at any non-controlled aerodrome, pilots should satisfy themselves that it is suitable for their operation by reference to ERSA, other commercial aerodrome guides, the company operations manual or by contacting the aerodrome operator.*
>
> *7.2 Traffic circuit direction*
>
> *7.2.1 The standard aerodrome traffic circuit facilitates the orderly flow. Unless an alternative requirement for an aerodrome is stated in the ERSA or NOTAMs, all turns must be made to the left (regulation 91.385).*
>
> *7.2.2 When arriving at an aerodrome to land, the pilot will normally join the circuit on upwind, crosswind (midfield), or at or before mid-downwind. Landings and take-offs should be made on the active runway or the runway most closely aligned into wind.*
>
> *7.2.3 If a secondary runway is being used (e.g. for crosswind or low-level circuits), pilots using the secondary runway should not impede the flow of traffic using the active runway.*
>
> *7.2.4 Aerodromes that have right-hand circuits are listed in the ERSA.*
>
> *7.4 Circuit Heights*
>
> *7.4.1 By convention, aircraft should fly the standard traffic circuit at the heights shown.*
>
> *7.4.2 During initial climb-out, the turn onto crosswind should be appropriate to the performance of the aircraft but, in any case, not less than 500 ft above terrain so as to be at circuit height when turning downwind (regulation 91.390). Pilots may vary the size of the circuit depending on:*
>
> *– the performance of the aircraft*
>
> *– AFM/Pilot's Operating Handbook requirements*
>
> *– company standard operating procedures*
>
> *– other safety reasons.*
>
> *7.7 Final approach*
>
> *7.7.1 The turn onto final approach should be:*

– *completed by a distance and height that is common to all operations at the aerodrome*

– *commensurate with the speed flown in the circuit for all aircraft of the same type.*

3.8. Aircraft operations at non-controlled aerodromes

There are several uncontrolled aerodromes in the vicinity of the LRWF area. Advisory Circulars (As) provide advice and guidance from CASA to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements. AC 91-10 v1.1 *Operations in the vicinity of non-controlled aerodromes* provides guidance for pilots flying at or in the vicinity of non-controlled aerodromes, with respect to CASR 91.

A conventional circuit pattern and heights are provided in AC 91-10 v1.1. 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 provided in AC 91-10 v1.1. are shown in Figure 3 and Figure 4

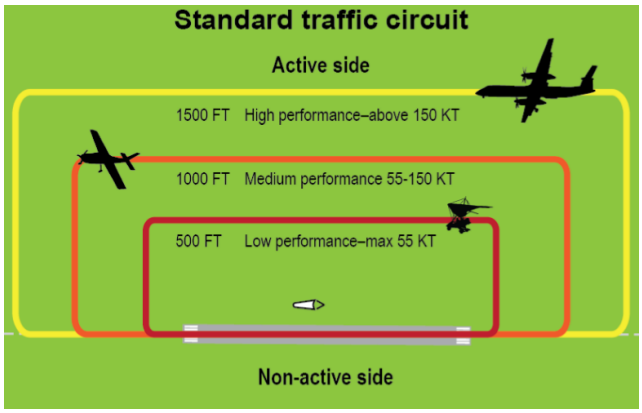

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

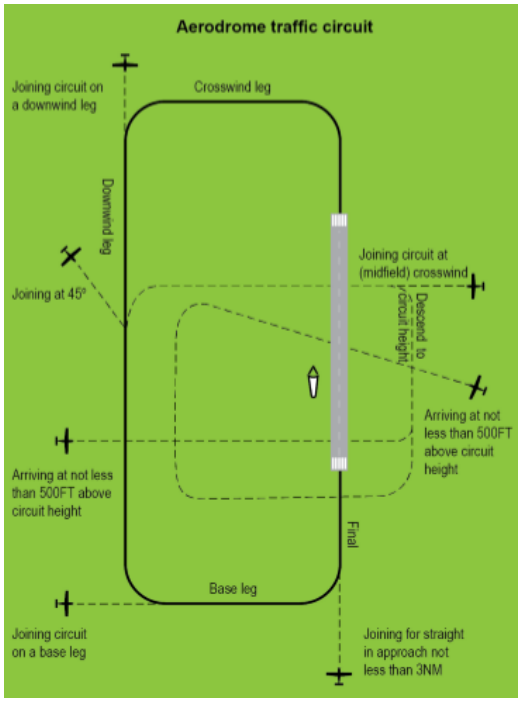

Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures.

AC 91-10 v1.1. paragraph 7.10 refers to a distance that is "normally" well outside the circuit area and where no traffic conflict exists, which is at least 3 nm The paragraph is copied below:

> *7.10 Departing the circuit area*
>
> *7.10.1 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 (Day VFR)

According to Australia's Aeronautical Information Package (AIP) the meteorological conditions required for visual flight in the applicable (class G) airspace at or below 3,000 ft AMSL or 1,000 ft AGL (whichever is the higher) are: 5,000 m visibility, clear of clouds and in sight of ground or water.

Civil Aviation Safety Regulation (1998) 91.267 (Minimum height rules—other areas) prescribes the minimum height for flight. Generally speaking, and unless otherwise approved, 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 300 m in visual flight during the day when not in the vicinity of built-up areas, and 1000 ft AGL over built up areas (within a horizontal radius of 600 m of the point on the ground or water immediately below the aeroplane).

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

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

3.9.2. Flight under Night Visual Flight Rules (Night VFR)

With respect to flight under the VFR at night, Civil Aviation Safety Regulations (1998) 91.277 requires that the pilot in command of an aircraft flying VFR at night must not fly below the following heights (unless during take-off and landing operations, within 3 nm of an aerodrome, or with an air traffic control clearance):

a) *the published lowest safe altitude for the route or route segment (if any);*

b) *the minimum sector altitude published in the authorised aeronautical information for the flight (if any);*

c) *the lowest safe altitude for the route or route segment;*

d) *1,000 ft above the highest obstacle on the ground or water within 10 nautical miles ahead of, and to either side of, the aircraft at that point on the route or route segment;*

e) *the lowest altitude for the route or route segment calculated in accordance with a method prescribed by the Part 91 Manual of Standards for the purposes of this paragraph.*

3.9.3. Flight under Instrument Flight Rules (Day or Night) (IFR)

According to CASR 91, 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 IFR or visual flight rules (VFR). Other general aviation operations under either IFR or VFR, during the day or at night, are also likely to be conducted at various aerodromes in the area.

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines). During the day, the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. Day VFR operators will most likely avoid the LRWF site once wind turbines are erected.

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

Given the irregular shape, height, and off-white colour of the WTGs, it is expected that the WTGs will be sufficiently visually conspicuous to pilots conducting day VFR operations within the vicinity of the LRWF site 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

Scheduled and non-scheduled passenger transport 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 in areas outside city and township built-up areas.

3.13. Military operations

There may be some high-speed low-level military jet aircraft and helicopter operations conducted in the area. Military operations are conducted under separate but compatible regulations and standards, including obstacle separation requirements.

Refer to Section 6 for a detailed response from Department of Defence.

3.14. Aerial application operations

Aerial application operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL, usually between 60 ft and 100 ft AGL.

Aerial application operations are conducted in the area.

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

The Aerial Application Association of Australia (AAAA) has a formal risk management program (which is recommended for use by its members) to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

The impact of the proposed WTGs on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the LRWF site was assessed.

3.14.1. Aerial Agricultural Association of Australia (AAAA)

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

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

3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;

4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and

5. adequately marked any wind farm infrastructure and advised pilots of its presence.

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

At the development stage, AAAA remains strongly opposed to all windfarms that are proposed to be built on agricultural land or land that is likely to be affected by bushfire. These areas are of critical safety importance to legitimate and legal low-level operations, such as those encountered during crop protection, pasture fertilisation or firebombing operations.

However, AAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAA has developed the following national operational protocols to support a consistent approach to aerial application where windfarms are in the operational vicinity.

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

3.14.2. 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 for other wind farm projects undertaken by Aviation Projects, and the results of consultation with AAAA and local aerial application operators, it is reasonable to conclude that safe aerial application operations would be possible on properties within the Project site and on neighbouring properties, subject to final WTG locations and by implementing recommendations provided in this report at Section 11.

To facilitate the flight planning of aerial application operators, details of the Project, including location and height information of WTGs, wind monitor towers (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 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.

3.15. Emergency Services

3.15.1. Royal Flying Doctor Service

Royal Flying Doctor Service (RFDS) and other emergency services operations are generally conducted under the IFR, except when arriving/departing a destination that is not serviced by instrument approach aids or procedures, in which case they would be operating day or night VFR.

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.

3.15.2. Aerial Firefighting

Aerial firefighting operations (firebombing in particular) are conducted under 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.*

4. INTERNAL CONTEXT

4.1. Wind farm description

The LRWF site is situated in an area comprised mainly of farming properties on a varied topography ranging from gently rolling hills to deeply incised valleys and steep ridgelines. The wind farm site is located adjacent to west of the Coolah Tops National Park and is access via Vinegaroy Road and a series of local roads including Coolah Creek Road and Pandora Pass Road. The Golden Highway is located at the southern end of the wind farm site. The proposed 330 kV transmission line generally extends from the wind farm site southwards and terminates at the proposed connection point into the national grid at Ulan.

Figure 5 shows a view looking south-east from Pandoras Pass Road towards the LRWF site.

Figure 5 Pandoras Pass Road looking south east towards the LRWF site

Figure 6 shows a view looking north from Coolah Creek Road, towards the Project site.

Figure 6 Coolah Creek Road looking north towards the LRWF site

Figure 7 shows a view looking east off Coolah Creek Road towards the LRWF site.

Figure 7 Coolah Creek Road looking east towards the LRWF site

Figure 8 shows a view looking north and east from Cassilis Road looking towards the LRWF site.

Figure 8 Cassilis Road looking north towards the LRWF site

Figure 9 shows a private runway (ALA 8), which is located off Mullaley-Coolah Road, Coolah and in proximity to the LRWF site. Aviation Projects was informed during the site visit that this runway is used fairly often by local pilots. The runway is not certified, and the runway is not listed in OzRunways.

Figure 9 Private runway located off Mullaley-Coolah Road in Coolah

4.2. Wind turbine generator (WTG) description

The RTS Project proposes a maximum WTG blade tip height of up to 215 m AGL. The highest elevation WTG is C18, located in the northeast portion of the site adjacent to Coolah Tops National Park. The maximum ground elevation for the proposed WTG C18 is 1,091 m AHD, which results in a maximum overall height of 1,311 m AHD (4,301 ft AMSL) (i.e. ground elevation plus 215 m blade tip height, plus a 5 m error budget).

Figure 10 shows the RTS Project WTG layout, with the highest elevation WTG highlighted in red colour (source: Tilt Renewables, Google Earth).

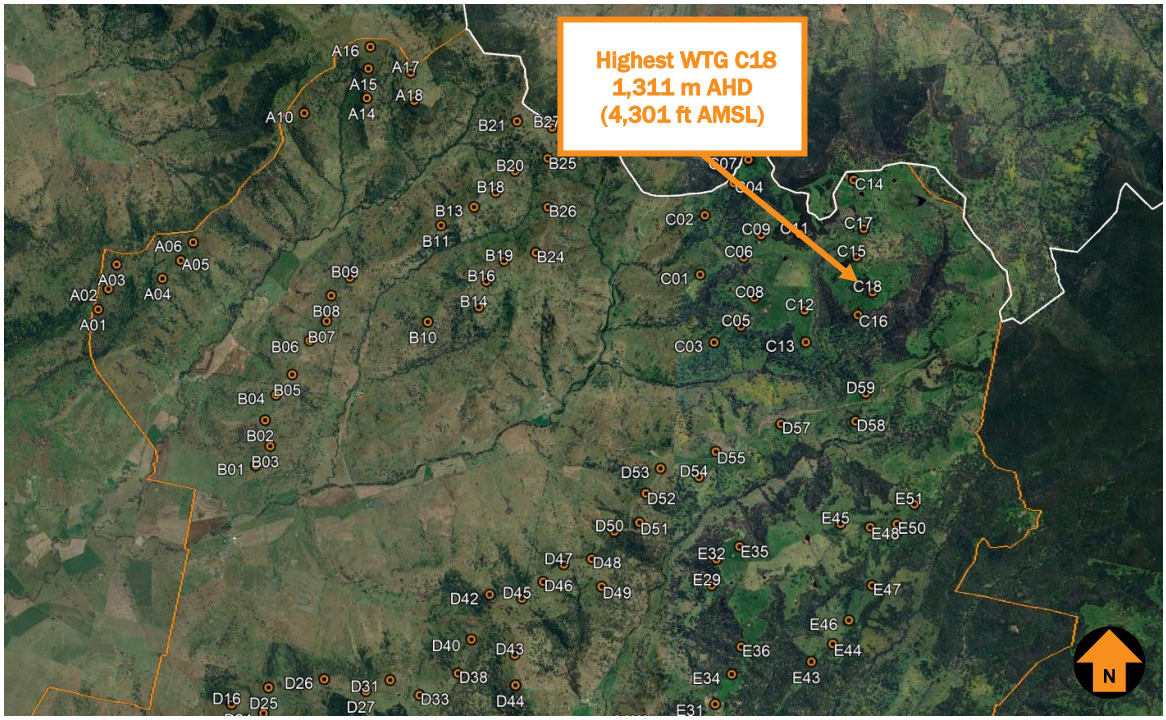

Figure 10 Proposed RTS Project WTG layout and highest elevation WTG (C18)

The Development Consent SSD 6696 allows for micrositing of WTGs by not more than 100 m and any consequential changes to access tracks and internal power cable routes. The potential micrositing of the WTGs 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 WTG position. This AIA assumes that a maximum blade tip height of 215 m AGL is implemented at all WTG locations. The coordinates and ground elevations of the RTS Project WTGs are listed in **Annexure 5.**

4.3. Temporary WMTs (already approved)

The Proponent successfully obtained separate development approvals in 2020 from the Warrumbungle Shire Council for the installation of two temporary WMTs, with a maximum height of 140 m AGL (WMT 1) and 110 m AGL (WMT 2). These two temporary WMTs therefore do not form part of the RTS Project.The details of these temporary WMTs are included here simply for context.

The design of the two temporary WMTs are lattice steel towers that are supported by guy wires anchored to the ground and attached at several levels on the WMT tower and which radiate out from the tower in three equidistant directions. WMT 1 has already been constructed, and WMT 2 is scheduled was constructed in April/May 2021.

The details of the two temporary WMTs are provided in Table 1 (source: Tilt Renewables).

Table 1 Temporary wind monitoring tower (WMTs) details

Details	*WMT 1 Mast*	*WMT 2 Mast*
Location (Easting, Northing)	770580, 6476690	772543, 6487106
Ground elevation at site (approximate)	915 m AHD (3,002 ft AMSL)	969 m AHD (3,179 ft AMSL)
Height of tower AGL	140 m (459 ft)	110 m (361 ft)
Height of tower AHD	1,055 m AHD (3,461 ft AMSL)	1,079 m AHD (3,540 ft AMSL)
Lighting	Nil	Nil
Marking	Aviation marker balls and Paint markings to top third	Aviation marker balls and Paint markings to top third
Design	Triangular galvanised lattice structure	Triangular galvanised lattice structure
Construction date	14 October 2020	May 2021
Reported to Airservices Australia (AsA)	Yes	Yes

The highest overall ground level for the temporary WMTs is approximately 969 m AHD (WMT 2), resulting in a maximum overall height of 1,079 m AHD (3,540 ft AMSL).

The height details of the constructed WMT 1 and WMT 2 have been notified to Airservices Australia for entry into Vertical Obstruction Database (VOD).

Figure 11 shows the location of the two proposed temporary WMTs as white triangles (source: Tilt Renewables, Google Earth).

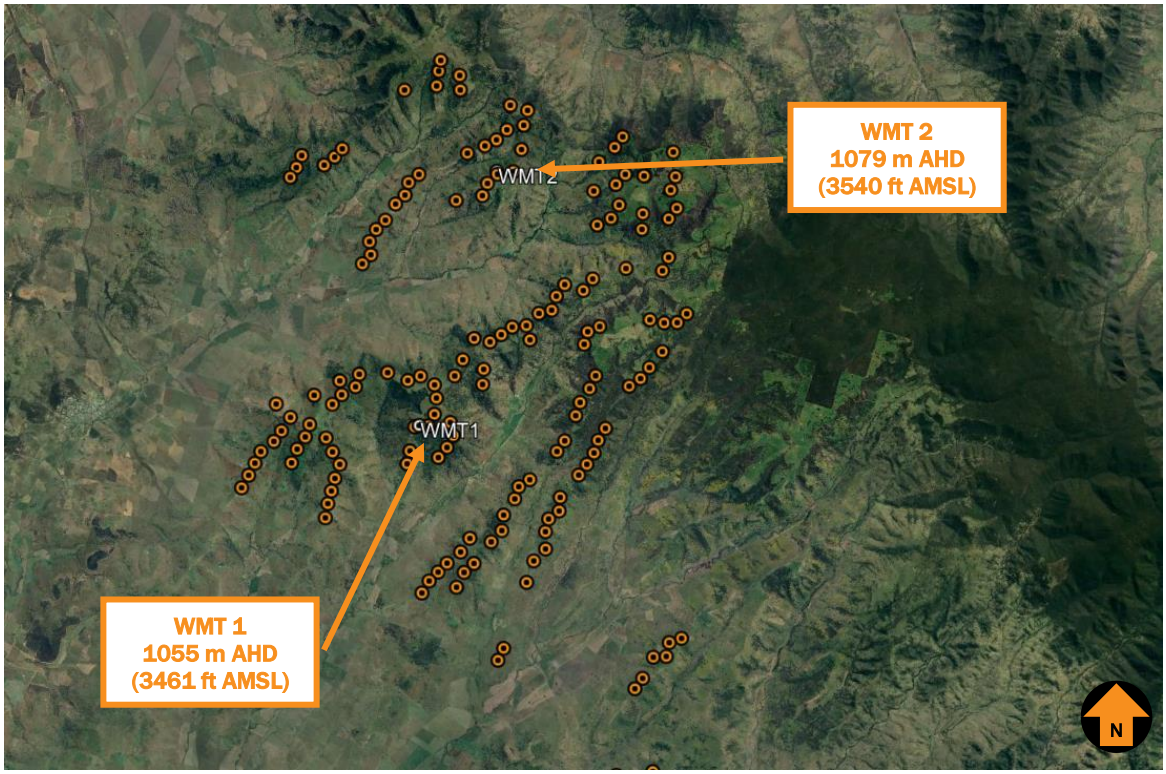

Figure 11 Proposed temporary wind monitoring towers (WMTs)

4.4. Permanent WMTs (forming part of RTS Project)

The Proponent is also proposing to install up to 11 permanent wind monitoring towers (WMTs) with a maximum height of up to 169 m (554 ft) AGL.

The Mod-1 Project sought approval for the installation of up to 14 WMTs at 40 indicative locations. Since then, design has continued to evolve and the RTS Project now seeks approval for up to 11 permanent WMTs.

The proposed location of the WMTs is shown in Figure 12. (Source: Tilt Renewable, Google Earth).

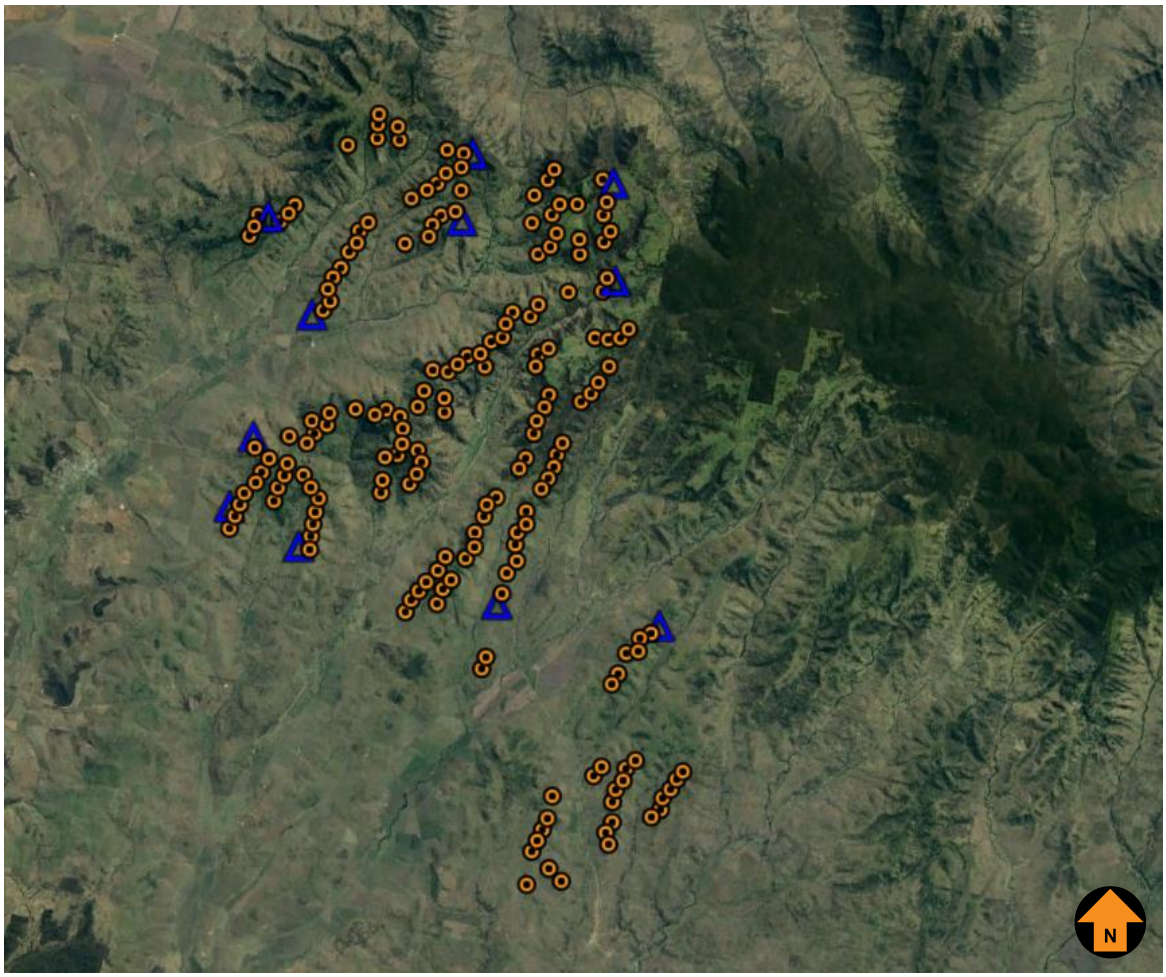

Figure 12 Indicative locations of the 11 shortlisted permanent WMTs and other proposed locations

4.5. Grid transmission alignment

The RTS Project includes the provision of a 330 kV transmission line which would connect the on-site wind farm collector substations to the wider grid network at the proposed switching station at Ulan. It is anticipated that the transmission line will be supported by poles (approximately 50 m AGL) or towers (approximately 60 m AGL), and generally spaced at approximately 300 m intervals.

The transmission line is proposed to follow the approved route between the wind farm and the proposed switching station at Ulan. The transmission line will extend through Warrumbungle Shire, Upper Hunter Shire, and Mid-Western Regional LGAs.

Figure 13 shows the RTS Project WTG layout and proposed transmission line route in magenta (source: Tilt Renewables, Google Earth).

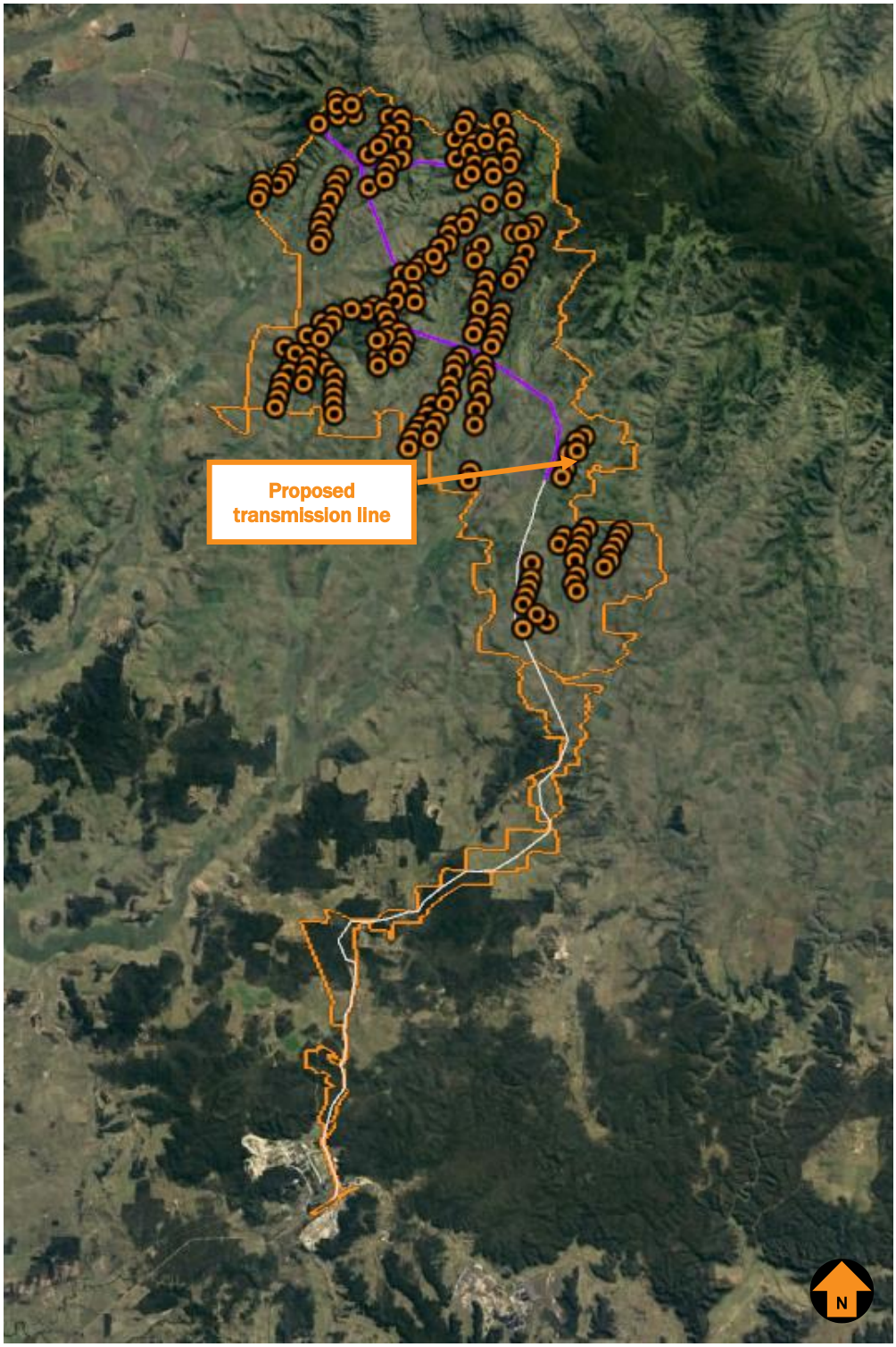

Figure 13 Proposed transmission line route

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

- Airservices Australia
- aerial operators
- aerodrome/ALA operators (Warrumbungle Shire Council/private ALAs)
- Department of Defence
- Mid-Western Regional Council
- Royal Flying Doctor Service
- Upper Hunter Shire Council
- Westpac Life Saver Rescue Helicopter Service
- NSW National Parks and Wildlife Services (NPWS)
- Yancoal Coal Mine (Ulan)

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

Note: There is no Regular Public Transport (RPT) services to/from Coolah Airport.

Table 2 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	30 June 2020 Email to Airport Developments	24 September 2020 Email from Mr William Zhao (Advisor Airport Development)	During initial consultation Aviation Projects advised Airservices Australia about the Modified Project. In an email response dated 24 September 2020, Mr William Zhao (Advisor Airport Development) advised the following: ***Airspace Procedures*** *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum turbine height of 1349m (4426ft) AHD, the proposed wind farm, including wind mast, will not affect any sector or circling altitude, nor any instrument approach or departure procedure at any nearby aerodromes. It will also not affect any overhead air routes.* *Note that procedures not designed by Airservices at any nearby aerodromes were not considered in this assessment.* ***Communications/Navigation/Surveillance (CNS) Facilities*** *This wind farm, to a maximum height of 1349m (4426ft) AHD, will not adversely impact the performance of Precision/Non-Precision Navigational Aids, HF/VHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.* ***Grid lowest safe altitude (LSALT)*** *Assessment of the wind farm shows that the following wind turbine will penetrate the published Grid LSALT:*	Once construction commences, complete Vertical Obstacle Notification Form – **to be completed**

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			• *C15 (formerly identified as ZEN001)* • *C18 (formerly identified as C070)* *An increase in the LSALT value of 100ft would be required^.* *When completing and submitting the Vertical Obstacle Notification Form (see below Vertical Obstacle Notification section for further information), please copy in the above Grid LSALT assessment text above and quote this assessment code in order for the changes to be implemented.* ***Summary*** *Based on the above assessment, Airservices view is that the proposed wind farm would not have an impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of any airport.* ***Vertical Obstacle Notification^*** *As this proposed wind farm is in excess of 30m (99ft) AGL, as soon as construction commences, the proponent must complete the Vertical Obstacle Notification Form for tall structures and submit the completed form to VOD@airservicesaustralia.com* ^ Note: The height of RTS Project turbines has been reduced to 215 m and an increase to the LSALT is no longer required.	
Aerial operator (Middlebrook Air)	9 July 2020 Email to Middlebrook Air		During initial consultation Aviation Projects advised Middlebrook Air about the Mod-1 Project. A follow up email was sent on 30 July 2020 and 13 August 2020, no response was received.	No further actions required

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
ALA 1 owner	9 June 2020 In person meeting with landowners		During the site visit conducted on 9 June 2020, a meeting was held with the landowners of ALA1. During this meeting, the landowner advised Aviation Projects of the operations that occur at the property – including sheep, and oat farming. The ALA is used for spraying of the property and is used infrequently. During the site visit it was understood that the runway is a one way in, one way out runway with only a right-hand circuit being operational. Due to existing obstacles to the northeast of the runway, pilots are unable to perform a left-hand circuit, which was confirmed during discussion with the landowners. The RTS Project will not impact on approach and take-off surfaces of ALA 1, nor will it impact the right-hand circuit.	No further action required; refer **Section 6.7**
ALA 2 owner	9 June 2020 In person meeting with landowners		During the site visit conducted on 9 June 2020, a meeting was held with the landowners of ALA 2. The landowners advised they were concerned about the impact of the Modified Project on their property, and the potential impact on turbulence, spraying and costs associated with aerial agriculture pilots not willing to accept work due to the location and placement of turbines adjacent to the property. Based on the analysis conducted by Aviation Projects, the RTS Project will have no impact to the take-off and approach surfaces but would be considered potentially hazardous obstacles for aircraft operating in the circuit area and indicative flight circuits at ALA 2.	No further action required; refer **Section 6.7**

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			Not withstanding this, consideration should be made to facilitate the flight planning of aerial application operators. Details of the RTS Project, including location and height information of wind turbines, wind monitoring towers and overhead powerlines should be provided to the landowners of ALA 2 so that, when asked for hazard information on their property, the landowners may provide the aerial application pilot with all relevant information.	
ALA 4 owner	9 June 2020 In person meeting with landowner		During the site visit conducted on 9 June 2020, a meeting was held with the landowner of ALA 4. During the meeting, it was identified that ALA 4 is used infrequently, and the aviation impact of the Modified Project was generally not a concern for the stakeholder. Discussions continued about the use of the ALA. The RTS Project is not located within the approach and take-off surfaces associated with ALA 4, nor are there any WTGs located within indicative flight circuits. Therefore, it is unlikely that the RTS Project will have an impact to operations at ALA 4.	No further action required.
Civil Aviation Safety Authority	CASA provided an assessment of the project, as proposed at the time, dated 12 July 2017, noting its assessment that the likelihood of the proposed wind farm being a hazard was remote. CASA has subsequently advised that it will only review assessments referred to it by a planning authority or agency.			
Department of Defence	30 June 2020 Email to Department of Defence	13 August 2020 Letter from Mr Charles Mangion (Director	During email consultation Department of Defence was informed about the Modified Project. In a letter response Department of Defence advised:	Once construction commences, complete Vertical Obstacle

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
		Land Planning & Regulation)	*Defence has conducted an assessment of the proposed wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar.* *The proposed structures will meet the definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com . Defence understands this assessment is yet to be considered by CASA. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres.* *Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.* *Defence has no objection to the proposed wind farm provided that the project complies with the above conditions.*	Notification Form – **to be completed**
Mid-Western Regional Council (aerodrome operator)	30 June 2020 Email to Mid-Western Regional Council	30 July 2020 Email from Ms Michelle Nielsen (Executive Assistant, Operations)	During email consultation Mid-Western Regional Council was informed about the Modified Project. In an email response Ms Nielsen Executive Assistant to Airport Manager Mr Bob Husband advised: *there are no concerns in regard to Mudgee Airport.*	No further actions required

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
NSW National Parks and Wildlife Service	1 September 2020 Email to NSW National Parks and Wildlife Service	15 September 2020 Email from Mr John Whittall (Manager, Castlereagh Area)	During email consultation NSW NPWS was informed about the Modified Project. In an email response Mr Whittall advised: *We note section 2.2 35 in Mitigation of Aviation-Related Impacts, that the owner of immediately adjacent property to the site may ask the Applicant to implement mitigation measures where pre-existing aerial agricultural activities are affected by the erection and/or operation of wind turbines. We submit that several NPWS operations adjacent to the project area would fit into this category, namely aerial baiting using fixed wing aircraft, aerial wildlife survey using fixed wing or rotary aircraft, and aerial shooting of vertebrate pests using rotary aircraft. It is important that spatial data can be made available to ensure future planning for these operations can safely and accurately take account of the adjacent wind turbine project. Based on past history however, it is unlikely that this project would significantly affect these operations within Coolah Tops National Park due to the historic proximity and frequency of these operations.* *We also note that firefighting activities were raised for consideration in section 3.15 – Aerial Firefighting. NPWS has a statutory obligation to control fires starting on the land it manages. Aerial firefighting on the interface of the national park and private land needs to be closely considered. Firefighting by air usually depends on water points and helipads on private land. One of the main safety considerations with low level flying is overhead powerlines, these are generally linier features in the landscape and are predictable to some extent. The proposed turbines are much higher and are somewhat randomly spaced across the landscape hence less predictable. Visibility is regularly impacted by smoke during fire fighting operations adding to the complexity of*	Consult with NSW RFS – **Completed** Consider the AFAC's position on wind turbines: *Wind Farms and Bush Fires Operations*, version 2.0– **Completed** Details of Project to be noted as appropriate on flight planning charts – **to be completed** No additional actions required

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
			safely managing aircraft. The AIA needs to consider the ability to safety conduct aerial firefighting operations. The NPWS concurs with the Australasian Fire and Emergency Services (AFAC) developed national position on the treatment of wind turbine towers in relation to aerial firefighting activities. We consider that the presence of the turbines would impact fire bombing in particular. However this risk is somewhat mitigated, due to a relatively low level of fire activity in Coolah Tops National Park, and no current history of firebombing activity with fixed wing aircraft having taken place within the park. *This section also states that firefighting operations are conducted in day VFR. More recently the Rural Fire Service have moved to include night time aerial operations in their suite of response to fires. This could impact decisions with respect to the use of lights on the wind turbines and wind monitoring towers.* *We believe that the Rural Fire Service should be consulted further in relation to the impacts on aerial firefighting on country adjacent and within Coolah Tops National Park. In particular, whether there are any buffers that should be applied to various types of firefighting aircraft that would need to work in the vicinity of the turbines and monitoring towers, and whether there would need to be protocols for switching off particular towers for the period where operations may be impacted by their operation. The Rural Fire Service should be asked for comments on the implications of night aerial firefighting operations in the vicinity of the project.*	

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
NSW Rural Fire Service (NSW RFS)	1 September 2020 Email to NSW RFS	15 September 2020 Email response from Mr Bernie O'Rourke (Supervisor, Operations (Aviation), Response and Coordination)	During email consultation NSW RFS was informed about the Modified Project. In an email response Mr O'Rourke advised: *We have no comments on the proposed wind farm. Wind farms will be treated like any other potential hazard to aircraft operations.*	No further actions required
Royal Flying Doctor Service	30 June 2020 Email to RFDS	7 July 2020 Email from Mr Justin Marr (General Manager Aviation, RFDS South Eastern Section)	During email consultation RFDS was informed about the Modified Project. In an email response Mr Marr advised: *Our technical Pilot has reviewed the AIA and has confirmed we have no objection to the development. The panned windfarm does not interfere with our operations into Coolah Aerodrome.*	No further actions required
Upper Hunter Shire Council	30 June 2020 Email to Upper Hunter Shire Council	27 July 2020 Email from Mr Mat Pringle (Director Environmental & Community Services)	During email consultation Upper Hunter Shire Council was informed about the Modified Project. In an email response Mr Pringle advised: *Upper Hunter Shire Council has no concerns with the proposal with respect to aviation impacts.*	No further actions required
Warrumbungle Shire Council (aerodrome operator)	30 June 2020 Email to Warrumbungle Shire Council	31 August 2020 Email from Mr Kevin Tighe (Director Technical Services)	During email consultation Warrumbungle Shire Council was informed about the Modified Project. In an email response Mr Tighe advised: *It is noted that the increased height will not interfere with operational air space of the Coolah Aerodrome.*	No further actions required

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Westpac Life Saver Rescue Helicopter Service	30 June 2020 Email to Westpac Life Saver Rescue Helicopter Service		During initial consultation Aviation Projects advised Westpac Life Saver Rescue Helicopter Service about the Modified Project. A follow up email was sent on 21 July 2020 no response was received.	No further actions required
Yancoal (Moolarben Coal)	24 September 2020 Email to Moolarben Coal	24 September 2020 Email from Ms Rebecca Shanks (Environment and Community Coordinator)	During initial consultation Aviation Projects advised Yancoal about the Modified Project, which is located in proximity to the Moolarben Coal site and a decommissioned ALA. In an email response Ms Shanks confirmed: *the aircraft landing strip adjacent to Moolarben coal is no longer in operation*.	No further actions required

6. AVIATION IMPACT STATEMENT

6.1. Overview

The NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* provides information to proponents and planning authorities to help identify any potential safety risks posed by wind turbine and wind monitoring installations from an aviation perspective.

Potential safety risks include (but are not limited to) impacts on flight procedures and aviation communications, navigation and surveillance (CNS) facilities which require assessment by Airservices Australia.

To facilitate these assessments all wind farm proposals submitted to Airservices Australia must include an Aviation Impact Statement (AIS).

The list of wind turbines (obstacles), showing coordinates and elevation data that are applicable to this AIS, are provided in Annexure 5.

6.2. Nearby certified aerodromes

The LRWF site is located within 30 nm (55.56 km) (area used to identify possible constraints) from one certified airport – Coolah Airport (YCAH).

The LRWF site is located beyond 30 nm from Coonabarabran Airport (YCBB), Dubbo Airport (YSDU), Mudgee Airport (YMDG), Quirindi Airport (YQDI), Scone Airport (YSCO) and Tamworth Airport (YSTW). Therefore, the RTS Project will not impact on the operational airspace of these airports.

The location of nearby airports (Coonabarabran (YCBB), Quirindi (YQDI), Scone (YSCO), Mudgee (YMDG) and Coolah (YCAH)) relative to the LRWF site is shown in Figure 14 (source: Tilt Renewables, Google Earth).

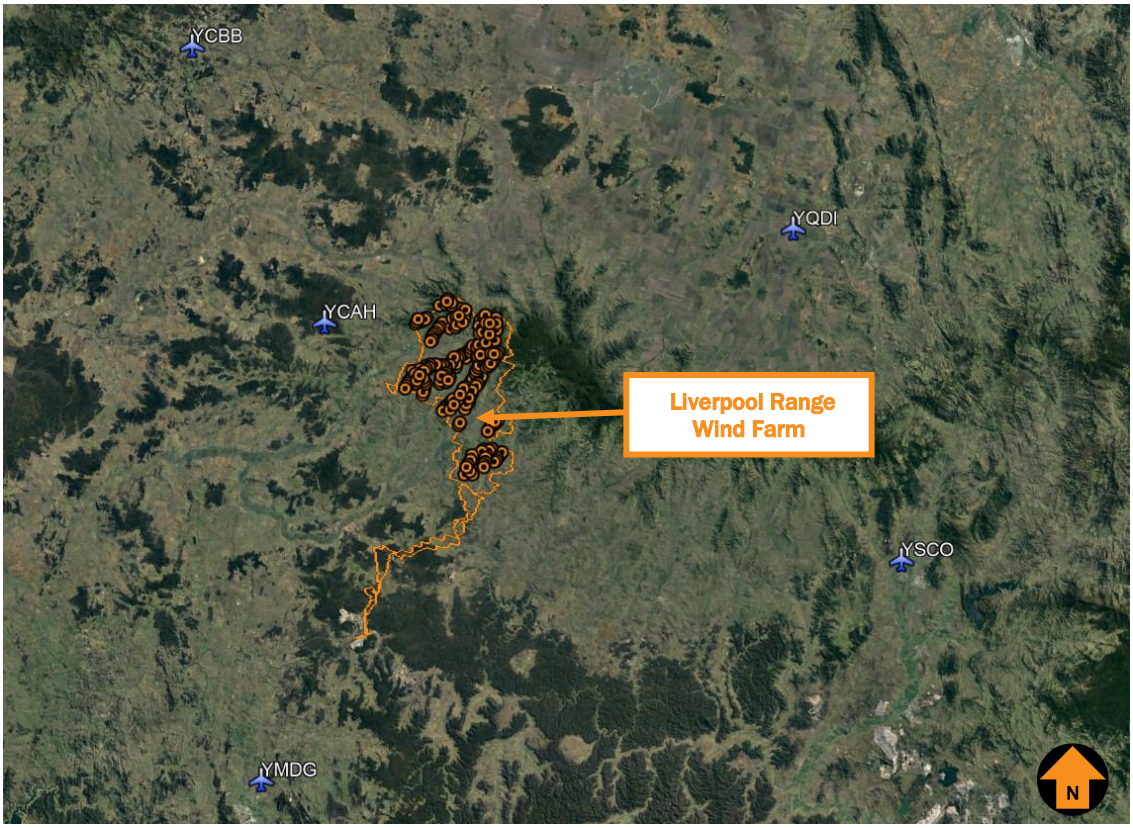

Figure 14 The LRWF site relative to nearby certified airports

Figure 15 shows buffer areas (including 10 nm and 25 nm MSAs and associated 5 nm buffer areas) for Coolah Airport (source: Tilt Renewables, Google Earth).

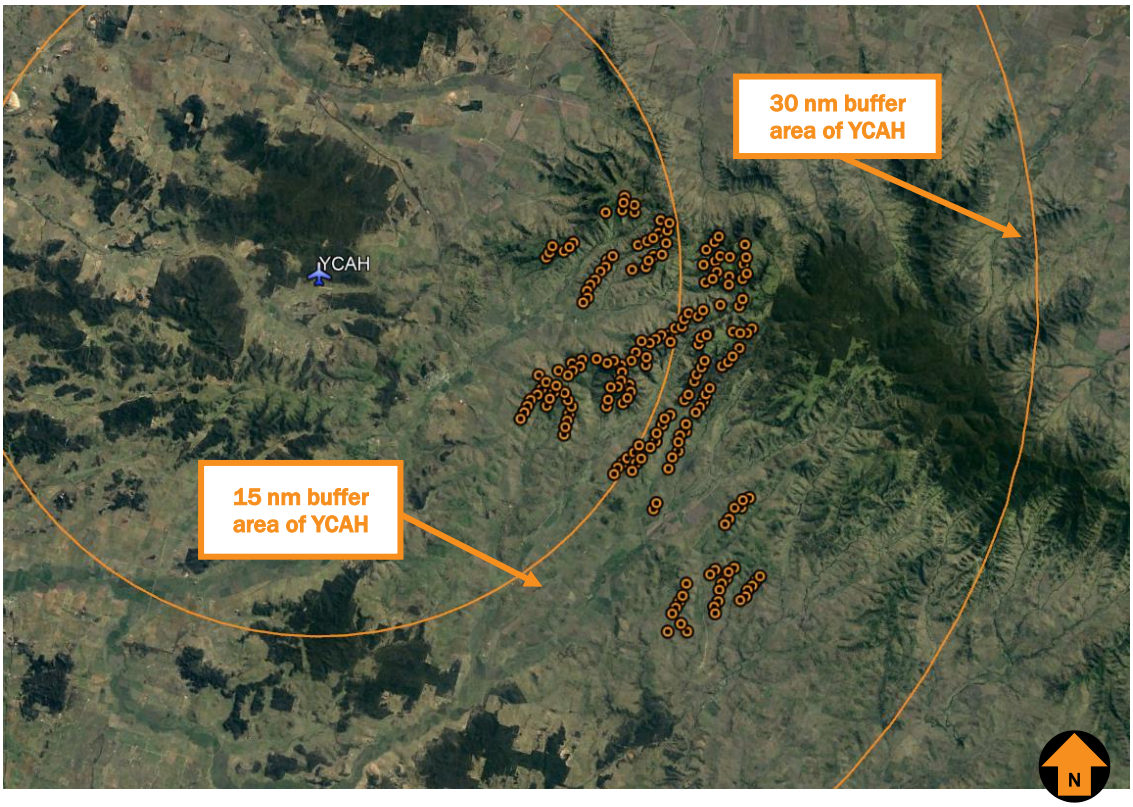

Figure 15 Coolah Airport's 15 nm and 30 nm buffer areas

6.3. Coolah Airport

Coolah Airport (YCAH) is a certified, Code 2, non-instrument approach runway, operated by Warrumbungle Shire Council, with a published aerodrome elevation of 504 m AHD (1,654 ft AMSL) (source: Airservices Australia, FAC YCAH-1, dated 15 June 2023).

Coolah Airport has one runway 08/26 of brown gravel grass surface with a length of 1,074 m, width 30 m and runway strip 90 m.

Figure 16 shows the Coolah Airport (YCAH) runway layout (source: Google Earth).

Figure 16 Coolah Airport (YCAH) runway layout

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

6.4. Instrument procedures – Coolah Airport

A check of the Aeronautical Information Publication (AIP) via the Airservices Australia website showed that Coolah Airport is not served by instrument or non-precision approach procedures (source: Airservices Australia, FAC YCAH-1, dated 15 June 2023).

6.5. PANS-OPS surfaces – Coolah Airport

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

6.6. Obstacle limitation surfaces – Coolah Airport

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

Coolah Airport is located approximately 18 km (9.6 nm) west of wind turbine A1. Therefore, the RTS Project will not impact Coolah Airport's OLS.

6.7. Nearby aircraft landing areas (ALAs)

As noted in the preliminary assessment and based on information provided by the Proponent for locations of nearby ALAs, there are approximately 48 ALAs within proximity to the proposed RTS Project.

Refer to Figure 17 for the ALAs identified in the preliminary assessment (source: Tilt Renewables, Google Earth).

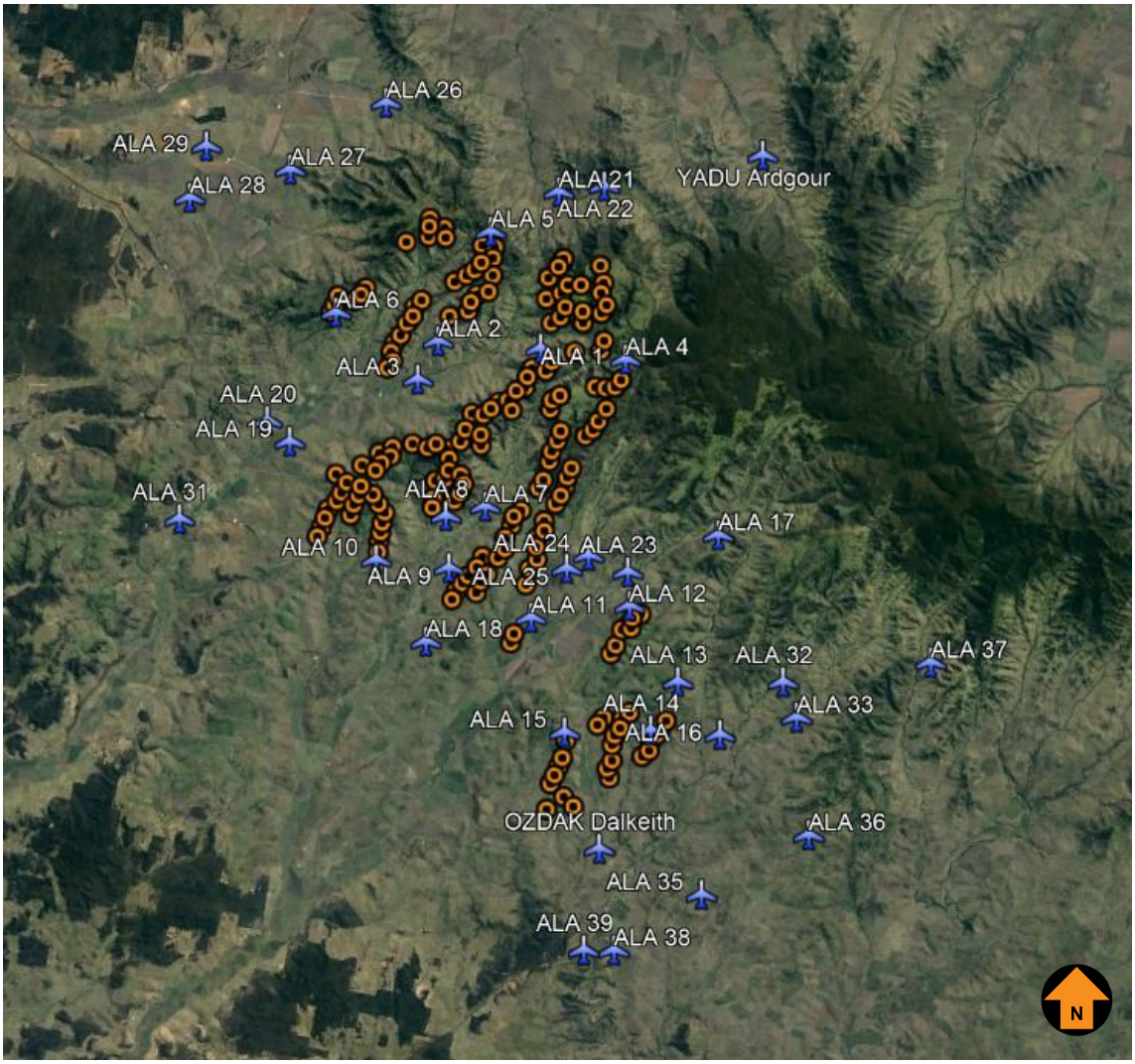

Figure 17 ALAs in proximity to the LRWF site

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

Further analysis based on a review of aerial imagery and OzRunways data identified that the majority of the ALAs were likely to be non-operational or located more than 3 nm from a WTG.

Additional search on OzRunways, which sources its data from Airservices Australia, returned two uncertified aerodromes (YADU and OZDAK Dalkeith) within close proximity to the LRWF site. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

Therefore, the ALA analysis is based on 11 ALAs located nearby the proposed RTS Project WTGs, including ALA 1, ALA 2, ALA 3, ALA 4, ALA 5, ALA 6, ALA 7, ALA8, ALA 9 ALA OZDAK and ALA YADU.

Figure 18 shows nearby ALAs with a 3 nm radius of these ALAs (source: Tilt Renewables, OzRunways and Google Earth).

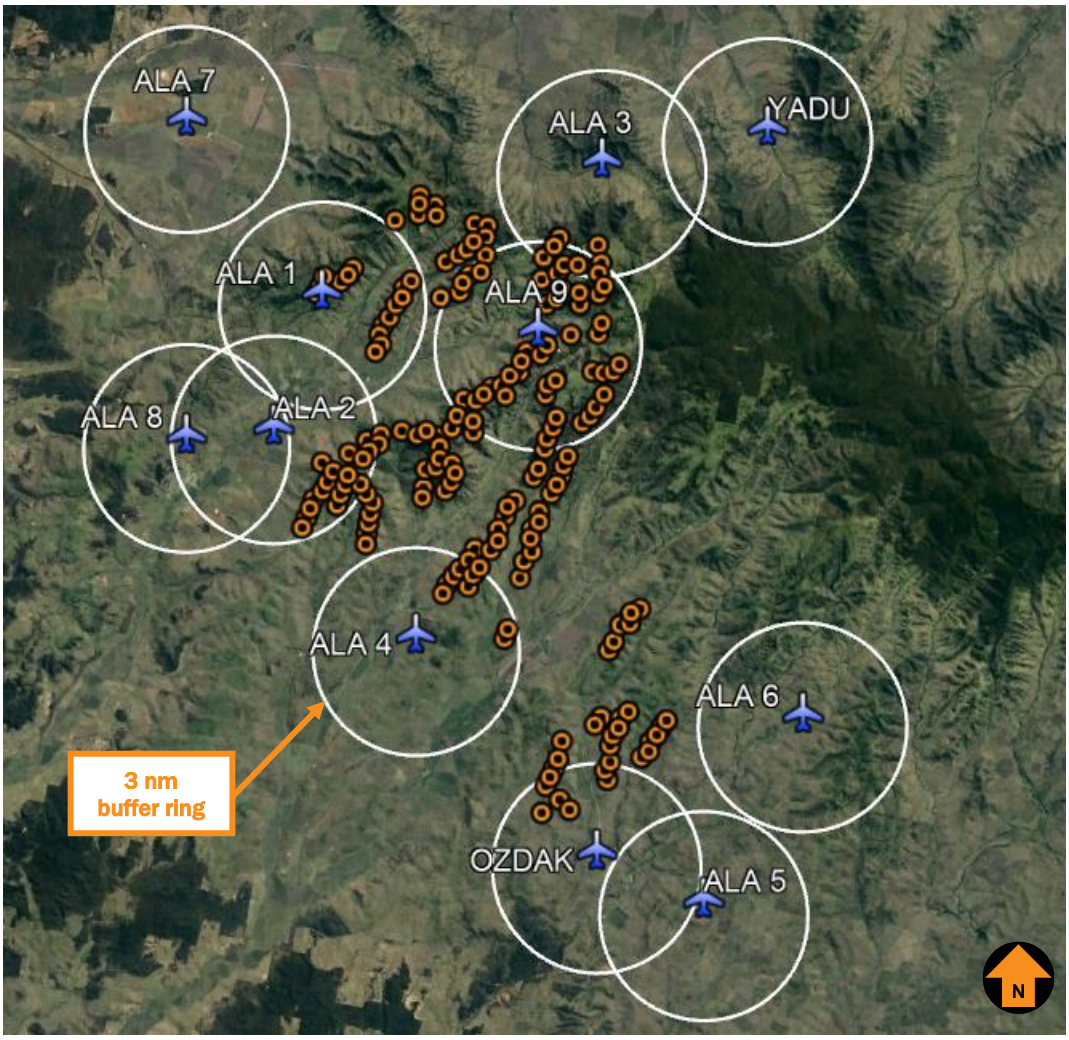

Figure 18 The LRWF site relative to nearby ALAs

The RTS Project will not impact ALA 5, ALA 6, ALA 7, ALA 8 and YADU approach and departure paths or the aerodromes' circuit operations. However, some of the proposed RTS Project WTGs are located within a 3 nm radius of ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA.

A close-up of potentially impacted ALAs is shown in Figure 19 (source: Tilt Renewables, OzRunways, Google Earth).

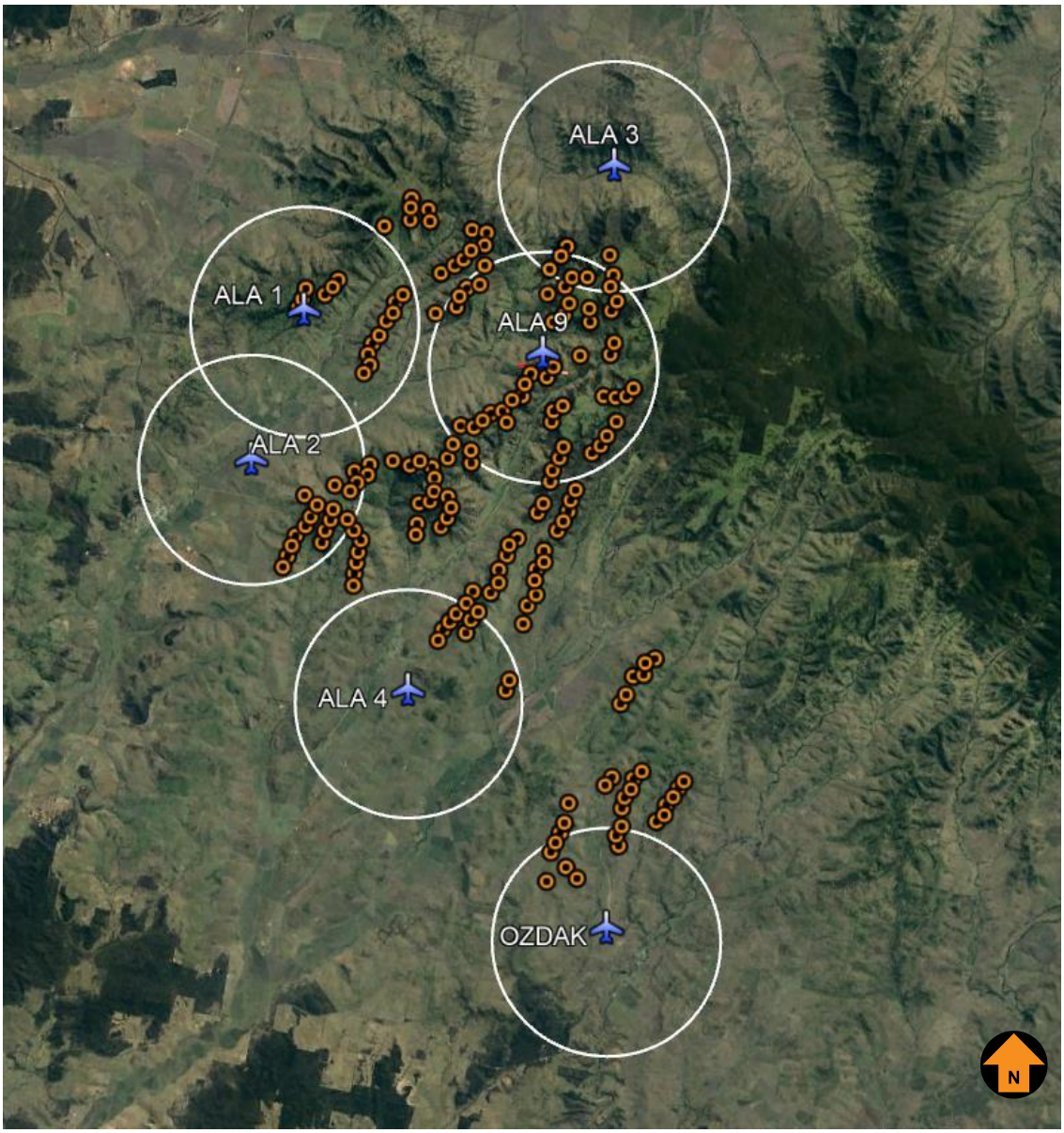

Figure 19 Close up of potentially impacted ALAs relative to the proposed RTS Project WTGs

Aircraft typically operate in circuit patterns when arriving and departing from an aerodrome. CASA AC 91-10 'Operations in the vicinity of non-controlled aerodromes' describes the standard traffic circuit and heights at which aircraft should fly. This is shown in Figure 20.

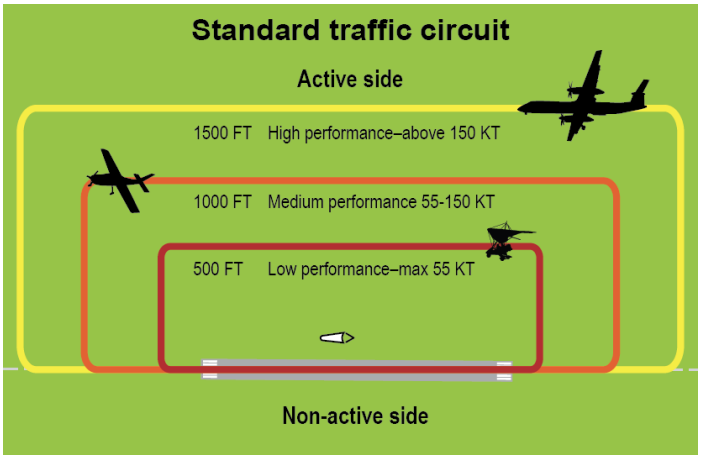

Figure 20 Standard traffic circuit

In addition, various entry and departure procedures are described for aircraft joining and departing a standard traffic circuit. Figure 21 shows the standard arrival and joining procedures for a standard traffic circuit.

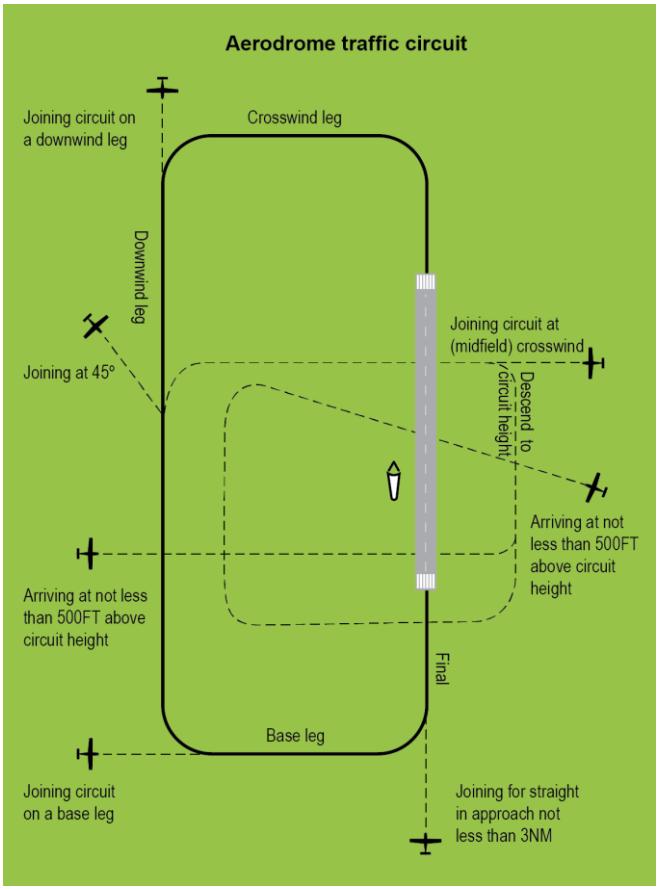

Figure 21 Traffic circuit arrival and joining procedures

Figure 22 shows a close up of the nearest RTS Project WTGs relative to ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA showing the indicative flight circuits (in black colour) and 3 nm radii of these ALAs (in white colour) (source: Tilt Renewables, Google Earth).

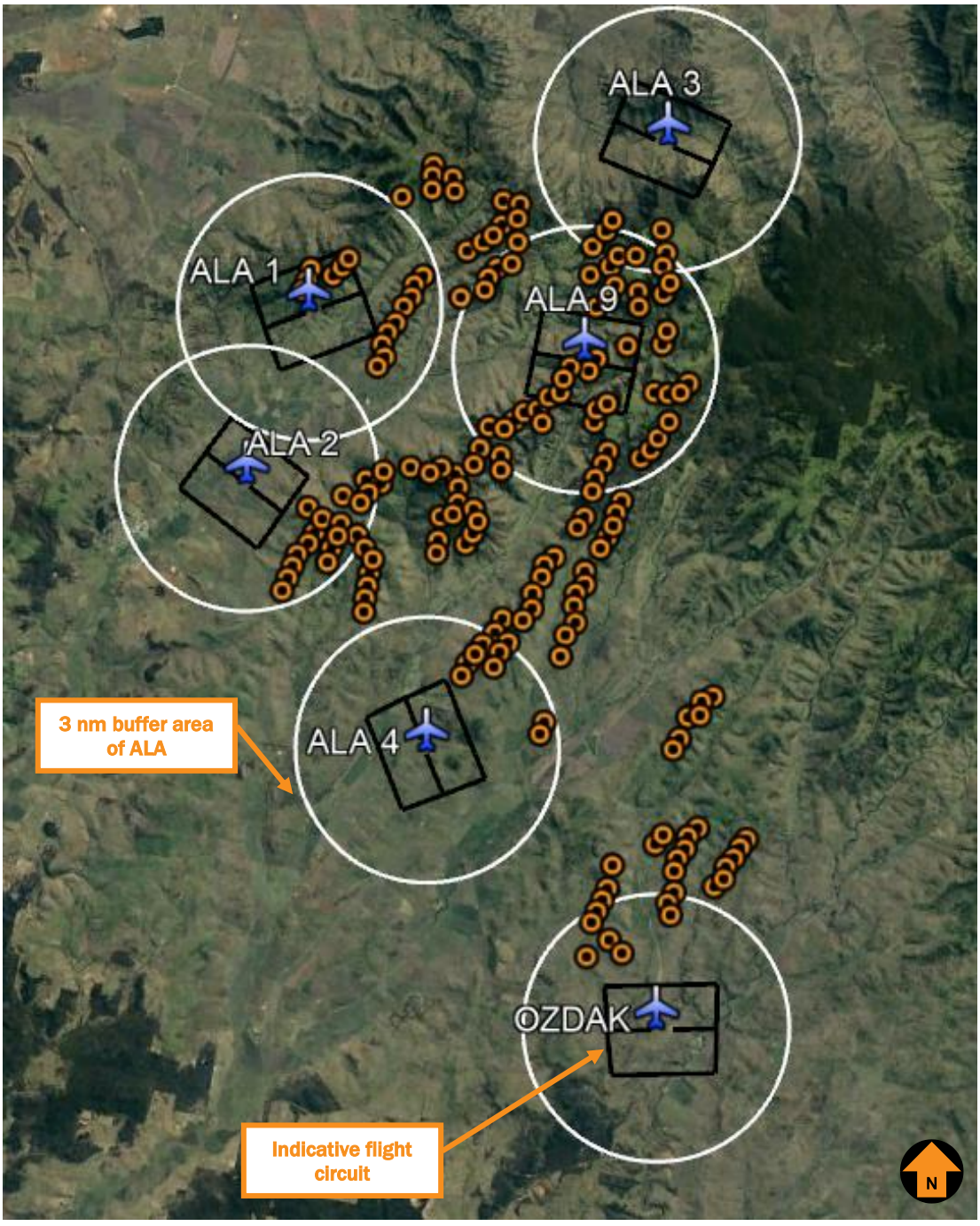

Figure 22 RTS Project WTGs within 3 nm radii of likely impacted ALAs

Note: due to existing obstacles located at ALA 1, the ALA is only operational for right-hand circuits, and pilots are only able to approach and take-off from the runway in the one direction.

The RTS Project WTGs are located outside the horizontal extent of indicative flight circuits of ALA 3, ALA 4 and OZDAK. Therefore, it is unlikely aerodromes circuit operations of ALA 3, ALA 4 and OZDAK ALA will be affected by the RTS Project. However, the aerodromes circuit operations of ALA 1, ALA 2 and ALA 9 may be impacted.

During the site visit, consultation with the landowners of ALA 1 and ALA 2 resulted in further analysis of aerodrome flight circuits to determine potential impacts on aerial flight operations conducted to/from the ALAs. Potential impacts has also been further assessed.

Note: Further analysis of aerodrome flight circuits was deemed not required for ALA 3, ALA 4 and OZDAK.

ALA 1 - Circuit Operations

During discussions with the landowners and through identification, it was assessed that ALA 1 is a one way in/one way out runway. As there are existing obstacles to the northern side of the runway, pilots do not approach or take-off from the left-hand circuit.

The indicative circuit as identified in Figure 23, is the most appropriate representation of the flight circuit.

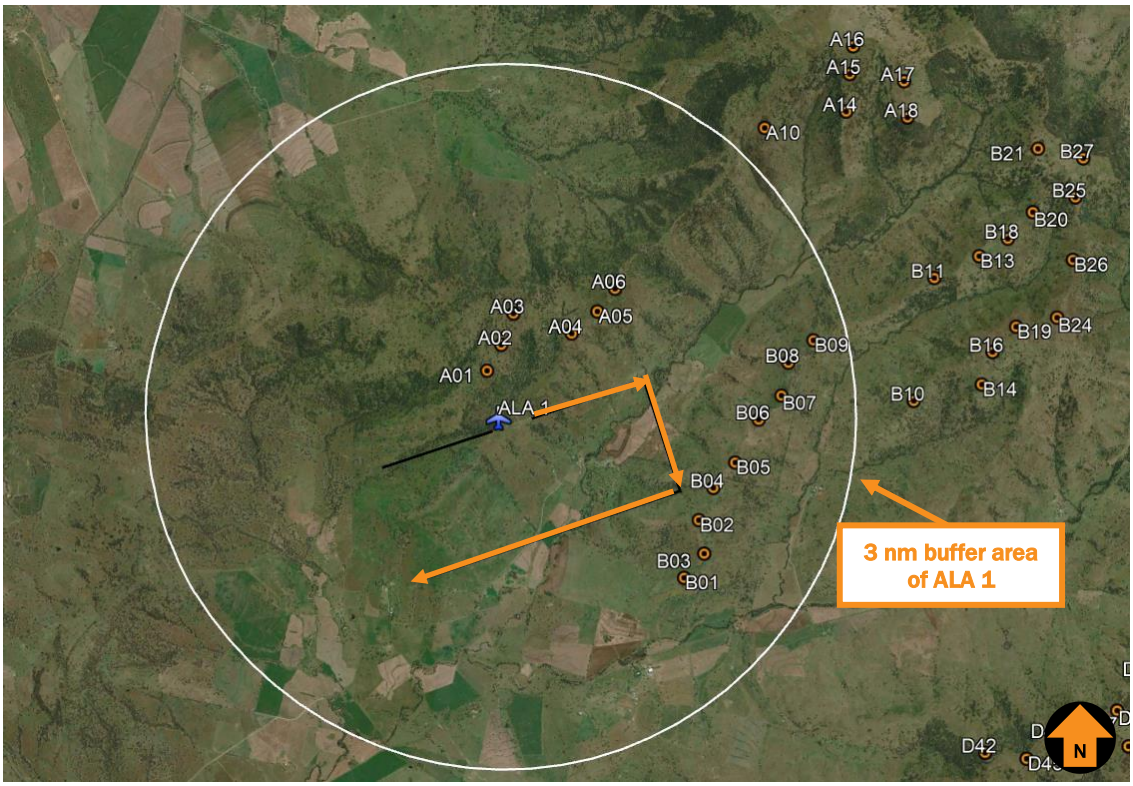

Figure 23 Proposed RTS Project WTGs within a 3 nm radius of ALA 1 and indicative flight circuit

Images taken at ALA 1 looking south-east in the departure direction for aircraft that are operating at the ALA - refer to Figure 24, Figure 25 and Figure 26.

Figure 24 White tires indicating the end of the runway, looking north-east at ALA 1

Figure 25 Obstacles located north of the runway at ALA 1, towards where the RTS Project will be located

Figure 26 Standing on the runway looking north northwest at ALA 1

The landowners for ALA 1 confirmed that the runway is used infrequently, and when in use pilots will only approach and take-off in the one direction, being the nominally indicative right-hand circuit. Existing obstacles to the north of the runway inhibit the use of a left-hand circuit. Therefore, it is unlikely that the RTS Project will impact circuit operations at ALA 1.

ALA 2 - Circuit Operations

As there is no published data available for the ALA 2, a conservative approach of a runway length of 500 m, with a runway width of 10 m was used for this analysis.

A close up of ALA 2 highlighting the indicative flight circuit and a 3 nm radius of this ALA is shown in Figure 27.

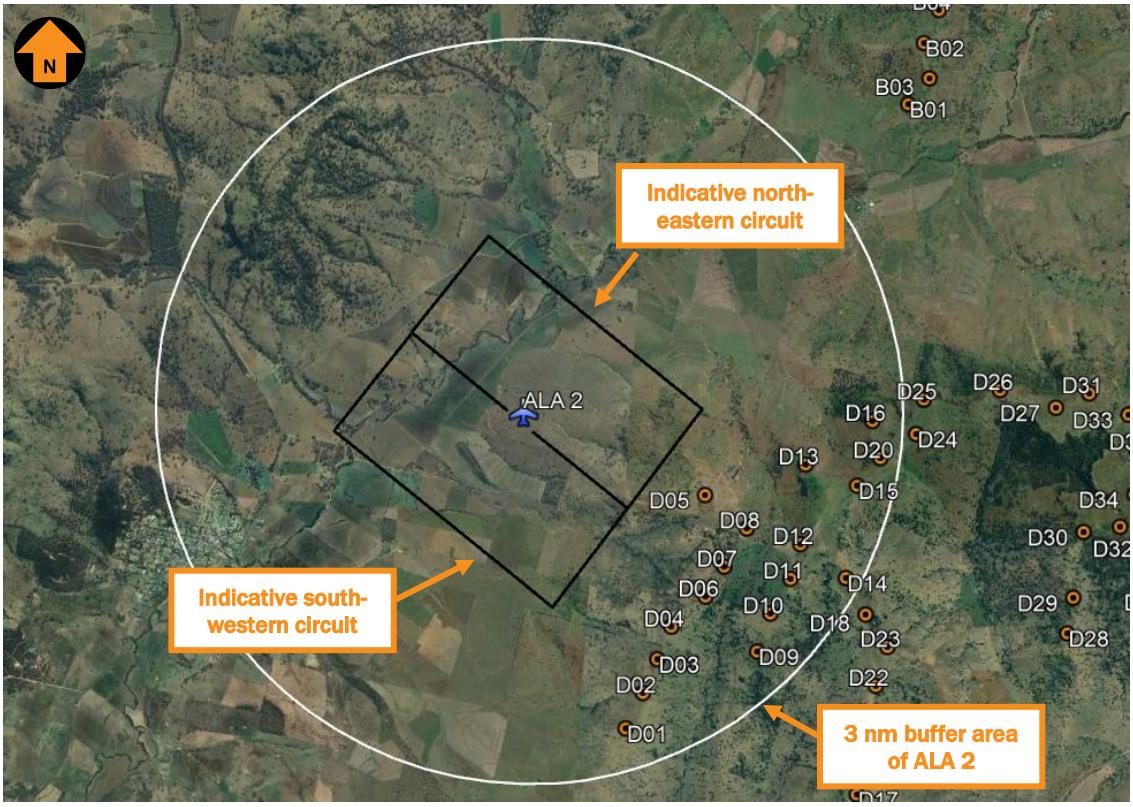

Figure 27 Proposed RTS Project WTGs within a 3 nm radius of ALA 2 and indicative flight circuits

Figure 28 situates the location of the runway of ALA 2 in proximity to the RTS Project.

Figure 28 Standing on runway at ALA 2 looking south-east towards Project site

CASA does not currently provide any regulatory guidance on obstacle control for uncertified aerodromes.

Previously published guidelines, CAAP 92-1 Guidelines for Aeroplane Landing Areas (now withdrawn) provided recommended obstacle clearances for runway flyover, landing and take-off. The recommended obstacle free area was defined by surfaces with a width of 30m either side of the runway centreline, splaying at 5% to 150 m and extending 900 m from the runway ends. This is shown in Figure 29.

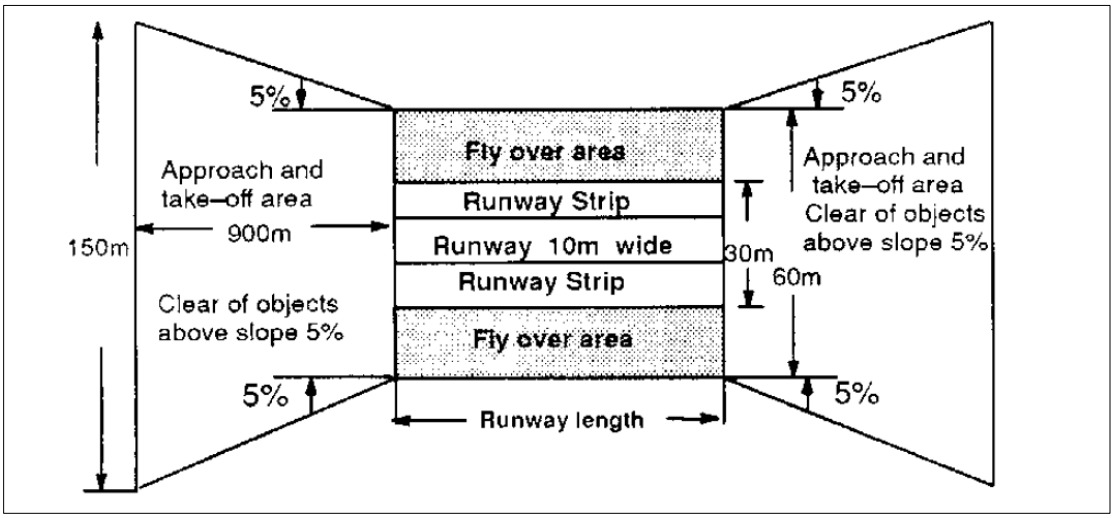

Figure 29 CAAP 92-1(1) Recommended obstacle free area

While CAAP 92-1(1) is no longer published, the obstacle clearance surfaces described provide a useful guideline for assessing whether obstacles are likely to compromise flight safety in critical landing and take-off

phases. The closest RTS Project WTG to ALA 2 is WTG D5 and is located approximately 2.7 km (1.4 nm) from the end of the runway. It will not affect the approach and take off surfaces.

Aircraft would typically operate at circuit heights of 500 ft above the runway within 3 nm radius of ALA. WTGs within 3 nm of ALA 2 have ground elevation of up to 325 m above the runway elevation, showing in Figure 34. With maximum tip heights of 215 m AGL, these WTGs will reach 540m (1172 ft) above the runway end. These WTGs would therefore be considered potentially hazardous obstacles for aircraft operating in the circuit area.

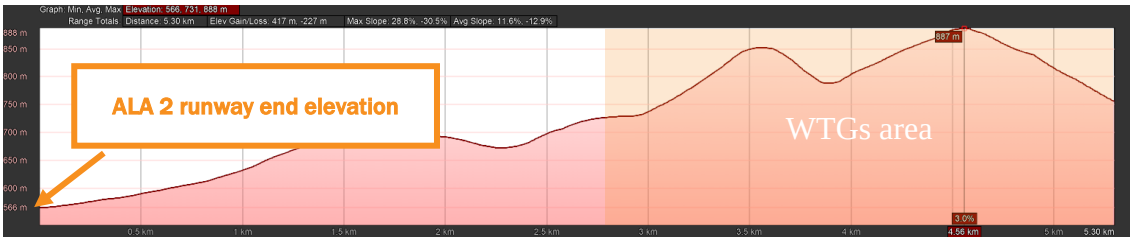

Figure 30 Elevation profile of ALA 2 related to close WTGs

WTGs within 3 nm of ALA 2 would be considered as potentially hazardous obstacles for circuit operations as shown in Figure 31. Consideration should be given to aircraft operating from/to the north west during approach/take-off at ALA 2.

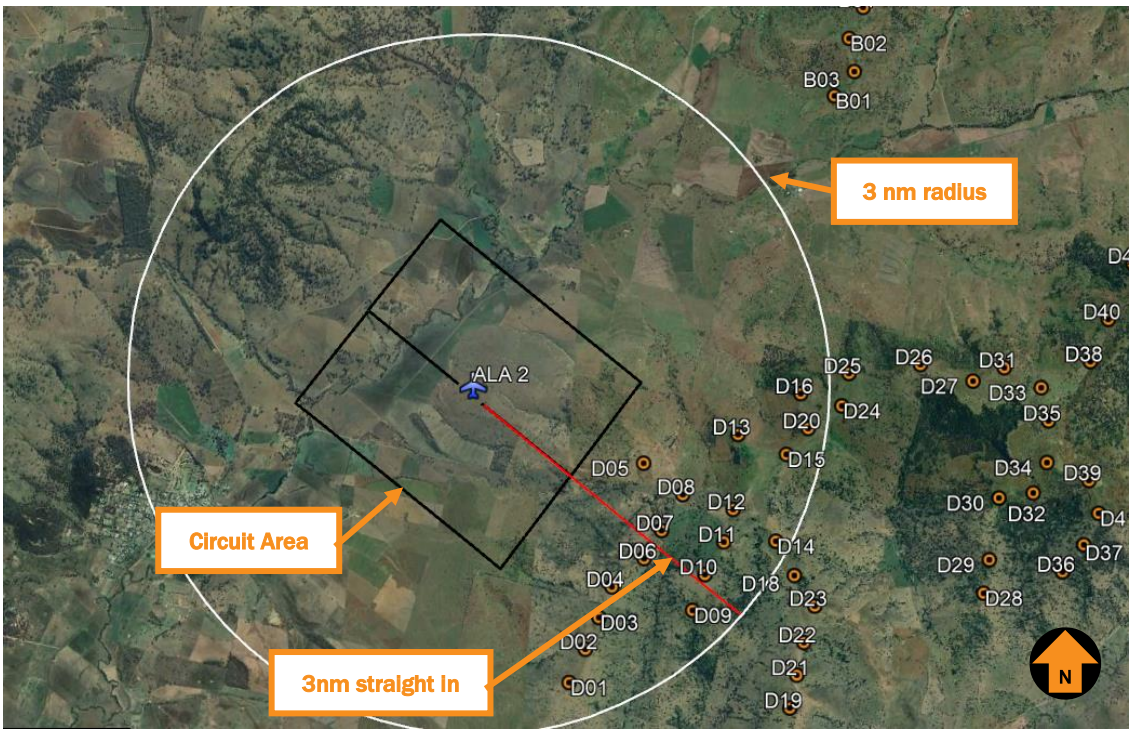

Figure 31 WTGs within 3 nm of ALA 2

ALA 9 - Circuit Operations

ALA 9 is located along State Forest Road, approximately 20 km north-east of Coolah (NSW).

Seven WTGs are planned to be installed in proximity of ALA 9. In addition to the WTGs, ancillary infrastructure such as overhead transmission lines and a substation are also proposed in the vicinity of the ALA – see Figure 32 (source: tilt Renewables and Aviation Projects).

ALA 9 is predominantly used for aerial agriculture (super application) with seeding generally undertaken by helicopter. Both fixed and rotary wing aircraft operate from the ALA.

Aircraft currently operate from the runway in both directions, subject to wind speed and direction.

The runway is approximately 520 m long and is located is located on the top of a ridge oriented generally west-north-west/east-south-east.

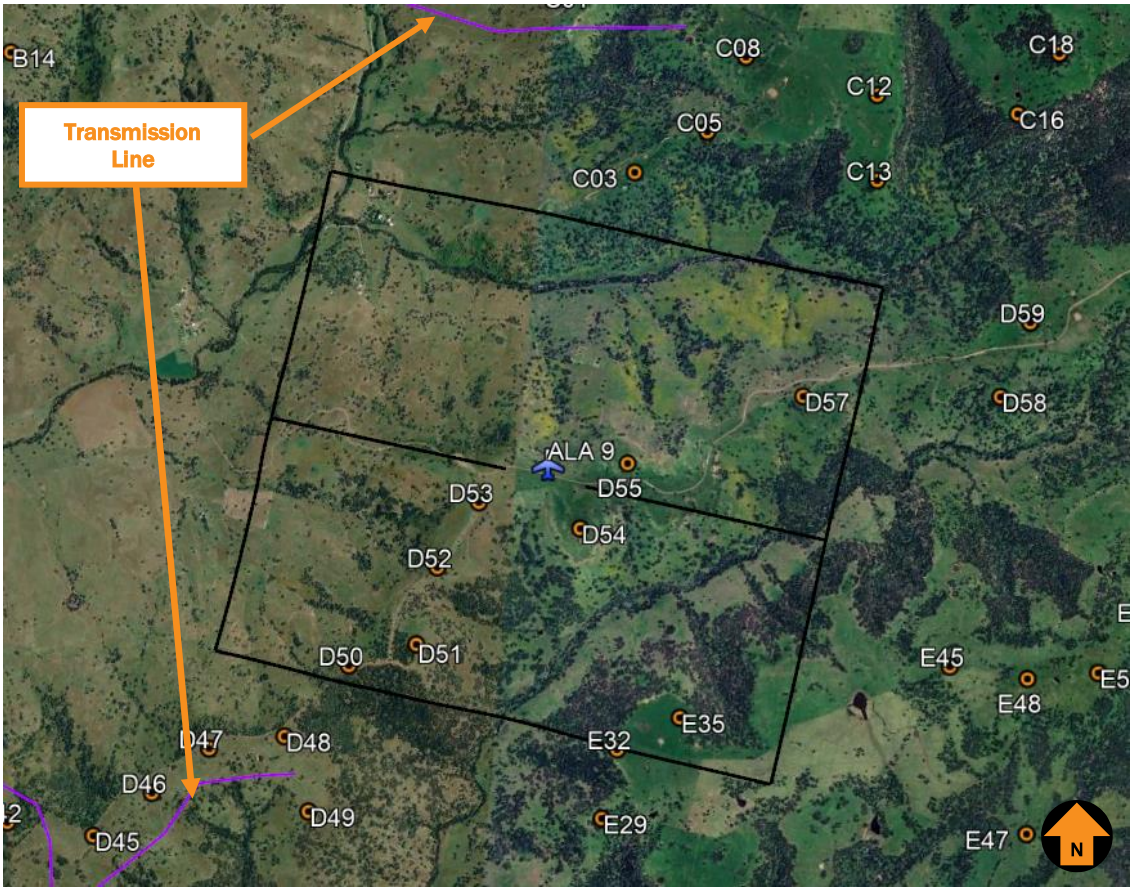

Figure 32 Project layout in relation to ALA 9

Following a review of the potential impacts arising from the illustrated alignment, it has been concluded that ALA 9 can remain operational. The transmission lines remain clear of the approach/take-off surface. A more detailed view of the south-eastern end of the take-off and approach surface alignment is illustrated in Figure 33.

Figure 33 ALA 9 approach and take-off surfaces

The following images show the views from each runway end looking in the direction nominated in the respective figure title.

Figure 34 View looking east from western end

Figure 35 View looking west from western end

Figure 36 View looking west from eastern end

ALA 9 is predominantly used for aerial application operations. 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.

For the purpose of this analysis the wind turbines located in proximity to the runway and circuit for the affected ALA have been analysed to identify any potential impacts.

The analysis of flight circuits is based on the recommendations provided in the CASA AC 91-10.

Standard circuit operations will not be available due to the proximity and height of the wind turbines to ALA 9.

The overhead transmission power line, supported by poles or towers with an anticipated height of up to 60m above ground level (AGL) runs semi-parallel to the runway and its take-off and approach surface and prevents an early turn to the right on take-off to the east, noting that the wind turbines to the north-east of the ALA 9 prevent manoeuvring to the north of runway centreline until above a standard circuit height.

ALA 9 operations will be unconstrained by the overhead transmission line.

In summary, aircraft operations at ALA 9:

- will be constrained due to the proximity and height of wind turbines
- will not be constrained by transmission lines.

Potential Wake Turbulence Impacts

NASF Guideline D provides guidance regarding wind turbine wake turbulence states:

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

For the purpose of the wake turbulence analysis, a 172 m rotor diameter has been used. Therefore, based on NASF Guideline D, the effects of wake turbulence could be noticeable at a distance of 2,752 m from the proposed wind turbines.

Aviation Projects, through research, has determined that any adverse turbulence would most likely be confined to within 7 rotor diameters of a WTG, but considers that a conservative area of 10 rotor diameters is likely to be the maximum area where wake turbulence from WTGs would be felt by pilots operating downstream of a WTG.

For WTGs with a 172 m rotor diameter, this area would therefore extend to a distance of 1720 m.

Adverse turbulence from any source is most critical during initial climb after take-off until the aircraft is established in a climb and at the appropriate speed, and during final approach where the aircraft is configured for landing and operating at a slow speed prior to landing.

Based on this consideration, the effects of wake turbulence could potentially be noticeable at ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA, in the following circumstances:

- while performing the southern right hand circuits at ALA 1
- while departing to the south-east at ALA 2
- when operating in the southern circuit at ALA 3
- while departing to the north-west at ALA 4
- while operating in the vicinity of ALA 9
- when operating in the northern circuit at OZDAK ALA.

ALA 1 is located in close proximity to several WTGs. Operations are conducted to the east only (landing to the west, take-off to the east). Figure 37 shows 2752 m and 1720m radius circles based on WTGs A1 and B1, to indicate that operations to the ALA may be affected by wake turbulence when the wind is blowing from the north clockwise around to the south.

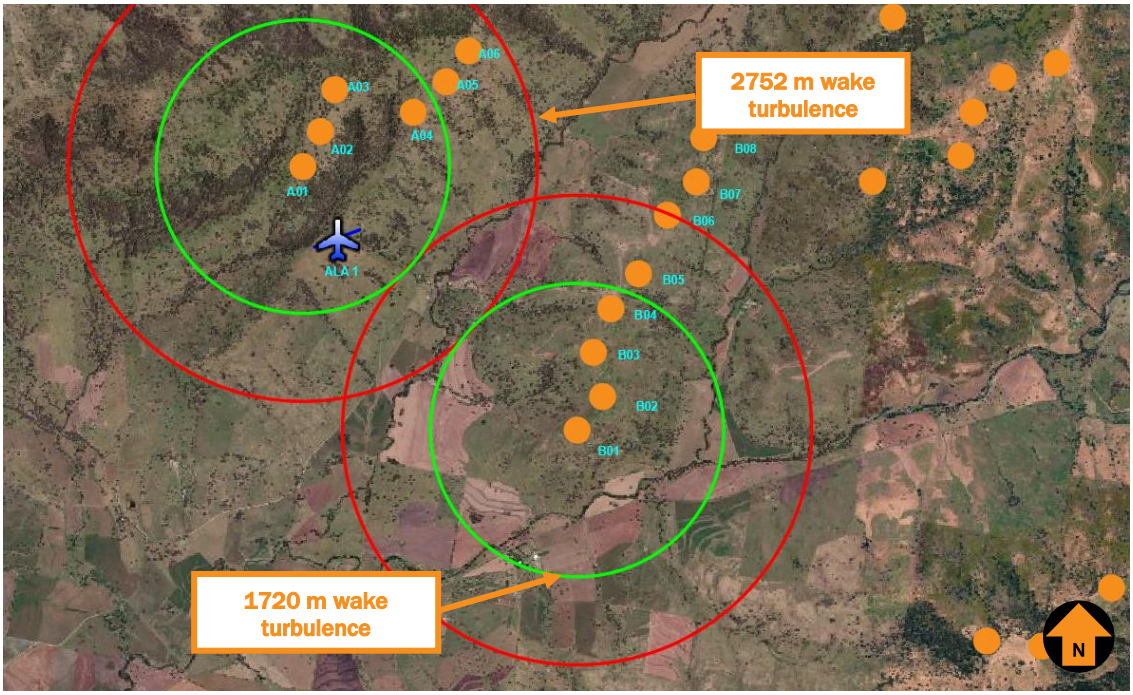

Figure 37 ALA 1 wake turbulence analysis

Figure 38 shows a red circle of radius 2752 m and a green circle of radius 1720 m based on D5 extending to ALA 2. When a south easterly wind is blowing, departures to the south-east may be affected by wake turbulence.

Note that operations on this ALA are likely to be restricted to the north-east (i.e. land to the south-east and take-off to the north-east), due to the slope of the runway (up to the south-east).

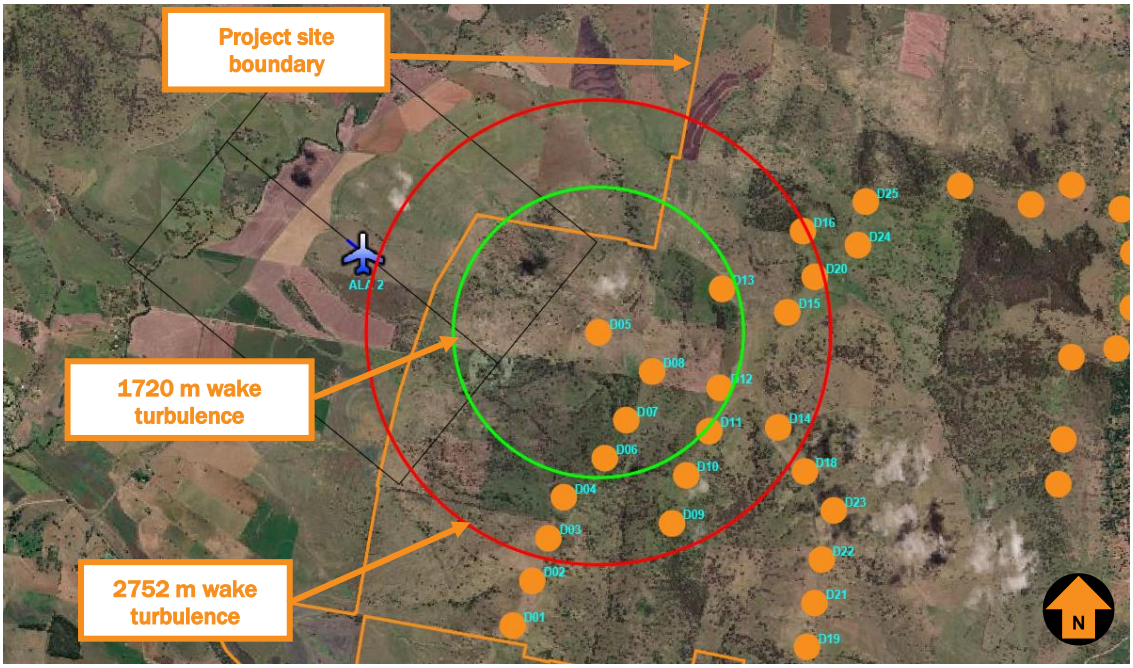

Figure 38 ALA 2 wake turbulence analysis

WTGs C7 and C14 are the closest WTGs to ALA 3. Figure 39 shows a red circle of radius 2752 m and a green circle of radius 1720 m based on these WTGs extending to near the ALA within the southern circuit. When a southerly wind is blowing, operations to the south (i.e. standard left hand circuit on the westerly runway direction) may be affected by wake turbulence.

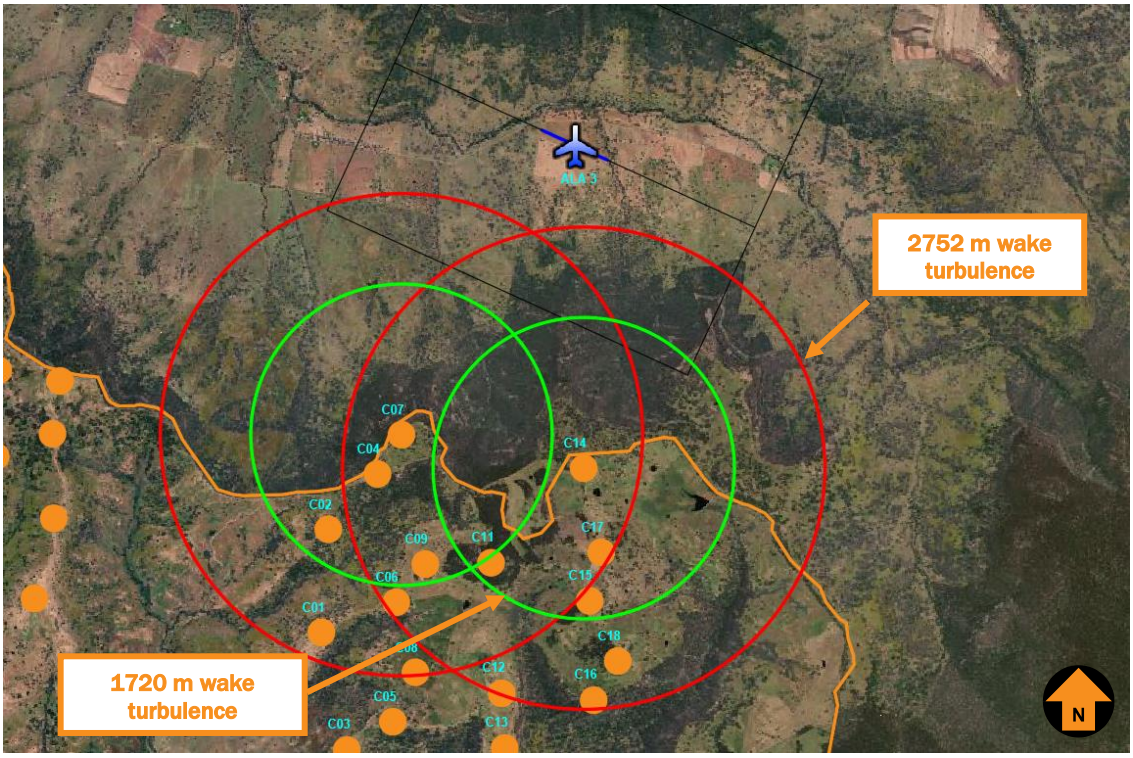

Figure 39 ALA 3 wake turbulence analysis

WTG E1 is the closest WTG to ALA 4. Figure 40 shows a red circle of radius 2752 m and a green circle of radius 1720m based on E1 extending to near ALA 4. When a northerly wind is blowing, departures to the north-west may be affected by wake turbulence.

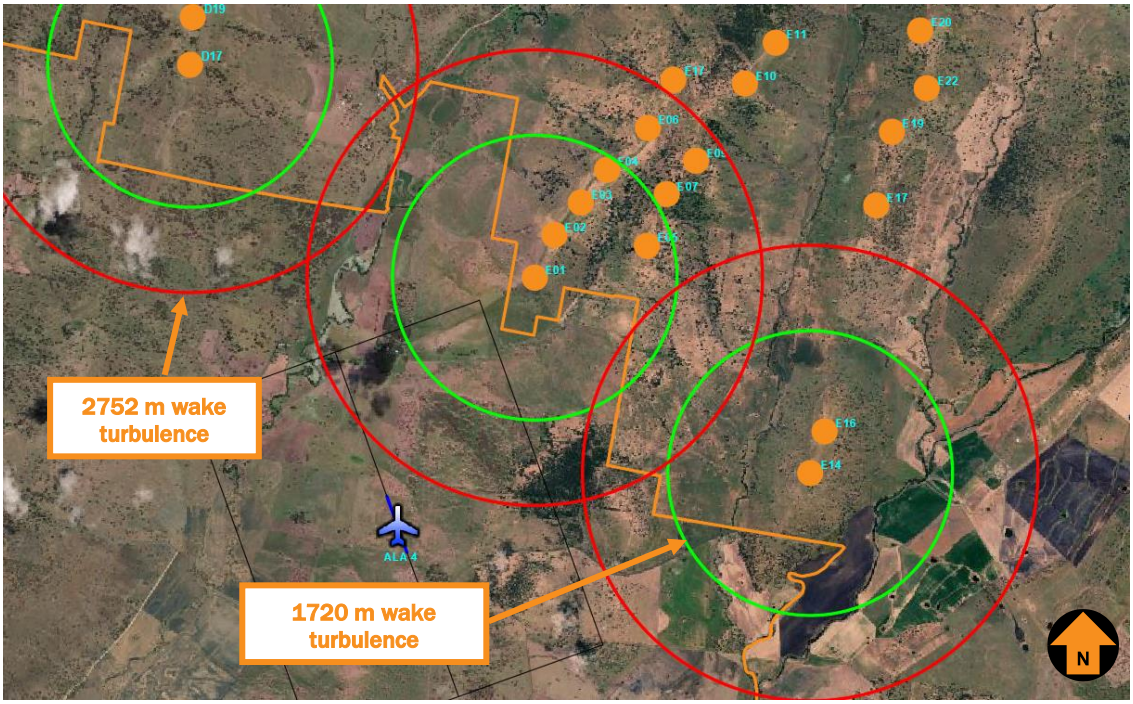

Figure 40 ALA 4 wake turbulence analysis

WTGs D53, D54 and D55 are the closest WTG to ALA 9. Figure 41 shows a red circle of radius 2752 m and a green circle of radius 1720 m based on the nearest three WTGs extending to over ALA 9. To avoid any adverse impact from downstream wake turbulence caused by the WTGs, aircraft operators should plan to operate when the WTGs closest to the ALA and within close proximity to the arrival and departure paths are not rotating, with due consideration of wind direction and the downstream projection of wake turbulence.

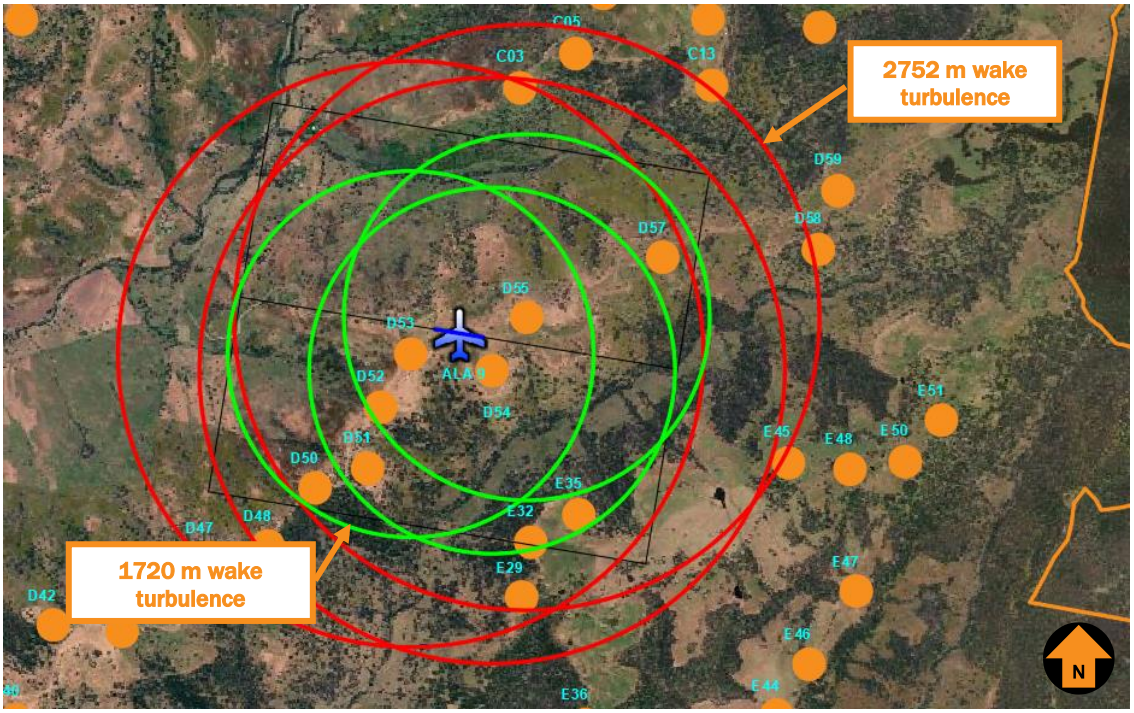

Figure 41 ALA 9 wake turbulence analysis

WTGs F1 and F8 are the closest WTGs to OZDAK ALA. Figure 42 shows a red circle of radius 2752 m and a green circle of radius 1720m based these WTGs extending to near the ALA within the northern circuit. When a northerly wind is blowing, operations to the north (i.e. standard left hand circuit on the easterly runway direction) may be affected by wake turbulence. In this case, operations should be limited to south of the ALA in stronger wind conditions.

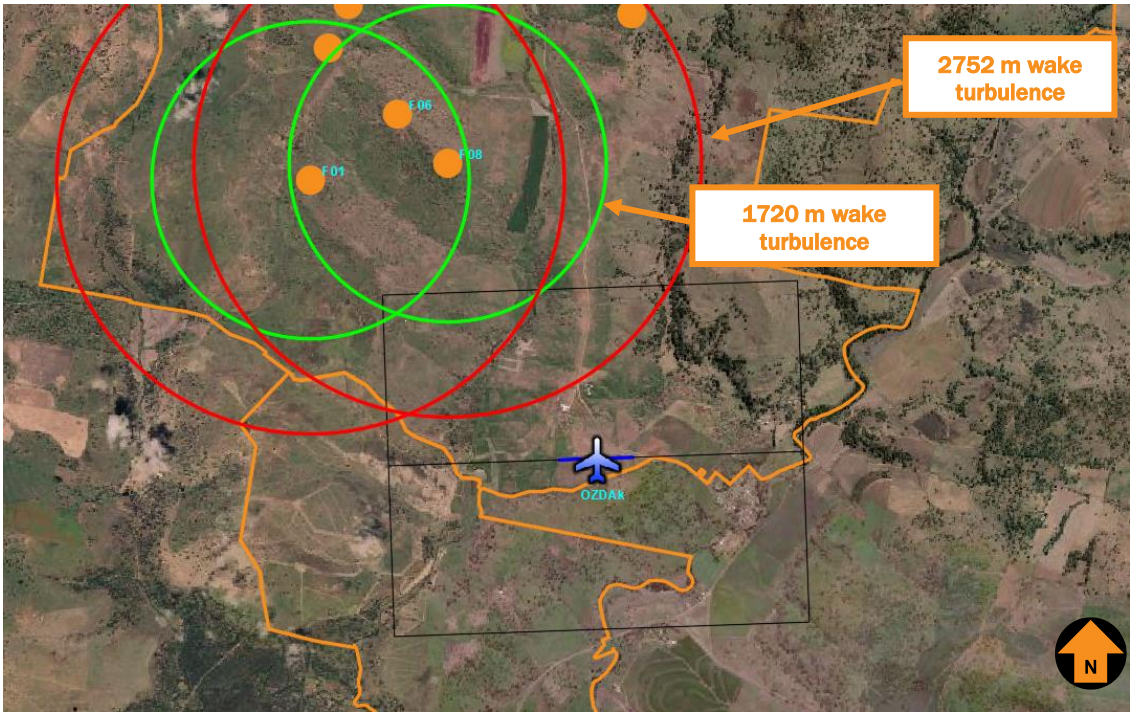

Figure 42 OZDAK ALA wake turbulence analysis

Transmission line

Figure 43 shows the proposed transmission line route (in red) relative to the nearby ALAs (source: Tilt Renewables, Google Earth).

The proposed transmission line route is located outside a 3 nm radius of ALA 1, ALA 2,ALA 4 and OZDAK. Therefore, the proposed 330 kV powerline will not impact these ALAs.

The overhead transmission power line will be within 3 nm of ALA 9, but aircraft operations will be relatively unconstrained by the overhead transmission line as it will be outside circuit area and approach / take off surfaces.

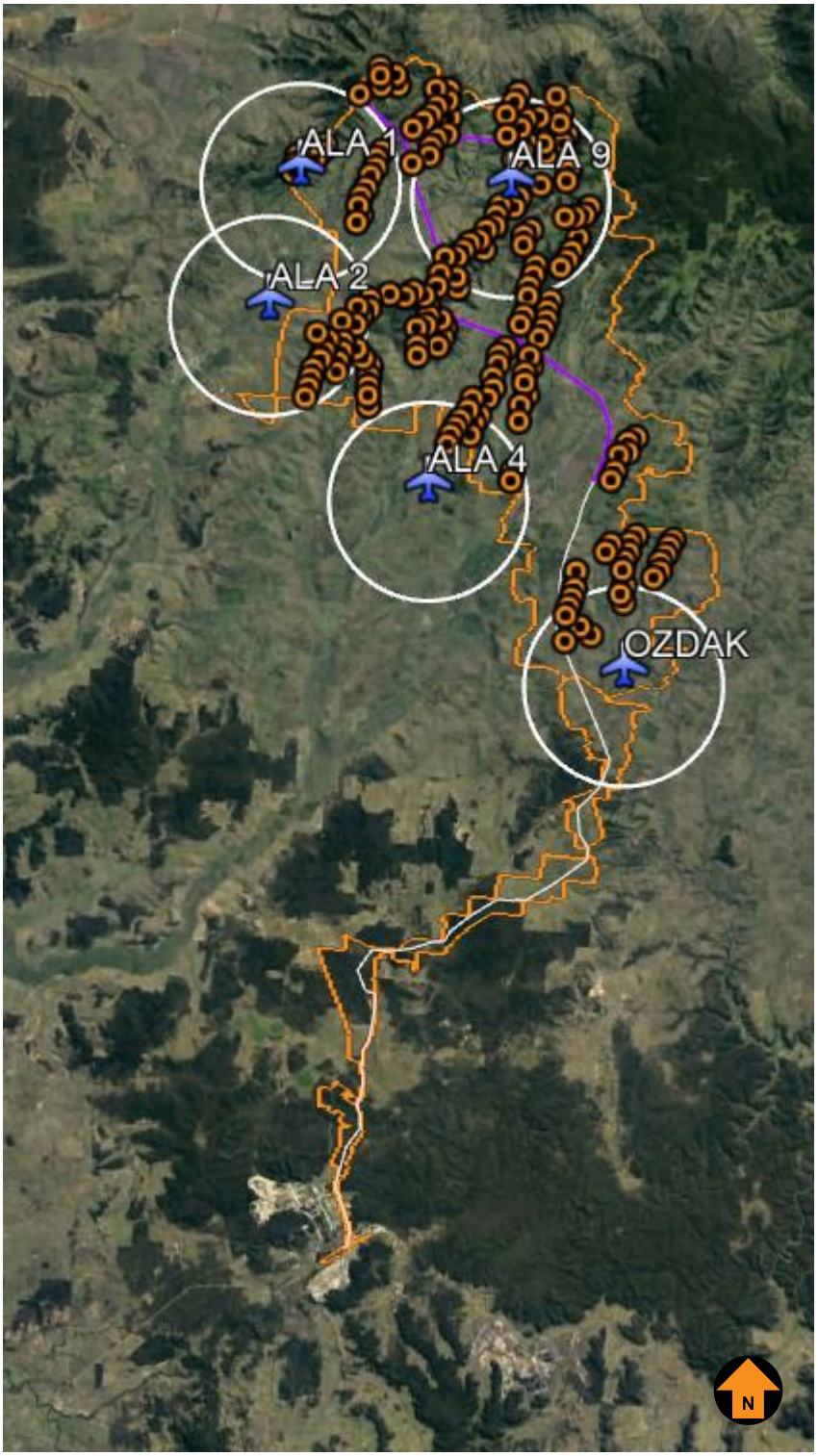

Figure 43 Transmission line route option relative to nearby ALAs

6.8. ALA analysis summary

The details of all discussed ALAs, their locations in relation to the RTS Project and potential impacts on aerodromes circuit operations and approach and departure paths are summarised in Table 3.

Table 3 Nearby aircraft landing areas (ALAs) – summary of potential impacts

ALA Name	*ICAO code*	*Registration status*	*Nearest WTG*	*Distance from the nearest WTG*	*Location relative to the nearest WTG*	*Impact on the OLS*	*Impact on flight circuit(s)*
ALA 1	N/A	uncertified	A1	0.9 km (0.50 nm)	south	Nil	Unlikely
ALA 2	N/A	uncertified	D5	3 km (1.6 nm)	north-west	Nil	Possible
ALA 3	N/A	uncertified	C14	3.7 km (2 nm)	north	Nil	Nil
ALA 4	N/A	uncertified	E1	3.5 km (1.9 nm)	south-west	Nil	Nil
ALA 5	N/A	uncertified	F8	9.0 km (5 nm)	south-east	Nil	Nil
ALA 6	N/A	uncertified	F35	7.3 km (3.9 nm)	east	Nil	Nil
ALA 7	N/A	uncertified	A03	11 km (6 nm)	north-west	Nil	Nil
ALA 8	N/A	uncertified	D5	7.5 km (4 nm)	west	Nil	Nil
ALA 9	N/A	Uncertified	D54	450 m (0.24 nm)	north	Nil	Likely
ALA 10	OZDAK	uncertified	F8	3.6 km (1.9 nm)	north	Nil	Nil
ALA 11	YADU	uncertified	C14	10.6 km (5.7 nm)	north-west	Nil	Nil

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

6.9. Air routes and LSALT

MOS 173 requires that a minimum obstacle clearance of 1,000 ft below the published LSALT is maintained along each air route.

The LRWF site is located within 3 grid LSALTs. The grid LSALT where the highest RTS Project WTG (C18) is located is 1,646 m AHD (5,400 ft AMSL) with a minimum obstacle clearance (MOC) surface of 1,341 m AHD (4,400 ft AMSL). WTG (C18) will be lower than 1341 m AHD (4400 ft AMSL) and will not impact the Grid LSALT.

Figure 44 provides the grid LSALTs and air routes in proximity to the RTS Project WTGs (source: ERC Low National, OzRunways, dated 10 May 2023).

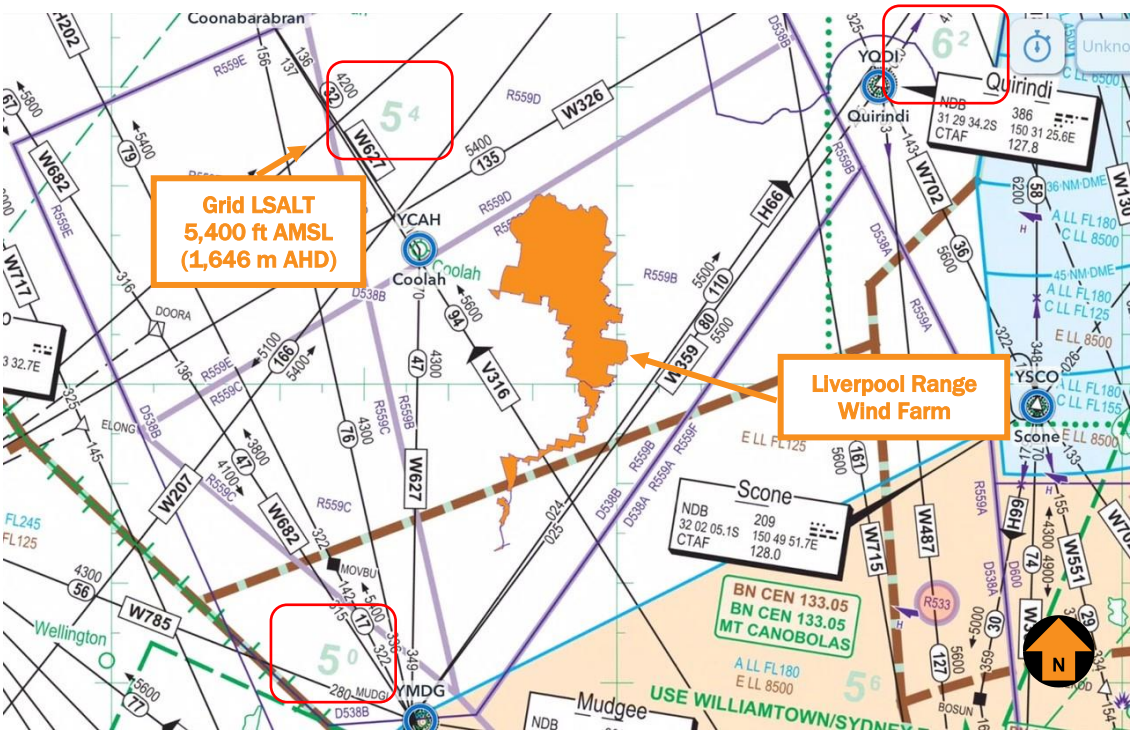

Figure 44 Air routes in proximity to the RTS Project WTG layout

An impact analysis of the surrounding air routes is provided in Table 4.

Table 4 Air route impact analysis

Air route	*Waypoint pair*	*Route LSALT*	*MOC*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
H66	MUDGI and YSTW	5,500 ft AMSL	1,372 m AHD 4,500 ft AMSL	Nil (below the controlling surface)	N/A	N/A
V316	YSSY and YCBB	5,600 ft AMSL	1,402 m AHD 4,600 ft AMSL	Nil (below the controlling surface)	N/A	N/A
W359	MUDGI and YSTW	5,500 ft AMSL	1,372 m AHD 4,500 ft AMSL	Nil (below the controlling surface)	N/A	N/A

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

The RTS Project will not impact on any nearby air routes.

6.10. Airspace Protection

The LRWF site is located outside controlled airspace (wholly within Class G airspace), within Restricted Area R559B, adjacent to Restricted Area R559D and within Danger Area D538B associated with RAAF Base Williamtown military restricted airspace. Figure 45 refers.

The restrictions of R559B on the airspace is detailed below:

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

The restrictions of R559D on the airspace is detailed below:

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

The restrictions of D538B on the airspace is detailed below:

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

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

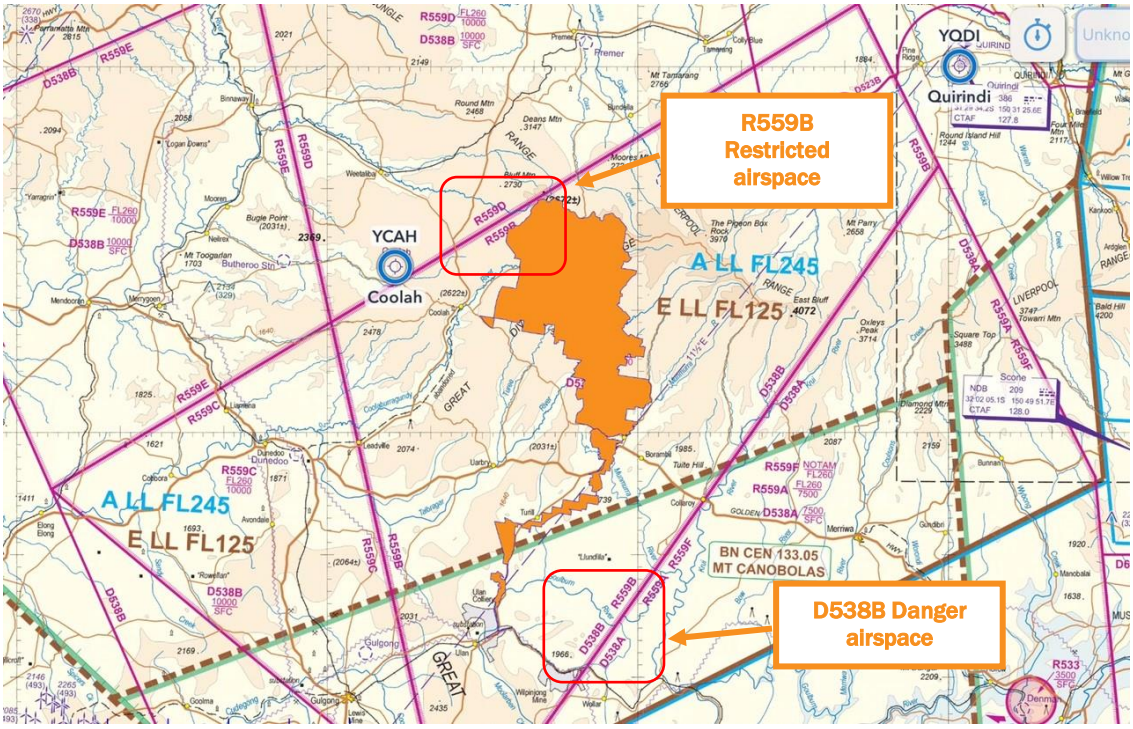

Figure 45 Danger and Restricted airspace relative to Project area

6.11. Aviation facilities

The following aviation facilities were identified in proximity to the LRWF site:

- non-directional (radio) beacon (NDB) at Quirindi Airport located approximately 58 km (31 nm) to the north-east from the LRWF site.
- NDB at Mudgee Airport located approximately 70 km (38 nm) to the south-west from the LRWF site.
- NDB at Scone Airport located approximately 79 km (43 nm) to the east from the LRWF site.

The RTS Project WTGs will not penetrate any protection areas, which extend to not more than 300 m, for the nominated aviation facilities.

Refer to Figure 46 for the location of nearby aviation facilities to the LRWF site (source: AsA, Google Earth).

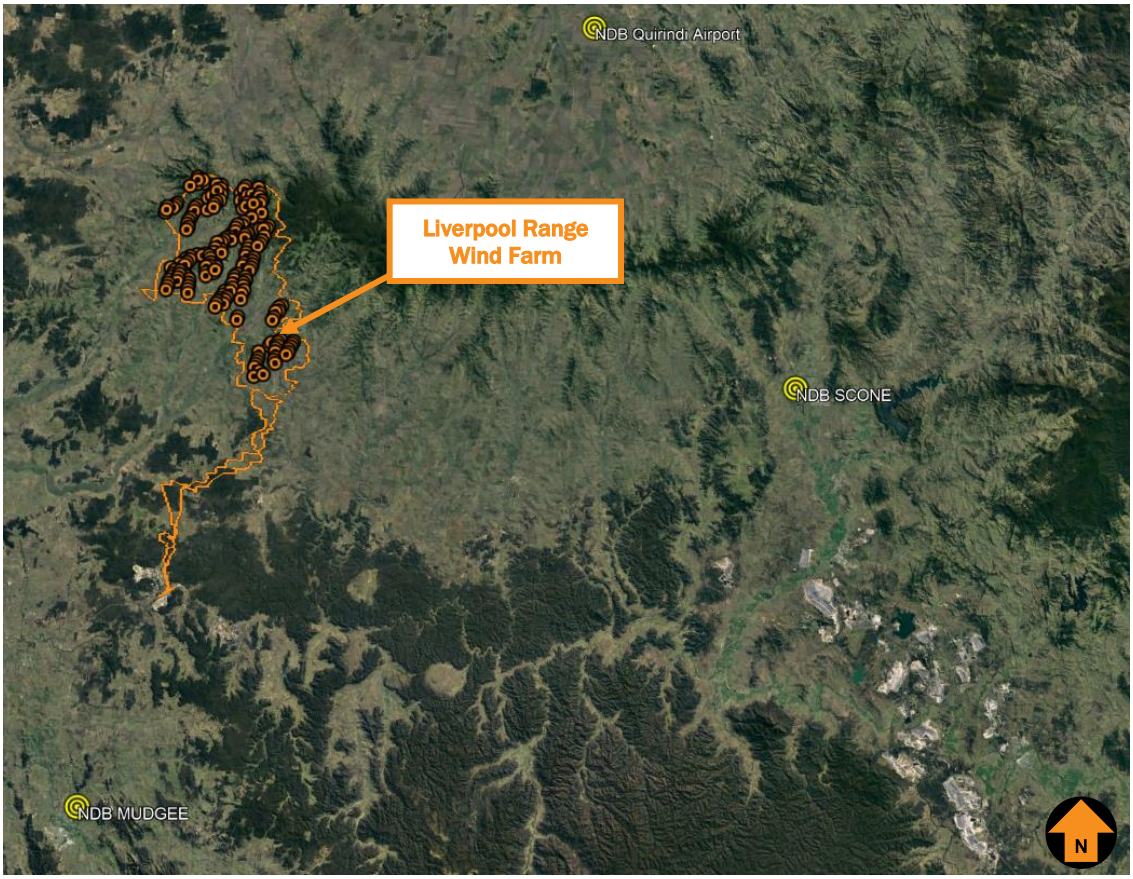

Figure 46 LRWF site location relative to nearby aviation facilities

6.12. Radar

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

The following radars were identified in proximity to the LRWF site:

- Mt Sandon SSR located approximately 141 km (76 nm) east
- Mt Boyce RSR located approximately 184 km (99 nm) south
- Williamtown tactical air command (TAC WLM) located approximately 197 km (107 nm) south-east
- Cecil Park SSR and Cecil Park PSR located approximately 227 km (123 nm) south
- Sydney SSR and Sydney PSR located approximately 248 km (134 nm) south
- The Round Mountain RSR located approximately 259 km (140 nm) north-east.

Refer to Figure 47 for the location of nearby navigation radars to the LRWF site (source: Airservices Australia, Google Earth).

Figure 47 LRWF site location relative to nearby navigation radars

The EUROCONTROL guidelines for assessing the potential impact of WTGs on surveillance sensors identifies the PSR and SSR safeguarding and assessments ranges.

The EUROCONTROL guidelines state:

> *When outside the radar line of sight of a PSR, the impact of the wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.*
>
> *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.*

The LRWF site is located in Zone 4 (accepted zone) and outside the radar line of sight of Mt Sandon SSR, Mt Boyce RSR, Williamtown tactical air command, Cecil Park SSR and PSR, Sydney SSR and PSR, and The Round Mountain RSR, and will not interfere with the serviceability of these aviation facilities.

6.13. Assessment Summary

Based on the RTS Project WTG layout and maximum blade tip height of up to 215 m AGL, the blade tip elevation of the highest WTG, which is C18, will not exceed 1,311 m AHD (4,301 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate any PANS-OPS surfaces (Coolah Airport is not served by instrument procedures)
- will not have an impact on nearby designated air routes
- will not have an impact on the grid LSALT will not have an impact on operational airspace
- is wholly contained within Class G airspace, but within lateral extent of the Danger Area D538B and may impact military flying training within this area
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

The list of WTGs (obstacles), showing coordinates and elevation data that are applicable to this AIS, are provided in **Annexure 5**.

6.14. Assessment recommendations

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

- consult with the Department of Defence on any potential impacts of the proposed RTS Project on military flying training within the Danger Area D538B

6.15. 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.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it is concluded that aviation lighting is not required for WTGs and WMTs, For completeness, relevant lighting standards and guidelines are summarised in **Annexure 3.**

This section therefore assesses the need for aviation marking for the proposed permanent WMTs and overhead 330 kV transmission lines.

7.1. Wind monitoring towers (WMTs)

Given that aerial operators might frequently use the airspace within the LRWF site and that it is expected that the proposed permanent WMTs will be constructed prior WTGs, the WMTs will be free-standing and not surrounded by any other obstacles. Therefore, the proposed WMTS should be marked with red/white/red bands as per the NASF Guideline D.

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

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

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

(8) The objects mentioned in subsection (7) must:

(a) be approximately equivalent in size to a cube with 600 mm sides; and

(b) be spaced 30 m apart along the length of the wire or cable.

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

- *the top 1/3 of wind monitoring towers to be painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;*
- *marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;*
- *ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or*
- *a flashing strobe light during daylight hours.*

The Proponent proposes to place aviation marker balls on the outside guy wires and paint the top 1/3 of WMTs structures in red and white bands.

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.

7.2. Overhead 330 kV transmission line

The RTS Project includes the provision of a 330 kV transmission line which would connect the on-site wind farm collector substations to the wider grid network at the proposed switching station at Ulan. The proposed transmission line will be approximately 96 km long and traverse through the Warrumbungle Shire, Upper Hunter Shire, and Mid-Western Regional LGAs. The transmission line is expected to be supported by poles or towers which are anticipated to be up to 60 m AGL tall.

The detailed design of the electrical reticulation will be finalised prior to the financing and construction of the RTS Project.

There is no regulatory requirement to mark or light power poles or overhead transmission lines.

According to the AAAA *Powerlines Policy* dated March 2011:

> *Most agricultural land in Australia is crisscrossed with powerlines and aerial application companies and pilots put enormous effort into managing these hazards safely, generally using a risk identification, assessment and management process in line with Australian Standard AS4360/ISO 3[1]000.*
>
> *The agricultural pilot curriculum mandated by CASA includes training for the safe management of powerlines and AAAA has been active in providing ongoing professional development for application pilots that includes a focus on planning, risk management and a knowledge of human factors relevant to managing powerlines in a low-level aviation environment.*

AAAA runs a specific training course for aerial application pilots entitled 'Wire Risk Management' to address these issues.

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

8.110 Marking of hazardous obstacles

(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.

(8) The objects mentioned in subsection (7) must:
(a) be approximately equivalent in size to a cube with 600 mm sides; and
(b) be spaced 30 m apart along the length of the wire or cable.

Following consultation with aerial operators, if a risk assessment is required, the Proponent should follow standards outlined in the AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations.*

8. ACCIDENT STATISTICS

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

8.1. General aviation operations

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

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

8.2. ATSB occurrence taxonomy

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

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

8.3. National aviation occurrence statistics 2010-2019

The Australian Transport Safety Bureau (ATSB) 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, and a further 154 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there were 35 fatalities from 22 fatal accidents**.** There have been no fatalities in scheduled commercial air transport in Australia since 2005.

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

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 5 (source: ATSB).

Table 5 Number of fatalities by General Aviation 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 48 refers to Fatal Accident Rate by operation type per million departures over the 6-year period (source: ATSB). Note the rates presented are not the full year range of the study (2010–2019). This was due to the availability of exposure data (departures and hours flown) which was only available between these years. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period ranged between 6.6 in 2014 and 4.9 in 2019.

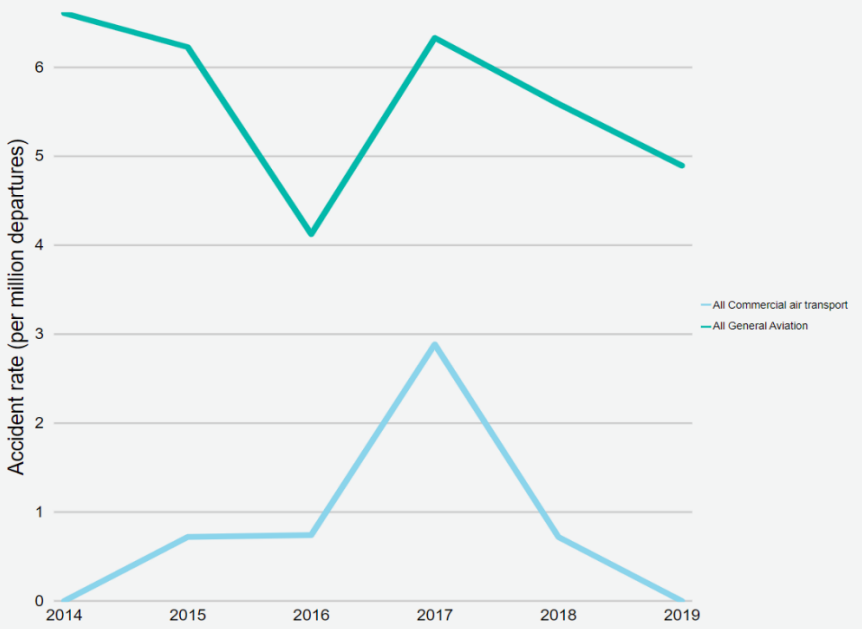

Figure 48 Fatal Accident Rate (per million departures) by Operation Type

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 6 (source: ATSB).

Table 6 Fatal accidents by GA sub-category – 2010 -2019

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

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

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

Of the 20,529 incidents, serious incidents and accidents in GA operations in the 10-year period, 1,404 (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

Worldwide since aviation accident statistics have been recorded, there have been a total of 4 aviation accidents involving a wind farm (i.e. where WTGs were erected). To provide some perspective on the likelihood of a VFR aircraft colliding with a WTG, a summary of the 4 accidents and the relevant factors applicable to this assessment is incorporated in this section.

Based on the statistics set out in the Global Wind Energy Council (GWEC) report 2016, 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.

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019. Aviation Projects has researched public sources of information, accessible via the world wide web, regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

The 4 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident, which resulted in 2 fatalities, occurred in Palm Springs in 2001. This accident involved a wind farm but was not caused by the wind farm. The cause of the accident was the 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 above a wind farm, and the aircraft struck a WTG on its descent and therefore the cause of the accident was not attributable to the wind farm and not applicable to this AIA.
- Two accidents involving collision with a WTG were during the day, as follows:
    - One accident occurred in Melle, Germany in 2017 as the result of a collision with a WTG mounted on a steel lattice tower at a very low altitude during the day with good visibility and no cloud. The accident resulted in one fatality. If the tower was solid and painted white, as is standard on contemporary wind farms, then it more than likely would have been more

visible than if it were to be equipped with an obstacle light which in all likelihood would not have been operating during daylight with good visibility conditions.

  - One accident occurred in Plouguin, France in 2008 when the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was flying in conditions of significantly reduced horizontal visibility in fog where the top of the WTGs were obscured by cloud. The WTGs became visible too late for avoidance manoeuvring and the aircraft made contact with two WTGs. The aircraft was damaged but landed safely. No fatalities were recorded.
  - In both of the above cases, it is difficult to conclude that obstacle lighting would have prevented the accidents.

- One fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC).

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group (wind-watch.org), which suggests a Cessna 182 collided with a WTG near Baraboo, Wisconsin, on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area. For this particular accident, NTSB found that the probable cause of the accident was VFR 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 in the NTSB database is made of WTGs or a wind farm.

A summary of the 4 accidents is provided in Table 7.

Table 7 Summary of accidents involving collision with a wind turbine

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

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
2	The Piper PA-32R-300, N8700E, was destroyed during an impact with the blades of a WTG, 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 obstacle 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 presence of WTGs. After sighting the WTGs he was unable to avoid them. The tip of the left wing struck the first WTG blade, followed by the tip of the right wing striking the blade of a second WTG. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plouguin, 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. The cause of this accident is not attributable to the wind farm.	Not applicable

9. RISK ASSESSMENT

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

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

9.1. Risk Identification

The primary risk being assessed is that of aviation safety associated with the height and location of WTGs and WMTs proposed by the RTS Project.

Based on an extensive review of accident statistics data (see summary in Section 8 above) and stakeholders who were consulted during the preparation of this AIA (see Section 5), 5 identified risk events associated with WTGs and WMTs relate to aviation safety or potential visual impact, and are listed as follows:

1. potential for an aircraft to collide with a WTG, controlled flight into terrain (CFIT) (related to aviation safety).
2. potential for an aircraft to collide with a WMT (CFIT) (related to aviation safety).
3. potential for a pilot to initiate manoeuvring in order to avoid colliding with a WTG or WMT resulting in collision with terrain (related to aviation safety).
4. potential for the hazards associated with the RTS Project to invoke operational limitations or procedures on operating crew (related to aviation safety).
5. Potential effect of obstacle lighting on neighbours (related to potential visual impact).

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. Therefore, 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.

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

9.2. Risk Analysis, Evaluation and Treatment

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

A summary of the level of risk associated with the RTS Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Tables 8 to 12.

Table 8 Aircraft collision with wind turbine generator (WTG)

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

Discussion

An aircraft collision with a wind turbine would result in harm to people and damage to property. Property could include the aircraft itself, as well as the 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 don't individually fly a significant number of hours in total, let alone in the area in question
- There is a very small chance that a pilot, suffering the stress of weather, will continue into poor weather conditions (contrary to the rules of flight) rather than divert away from it, is not aware of the wind farm, will not consider it or will not be able to accurately navigate around it.
- If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a WTG.

Refer to the discussion of worldwide accidents in Section 8.

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

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 LRWF site is clear of the obstacle limitation surfaces (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 (see Section 8). Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two 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 LRWF site is clear of the obstacle limitation surfaces (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 RTS Project WTGs will be a maximum of 215 m (706 ft) AGL at the top of the WTG blade tip. The WTG blade at its maximum height will be approximately 63 m (206 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 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 WTG hub (assumed to be approximately 150-160 m AGL), obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles (including terrain) which are 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 undertaken specifically for and prior to undertaking such authorised flights. Any obstacle including WTGs in the path of the authorised flight would be specifically risk assessed during that process.
- The WTGs are typically coloured white so they should be visible to pilots during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts.
- Because the RTS Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction.

Level of Risk

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

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 RTS Project should be communicated to local and regional aircraft operators (refer to **Section 5**) prior to 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 blades prior to the commencement of the subject aircraft operations within the LRWF site.
    - Arrangements should be made to publish details of the RTS Project in ERSA for surrounding aerodromes, which would involve notification to Airservices Australia.

Residual Risk

With the implementation of the Recommended Treatments listed above, 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) and hence is not justified.

The level of risk with the implementation of the Recommended Treatments 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 RTS Project WTG without obstacle lighting on the WTGs.

Residual Risk	7 - Tolerable

Table 9 Aircraft collision with wind monitoring tower (WMT)

Risk ID:	**2. Aircraft collision with a wind monitoring tower (WMT) (CFIT)**
Discussion An aircraft collision with a WMT would result in harm to people and damage to property. The Proponent has approval to construct 2 temporary lattice steel WMTs supported by guy wires in three directions, being a nominal 110 m (361 ft) AGL and 140 m (459 ft) AGL. One WMT has already been constructed, and the other WMT is due to be constructed in May/April 2021. In addition, the RTS Project proposes up to 10 permanent lattice steel WMTs supported by guy wires in three directions across the LRWF site, with a maximum height of 169 m (554 ft) AGL. The WMT towers will be steel lattice masts and will be installed at different locations around the LRWF site. The proposed temporary and permanent WMTs will have high visibility aviation marker balls up on the top-level guy wires and the top 1/3 of the WMTs painted in red/white/red bands of equal length. The location of the proposed temporary and permanent WMT locations and other applicable details will be provided to Airservices Australia prior to construction. There are a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and none were in Australia. There is a relatively low rate of aircraft activity in the vicinity of the LRWF site. There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm. If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: • whether the object or structure will be a hazard to aircraft operations • 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 temporary and permanent WMT locations will be advised to CASA and Airservices Australia prior to construction.
- 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 highest temporary WMT will be at a maximum height of 140 m (459 ft), which will be 41 ft (12 m) below the minimum height of 500 ft AGL for an aircraft flying at this height. The highest permanent WMT will be at a maximum height of 169 m (554 ft) AGL, which will be 54 ft (16.6 m) above the minimum height of 500 ft AGL for an aircraft flying at this height.
- In the event that descending cloud forces an aircraft lower than 152.4 m (500 ft) AGL, the minimum visibility of 5,000 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 (1,000 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.
- Since the WMTs will be higher than 100 m AGL, there is a statutory requirement to report them to CASA and Airservices Australia prior to construction.

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 any WMTs when they are constructed should be advised to Airservices Australia.
- Consideration could be given to marking any wind monitoring towers according to the requirements set in MOS 139 Chapter 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically:

  8.110 (5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is,

approximately, the lesser of: 1/7 of the height of the structure; or 30 m. *8.110 (7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects. (8) The objects mentioned in subsection (7) must: be approximately equivalent in size to a cube with 600 mm sides; and be spaced 30 m apart along the length of the wire or cable.* • Ensure details of any additional WMTs at the LRWF site have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.
Residual Risk With the additional Recommended Treatments listed above, the likelihood of an aircraft collision with a WMT 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. Under these circumstances, the level of risk under the proposed treatment plan is considered **ALARP.** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the temporary WMTs and the RTS Project permanent WMTs, without obstacle lighting on the WMTs.**
Residual Risk | 7 - Tolerable

Table 10 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 LRWF site is clear of the obstacle limitation surfaces (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 WTGs will be a maximum of 215 m (706 ft) AGL at the top of the WTG blade tip. The WTG blade at its maximum height will be approximately 63 m (206 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL.

Nevertheless, the minimum visibility of 5,000 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 WTG hub (approximately 120-130 m AGL), obstacle lighting would be obscured and therefore ineffective.

Aircraft are restricted to a minimum height of 304.8 m (1,000 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 WTGs can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the turbines to CASA.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid WTGs, but none in Australia, and all were during the day (see Section 8). 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 LRWF site is clear of the obstacle limitation surfaces (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.
- Nevertheless, the minimum visibility of 5,000 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 WTG hub (approximately 120-130 m AGL), obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The WTGs are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of the WTGs can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs 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 RTS Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to 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 LRWF site.
Residual Risk With the additional Recommended Treatments listed above, 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 assessed that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a RTS Project WTG without obstacle lighting on the WTGs.**

Residual Risk	7 - Tolerable

Table 11 Effect of the RTS 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 LRWF site.	
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 LRWF site is clear of the obstacle limitation surface (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 215 m (706 ft) AGL at the top of the blade tip, so the WTG blade at its maximum height will be approximately 63 m (206 ft) above aircraft flying at the minimum altitude of 152.4 m (500 ft) AGL. • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs and WMTs. • 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 and WMTs. • If cloud descends below the WTG hub (approximately 120-130 m AGL), obstacle lighting would be obscured and therefore ineffective. • Aircraft are restricted to a minimum height of 304.8 m (1,000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).	

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

Recommended Treatments

Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the LRWF site, there is likely to be little additional safety benefits 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 RTS Project WTGs and WMTs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to 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 LRWF site.

Residual Risk

Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.**

It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the RTS Project WTGs and WMTs.

Residual Risk	5 – Tolerable

Table 12 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 WTGs and/or WMTs at the LRWF site. Installation and operation of obstacle lighting on WTGs or WMTs can have an adverse effect on nearby residents' visual amenity and enjoyment, specifically at night and in good visibility conditions. The LRWF site is located approximately 100 km southeast of the Siding Springs Observatory within a Dark Sky Region in NSW, and subject to the local controls for lighting and consultation requirements set out in the NSW *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Springs* (Department of Planning and Environment, 2016). If the WTGs or WMTs are higher than 150 m (492 ft) AGL, the WTGs must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Consequence The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be: • 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. This would be a Major consequence.	
Consequence	Major
Untreated Likelihood The likelihood of high site impact, moderate 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 will be higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Level of Risk The level of risk associated with an Almost certain likelihood of a Major consequence is 9.	
Current Level of Risk	9 - Unacceptable

Risk Decision A risk level of 9 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.

As per the above safety risk assessment, the provision of lighting for the WTGs and permanent WMTs is not necessary to provide an acceptable level of safety.

However, if CASA or planning authority decide that obstacle 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 that have 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.

These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to residents within and around the LRWF site.

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 associated with the obstacle lighting.

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 **Major** consequence is **Likely**, with a resulting risk level of **8 – Unacceptable**.

It is our assessment that visual impact from obstacle lights can be negated if they are not installed. If obstacle lights are requested to be installed, various lighting design measures are potentially available which may result in an acceptable risk of visual impact to neighbours. These measures vary in cost and effectiveness.

Residual Risk	**8 - Unacceptable**

10. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

10.1. Project description

The RTS Project will comprise of the following:

- up to 185 wind turbines
- maximum overall height (tip height) of the WTGs is up to 215 m AGL
- highest wind turbine is C18 with ground elevation of 1,096 m AHD and overall height of 1,311 m (4,301 ft AMSL)
- up to 10 permanent WMTs with a maximum height of up to 169 m (554 ft) AGL, which will be reported to Airservices Australia once the final locations are confirmed prior to construction.

In addition, 2 temporary WMTs with a maximum height of 110 m (361 ft) AGL and 140 m (439 ft) AGL have already been granted approval at the LRWF site, and therefore do not form part of the RTS Project. The 140 m WMT was constructed in 2020 and already reported to Airservices Australia. The 110 m WMT was constructed in May 2021 and has been notified to Airservices Australia.

10.2. Regulatory requirements

The following regulatory requirements apply:

- There is no regulatory requirement for lighting of obstacles lower than 150 m (492 ft) AGL that are not within the vicinity of an aerodrome.
- With respect to MOS 139 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 MOS 139 Chapter 8 Division 10 8.110.
- WTGs must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.

10.3. Planning considerations

There are no provisions for airfields included in the Warrumbungle Local Environmental Plan 2013.

The Upper Hunter Shire Local Environment Plan 2013 includes provisions for airspace operations at Scone Airport. The Project is located more than 30 nm from Scone Airport and will therefore have no impact to Scone Airports airspace, or operations.

The Mid-Western Regional Local Environmental Plan 2012 includes provisions for the protection of airspace surrounding Mudgee Airport. The Project is located outside of the 30 nm buffer area associated with Mudgee Airport and will therefore have no impact on the airport.

10.4. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties. Consultation is detailed in **Section 5.**

10.5. Aviation Impact Statement

Based on the proposed RTS Project layout and overall turbine blade tip height limit of 250 m AGL, the blade tip elevation of the highest WTG, which is C18, will not exceed 1,311 m AHD (4,301 ft AMSL) and:

- will not penetrate any OLS surfaces
- will not penetrate any PANS-OPS surfaces (Coolah Airport is not served by instrument procedures)
- will not have an impact on nearby designated air routes
- will not have an impact on the grid LSALT
- will not have an impact on operational airspace
- is wholly contained within Class G airspace, but within lateral extent of the Danger Area D538B. Low level military flight operations within Danger Area D538B will need to be conducted in consideration of the RTS Project WTGs
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

Airservices Australia response is copied below:

> ***Airspace Procedures***
>
> *With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum turbine height of 1349m (4426ft) AHD, the proposed wind farm, including wind mast, will not affect any sector or circling altitude, nor any instrument approach or departure procedure at any nearby aerodromes. It will also not affect any overhead air routes.*
>
> *Note that procedures not designed by Airservices at any nearby aerodromes were not considered in this assessment.*
>
> ***Communications/Navigation/Surveillance (CNS) Facilities***
>
> *This wind farm, to a maximum height of 1349m (4426ft) AHD, will not adversely impact the performance of Precision/Non-Precision Navigational Aids, HF/VHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.*
>
> ***Grid lowest safe altitude (LSALT)***
>
> *Assessment of the wind farm shows that the following wind turbine will penetrate the published Grid LSALT:*
>
> - *C15 (formerly identified as ZEN001)*
> - *C18 (formerly identified as C070)*
>
> *An increase in the LSALT value of 100ft would be required.*
>
> *When completing and submitting the Vertical Obstacle Notification Form (see below Vertical Obstacle Notification section for further information), please copy in the above Grid LSALT assessment text above and quote this assessment code in order for the changes to be implemented.*

Summary

Based on the above assessment, Airservices view is that the proposed wind farm would not have an impact on the safety, efficiency or regularity of existing, or future air transport operations into or out of any airport. [emphasis added]

Vertical Obstacle Notification

As this proposed wind farm is in excess of 30m (99ft) AGL, as soon as construction commences, the proponent must complete the Vertical Obstacle Notification Form for tall structures and submit the completed form to VOD@airservicesaustralia.com

Department of Defence response is copied below:

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

The proposed structures will meet the definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com .

Defence understands this assessment is yet to be considered by CASA. If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres.

Defence notes that the National Airports Safeguarding Framework Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers - Paragraph 39 recommends the top 1/3 of wind monitoring towers are painted in alternating contrasting bands of colour in accordance with the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998.

Defence has no objection to the proposed wind farm provided that the project complies with the above conditions. [emphasis added]

10.6. Aircraft operator characteristics

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

The Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, stopping the rotation of the WTG blades prior to the commencement of the subject aircraft operations within the LRWF site.

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.

The effects of wake turbulence could be noticeable at ALA 1, ALA 2, ALA 3, ALA 4, ALA 9 and OZDAK ALA.

Operations to ALA 1 may be affected by wake turbulence when the wind is blowing from the north clockwise around to the south.

The landowners for ALA 1 confirmed that the runway is used infrequently, and when in use pilots will only approach and take-off in the one direction, being the nominally indicative right-hand circuit. Existing obstacles to

the north of the runway inhibit the use of a left-hand circuit. Therefore, it is unlikely that the RTS Project will impact circuit operations or approach and take-off surfaces at ALA 1.

Departures from ALA 2 to the south-east may be affected by wake turbulence when a south easterly wind is blowing.

Aircraft would typically operate at circuit heights of 500 ft above the runway within 3 nm radius of ALA. WTGs within 3 nm of ALA 2 have ground elevation of up to 325 m above the runway elevation, showing in Figure 34. With maximum tip heights of 215m of these WTGs, which will reach 540m (1172 ft) above the runway end. These WTGs would therefore be considered potentially hazardous obstacles for aircraft operating in the circuit area.

Operations to the south (i.e. standard left hand circuit on the westerly runway direction) at ALA 3 may be affected by wake turbulence when a southerly wind is blowing.

WTG E1 is the closest WTG to ALA 4. Figure 43 shows a red circle of radius 2752 m based on E1 extending to near ALA 4. When a northerly wind is blowing, departures to the north-west may be affected by wake turbulence.

Operations to the north (i.e. standard left hand circuit on the easterly runway direction) of OZDAK ALA may be affected by wake turbulence when a northerly wind is blowing. In this case, operations should be limited to south of the ALA.

WTG D54 is the closest WTG to ALA 9, which is located approximately 450 m from the ALA. Standard circuit operations will not be available due to the proximity and height of the wind turbines to ALA 9. The overhead transmission power line, supported by poles or towers with an anticipated height of less than 55 m above ground level (AGL). Operations will be relatively unconstrained by the overhead transmission line. It should be noted the approach and take-off surfaces for ALA 9 will remain clear of any obstacles.

To avoid any adverse impact from downstream wake turbulence caused by the WTGs in the proximity of ALA 9, aircraft operators should plan to operate when the WTGs closest to the ALA and within proximity to the arrival and departure paths are not rotating, with due consideration of wind direction and the downstream projection of wake turbulence.

Further analysis of aerodrome flight circuits was deemed not required for ALA 3, ALA 4 and OZDAK, as the aerodrome flight circuits and approach and take-off surfaces of these ALAs are not impacted by the RTS Project.

10.7. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to MOS 139 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 MOS 139 Chapter 8 Division 10 8.110.
- WTGs must be lit in accordance with MOS 139 Chapter 9 Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- Aviation Projects has assessed that the proposed WTGs and WMTs 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 WTGs, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- Consideration should be given to marking the temporary and permanent WMTs according to the requirements set out in MOS 139 Section 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D). Specifically:
    - marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires
    - paint markings should be applied in alternating contrasting bands of colour to at least the top 1/3 of the mast.
- Maximum height of the 330 kV transmission line poles or towers is anticipated to be up to 60m. The transmission line alignment is located outside a 3 nm radius of ALA 1, ALA 2, ALA 4 and ALA 5. Therefore, the proposed transmission line will not impact these ALAs.

10.8. Comparative Assessment - Approved Project and RTS Project

As detailed in Section 6, the findings of this AIA are consistent with those set out in the *Liverpool Range Wind Farm Aviation Impact Assessment (09 February 2017)* previously prepared by REHBEIN Airport Consulting in support of the original development application.

The REHBEIN Airport Consulting report was based on a maximum blade tip height of 165 m AGL. The WTGs height has been amended to a maximum blade tip height of 215 m AGL. There will no impact on Grid LSALT by the RTS Project.

10.9. Summary of risks

A summary of the level of residual risk associated with the RTS Project with the Recommended Treatments implemented, is provided in Table 13.

Table 13 Summary of Residual Risks

Identified Risk	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine generator (WTG)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the RTS Project WTGs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with wind monitoring tower (WMT)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Although there is no obligation to do so, consideration has been made for marking the WMTs according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Communicate details of WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Communicate details of the RTS Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	**Acceptable without obstacle lighting (ALARP)** Communicate details of the RTS Project WTGs and WMTs to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights on WTGs and/or WMTs	Major	Likely	8	**Acceptable without obstacle lighting** (zero risk of visual impact if obstacle lighting is not installed to WTGs and/or WMTs). If lights are installed, design and mitigation measures unlikely to remove all effects. Likely to have high site impact, moderate local impact.

11. RECOMMENDATIONS

Recommended actions resulting from this AIA are provided below.

Notification and reporting

1. 'As constructed' details of WTGs and WMT coordinates and elevations should be provided to Airservices Australia, using the following email address: vod@airservicesaustralia.com.
2. Department of Defence should be consulted if there is any subsequent modification in the WTG height or scale of development, using the following email address: land.planning@defence.gov.au.
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office (via phone number: 02 6268 5063) until they are incorporated in published operational documents. With respect to crane operations during the construction of the RTS Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction so they can plan their operations accordingly
5. To facilitate the flight planning of aerial application operators, details of the RTS Project, including location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

6. Whilst not a statutory requirement, 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 LRWF site, particularly at ALAs 1, 2, 3, 4, 9 and OZDAK ALA.

Marking of wind turbine generators (WTGs)

7. The WTG blades, nacelle, hubs and towers should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Lighting of WTGs

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

Marking of wind monitoring towers (WMTs)

9. Although there is no regulatory requirement, to mitigate aviation safety risks to low level aircraft operations in the area, consideration should be given to marking the 2 temporary WMTs (subject to separate approvals) and up to 10 permanent RTS Project 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.

Markers and markings are preferred to the flashing strobe light.

Marking of overhead transmission lines and poles

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

Micrositing

11. In accordance with Development Consent SSD 6696 WTGs may only be microsited less than 100 m from an approved location. The potential micrositing of the WTGs has 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 WTG position. The micrositing of the WTGs is likely to not result in a change in the maximum overall blade tip height of 1,347 m (4,418 ft) (C18) assessed in this AIA. No further assessment is likely to be required from micrositing WTGs and the conclusions of this AIA would remain the same.

Triggers for review

12. Triggers for review of the risk assessment set out in this AIA 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. CASA regulatory requirements – Lighting and Marking
4. Risk Framework
5. Turbine coordinates and heights

ANNEXURE 1 – REFERENCES

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

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 02 December 2021
- Airservices Australia, Designated Airspace Handbook, effective 02 December 2021
- Bureau of Meteorology, NSW/ACT Radar Sites Table and Information, http://www.bom.gov.au/australia/radar/nsw_radar_sites_table.shtml
- Civil Aviation Safety Authority, Civil Aviation Regulations 1998 (CAR)
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 166-01 (v4.2): Operations in the vicinity of non-controlled aerodromes, dated February 2019
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016
- Civil Aviation Safety Authority, *Part 139 (Aerodromes) Manual of Standards 2019*, dated 13 August 2020
- Civil Aviation Safety Authority, Advisory Circular (AC) 139.E-01 v1.0: *Reporting of Tall Structures*, dated 08 December 2021
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, dated June 2013
- Department of Planning and Environment, NSW Government, *NSW Wind Farm Guideline for State significant wind energy development*, December 2016
- Department of Planning and Environment, NSW State Government, Wind Energy: Visual Assessment Bulletin – For State significant wind energy development, December 2016
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- Mid-Western Regional Council, *Mid-Western Regional Development Control Plan 2013,* amendment No 4, commencement 21 June 2019
- Mid-Western Regional Council, *Mid-Western Regional Local Environmental Plan 2012*, current version dated 01 December 2021
- OzRunways, aeronautical navigation charts extracts, dated 02 December 2021

- Standards Australia, ISO 31000:2018 *Risk management - Guidelines*
- Standards Australia, AS 3891.2:2018 *Air navigation – Cables and their supporting structures – Marking and safety requirements Part 2: Low level aviation operations*
- Upper Hunter Shire Council, Upper Hunter Local Environmental Plan 2013, current version dated 26 November 2021
- Warrumbungle Shire Council, *Warrumbungle Local Environmental Plan 2013*, current version dated 26 November 2021
- Warrumbungle Shire Council, *Warrumbungle Shire Council Development Control Plan 2015*, amendment 16 February 2017.

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)	The 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 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

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

Manual of Standards Part 139—Aerodromes

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

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

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

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

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

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

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

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

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

6. *High-intensity obstacle lights:*

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

b. *must be flashing white lights.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

c. provided at lower levels to indicate the full height of the structure; and

d. *spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.*

Advisory Circular 139.E01v1.0—Reporting of Tall Structures

In Advisory Circular (AC) 139.E01v1.0—*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 for the RAAF, or

c) 30 m above ground level elsewhere for Airservices Australia.

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

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

International Civil Aviation Organisation

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

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

> *6.2.4 Wind turbines*
>
> *6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.*
>
> *Note 1.— Additional lighting or markings may be provided where in the opinion of the State such lighting or markings are deemed necessary.*
>
> *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 obstacle limitation surfaces states the following:

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

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

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

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

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

Light characteristics

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

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

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

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

1. *Low-intensity obstacle lights must have the following:*
    a. *fixed lights showing red;*
    b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*
    c. *a minimum intensity of 100 candela (cd);*
    d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*
    e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*
    f. *not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.*

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

a. *taxiway obstacles;*

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

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

1. *Medium-intensity obstacle lights must:*

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

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

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

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

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

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

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

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

Visual impact of night lighting

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

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

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness
- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
  - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal
  - such that no light is emitted at or below 10 degrees below horizontal
- Where two lights are mounted on a nacelle, dynamic shielding or light extinction of one light at a time, for the period that a blade is passing in front of the light, is permissible, providing that at all times at least one light can be seen, without interruption, from every angle of azimuth

- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall turbine.

Marking of turbines

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

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

Wind monitoring towers

The details of the WMTs were introduced in **Section 4** of this report.

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

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

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

- the top 1/3 of wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers
- marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires
- ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation
- a flashing strobe light during daylight hours.

ANNEXURE 4 – RISK 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 – RTS PROJECT TURBINE COORDINATES AND HEIGHTS

Source: Tilt Renewables, LRWF_RTS_Modified Turbine Layout_L8_185WTG_Spreadsheet_20230501.xlsx

WMT ID	Easting	Northing	Base Elevation (m AHD)
A01	764360.7	6485938	883
A02	764566.8	6486348.3	916
A03	764737.4	6486840.8	945
A04	765656.7	6486573	909
A05	766042.9	6486931.6	922
A06	766305.2	6487293.7	965
A10	768522	6489885	1038
A14	769778.7	6490193.3	1059
A15	769806.1	6490772.8	1069
A16	769841.5	6491204.5	1067
A17	770656.8	6490699.3	1065
A18	770735.7	6490141.6	1057
B01	767578.5	6482849	762
B02	767769.7	6483760.5	796
B03	767877	6483242.1	780
B04	767974.6	6484271	759
B05	768299.1	6484682.6	782
B06	768637.6	6485368.1	781
B07	768977.1	6485759.4	792
B08	769063.2	6486276.5	797
B09	769439.7	6486643	809
B10	771045.1	6485765.7	883
B11	771282.5	6487692.7	913
B13	771954.9	6488051.7	986
B14	772082.3	6486064.9	972

WMT ID	Easting	Northing	Base Elevation (m AHD)
B16	772225.1	6486574.9	978
B18	772386.2	6488340.1	998
B19	772575.2	6486982.4	983
B20	772763.1	6488774.3	990
B21	772792.6	6489754.6	1021
B24	773205.9	6487151.7	989
B25	773412.4	6489030.1	998
B26	773426.8	6488065.9	944
B27	773499.2	6489633.3	1047
C01	776481	6486764.4	899
C02	776559.5	6487940.7	927
C03	776772	6485421.2	967
C04	777120.8	6488572	984
C05	777296.6	6485743.6	999
C06	777334.8	6487107.9	974
C07	777395.1	6489019.7	1075
C08	777554.1	6486308.5	1013
C09	777667.3	6487543.4	1044
C11	778417.3	6487559	1085
C12	778539.1	6486067.9	1055
C13	778573.4	6485444.7	1027
C14	779475.1	6488637.9	1053
C15	779541.1	6487123.9	1086
C16	779588.3	6485989.8	1027
C17	779674.1	6487677.2	1086
C18	779864	6486437.1	1091
D01	763794.6	6473432.4	818
D02	764026.2	6473962.7	830
D03	764216.8	6474466.9	846

WMT ID	Easting	Northing	Base Elevation (m AHD)
D04	764399.7	6474954.2	877
D05	764809.6	6476905.4	857
D06	764885.1	6475415.8	851
D07	765139.9	6475866.8	858
D08	765447.1	6476442.9	900
D09	765682.1	6474643.5	842
D10	765851.3	6475212.4	884
D11	766123.3	6475735.5	933
D12	766245.8	6476249.2	949
D13	766275.7	6477420.7	872
D14	766940.6	6475781.5	885
D15	767048.4	6477144	874
D16	767234.4	6478104.7	881
D17	767250.6	6472605.8	752
D18	767257.7	6475257.8	854
D19	767282.1	6473181.7	775
D20	767373.4	6477563.1	883
D21	767370.9	6473699.5	783
D22	767458.2	6474215	791
D23	767599.8	6474796.6	854
D24	767886.8	6477939.7	879
D25	767979	6478453.5	886
D26	769097.1	6478642.7	891
D27	769937.3	6478420.1	894
D28	770260.3	6475108.7	778
D29	770321.7	6475637.7	812
D30	770415.9	6476611.5	914
D31	770420.1	6478652.1	900
D32	770951.7	6476713.9	908

WMT ID	Easting	Northing	Base Elevation (m AHD)
D33	771013.7	6478364	890
D34	771142.3	6477197.9	923
D35	771149.4	6477850.7	884
D36	771479.8	6475500.9	835
D37	771784.4	6475940.1	883
D38	771774.5	6478808.3	893
D39	771812.7	6476946.5	929
D40	772031.2	6479483.4	896
D41	771987.1	6476442.3	921
D42	772383.1	6480376.4	915
D43	772898.1	6479197.2	884
D44	772920.4	6478595.8	895
D45	773029.6	6480314.3	922
D46	773445.2	6480651.3	924
D47	773848.9	6480999	924
D48	774403.6	6481119.2	921
D49	774609.2	6480574.3	919
D50	774845	6481663	910
D51	775337.8	6481846.2	918
D52	775461.3	6482422.1	911
D53	775743.8	6482919.8	907
D54	776508.7	6482765.4	921
D55	776834.8	6483265.8	933
D57	778113.2	6483830.8	942
D58	779577	6483903.3	968
D59	779760.6	6484455.9	1020
E01	771416.8	6470033.7	731
E02	771655.4	6470550.2	748
E03	771973.8	6470942.5	767

WMT ID	Easting	Northing	Base Elevation (m AHD)
E04	772291.3	6471337.4	772
E05	772772.9	6470418.8	759
E06	772784.3	6471841.1	782
E07	773012	6471044.5	755
E08	773091.3	6472424.5	788
E09	773365.9	6471446.7	782
E10	773955.6	6472378.8	785
E11	774330.4	6472872.9	776
E12	774332.1	6473497.5	786
E13	774702.8	6474188.1	797
E14	774745.4	6467672.7	664
E15	774811	6474695.1	806
E16	774919.3	6468177	663
E17	775216.5	6475017.6	778
E18	775544.1	6470908	702
E19	775734.1	6471796.6	712
E20	776074.4	6473020.4	769
E21	776145.2	6473541	779
E22	776153.3	6472322.4	719
E23	776175.8	6476263.4	835
E24	776439.7	6476720.5	848
E25	776508.8	6474451.5	802
E26	776528.5	6473904	786
E28	776767.3	6477770.9	921
E29	776786.6	6480639.2	933
E31	776882.7	6478314.4	925
E32	776872.9	6481153.2	933
E33	777149.3	6475420.5	828
E34	777201.8	6478904.8	925

WMT ID	Easting	Northing	Base Elevation (m AHD)
E35	777324.4	6481410.4	931
E36	777382.1	6479440.6	911
E37	777428.8	6475882.5	800
E38	777662.4	6476369.6	837
E39	777771	6476892.5	890
E40	778007	6477394.5	862
E43	778767.7	6479174.2	910
E44	779184.5	6479529.8	902
E45	779295.6	6481898.7	1021
E46	779488.5	6480006.7	957
E47	779933	6480695.3	955
E48	779873.9	6481838.1	1003
E50	780393.6	6481909	1010
E51	780733.6	6482300.4	1012
F01	776890	6458474.7	590
F02	777082.1	6459907.4	656
F03	777300.5	6460379	651
F04	777517	6460853	631
F05	777720.6	6461337.8	641
F06	777833.6	6459190.4	642
F07	777907.6	6462294.2	636
F08	778377.8	6458657.9	641
F09	779661.6	6463197.4	648
F10	780000.6	6463590.4	644
F11	780236.3	6460778.2	643
F12	780354.6	6467150.4	745
F13	780373.4	6460278.6	629
F14	780499.6	6462103.4	649
F15	780509.9	6461228.7	644

WMT ID	Easting	Northing	Base Elevation (m AHD)
F16	780618.6	6467599.4	749
F17	780622.6	6462625.4	650
F20	780939.6	6463036.4	657
F21	780950.8	6468487.8	762
F22	781044	6463545.6	667
F24	781449.7	6463905.4	670
F25	781464	6468579.2	764
F26	781521	6469143.4	784
F28	781996.4	6469360.2	762
F30	782186.8	6461499.2	642
F31	782572.6	6461823.2	649
F32	782652.8	6462321.3	656
F33	782987.9	6462703.6	656
F34	783238.1	6463141.3	662
F35	783496.8	6463475.8	668

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