AVIATION PROJECTS

June 2025

AVIATION IMPACT ASSESSMENT

TALL TREE WIND FARM

Prepared for Acciona Energy Australia Global Pty Ltd

DOCUMENT CONTROL

Document Title: Tall Tree Wind Farm – Aviation Impact Assessment

Reference: 103401-06

Prepared by: P White

Reviewed by: K Madden

Released by:

REVISION HISTORY

Version	Description	Transmitted	Reviewed by	Date
0.1	First draft	3 February 2025	JP	17 February 2025
0.2	Second Draft	25 February 2025	PT	02 May 2025
0.3	Third Draft	19 May 2025	PT	2 June 2025
0.4	Fourth Draft	3 June 2025	PT/GC	4 June 2025
0.5	Fifth Draft	4 June 2025		

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ACRONYMS

AAAA	Aerial Application Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AFM	Aircraft Flight Manual
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area (uncertified aerodrome)
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
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
DAH	Designated Airspace Handbook
EIS	environmental impact statement
ERC-H	AIP En-route chart high
ERC-L	AIP En-route chart low
ERSA	AIP En Route Supplement Australia
GA	general aviation
ICAO	International Civil Aviation Organization
IFR	instrument flight rules

IMC	instrument meteorological conditions
LGA	local government area
LSALT	lowest safe altitude
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	non-directional (radio) beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations
POH	Pilot Operating Handbook
PSR	primary surveillance radar
RAAF	Royal Australian Air Force
REZ	Renewable Energy Zone
RFDS	Royal Flying Doctor Service
RPT	regular public transport
RSR	route surveillance radar
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

Nil

EXECUTIVE SUMMARY

Introduction

Acciona Energy Australia Global Pty Ltd (Acciona) is seeking planning approval under the Environmental Effects Act 1978 (EE Act) for the Tall Tree Wind Farm, a wind energy project located to the south of Meredith, to the north of Teesdale and to the west of Lethbridge in Central West Victoria, approximately 85 km west of Melbourne, and approximately 23 km north-west of Geelong, within the Golden Plains Shire. The Project area also abuts Bamganie State Forest to the north-west. The project is located within the proposed Central Highlands Renewable Energy Zone (REZ).

The Project extends over an area of approximately 5350 hectares (Ha). This excludes the Transmission line route which follows a corridor approximately 11km in length from Lower Plains Road to the connection point to the existing 220kV transmission network to the south-east of Meredith.

The Project requires an aviation impact assessment (AIA) to be undertaken in accordance with the:

- National Airspace Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Civil Aviation Safety Regulations (CASR) 1998, associated Manuals of Standards and other guidance material

This AIA assesses the potential aviation impacts, provides aviation safety advice with respect to 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) as required by Airservices Australia and a qualitative risk assessment to advise on the need for obstacle lighting.

Project description

The Project consists of the following key components:

Up to 53 WTGs, each comprising:

- Three blades mounted to a rotor hub (up to a hub height of up to 169 m) on a nacelle above a tubular steel tower, with a blade tip height (half rotor diameter plus hub height) of up to 250.5 m AGL
- A rotor diameter up to 183 m;
- A gearbox and generator assembly housed in the nacelle; and
- Adjacent hardstands for use as crane pads, assembly and laydown areas;

Electrical infrastructure comprising:

- One (1) 220kV electrical substation, including control room, transformers, circuit breakers, switches and other ancillary equipment;
- A battery energy storage system (BESS) of up to 800 MWh capacity;
- Underground internal 33 kV electrical reticulation connecting the WTGs to the onsite substations (where practicable, these generally follow site access tracks);

- A 220kV overhead transmission line of up to 11.3 km, connecting to the substation and to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment) to provide connection to the existing Moorabool to Ballarat 220kV transmission line.

Ancillary infrastructure:

- Operations and maintenance (O&M) facilities including office, carpark and warehouse;
- Internal access tracks (combined total length of approximately 134.2 km) connecting the WTGs and associated Project infrastructure with the public road network;
- Decommissioning of one temporary wind monitoring towers (WMT) and installation of up to four permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location and will have a maximum height of up to 170 m AGL; and

Temporary elements:

- Two temporary construction site compounds, comprising site buildings and facilities for construction contractors / equipment, site offices, car parking and amenities for the construction workforce;
- Two concrete batching plants to supply concrete for WTG footings and substation construction works;
- Earthworks for access tracks, WTG platforms and foundations;
- Two hardstand laydown areas for the storage of construction materials, plant, and equipment;
- Up to four semi-permanent meteorological monitoring masts will be in place for up to 5 years.. The temporary monitoring masts will each be located close to a WTG location with a maximum height of up to 170 m AGL;
- A quarry, or quarries, to source raw material required for construction;
- The transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure; and
- Beneficial reuse of materials won from within the development footprint during cut and fill and WTG foundation excavation works for use in access track, hardstands and foundation material.
- The Project Area will be rehabilitated after decommissioning of the site.

Conclusions

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

Aviation Impact Statement (AIS)

Based on the WTG layout and maximum blade tip height of up to 250.5 m AGL, the blade tip elevation of the highest WTG, which is WTG 5, will not exceed 592.8 m AHD (1944.9 ft AMSL);

- There are two certified aerodromes located within 30 nm (56 km) of the Project – Avalon Airport (YMAV) and Ballarat Airport (YBLT).
    - The Project will infringe the PANS-OPS surface related to the 25 nm Minimum Safe Altitude (MSA) of Avalon Airport requiring an amendment to accommodate the Project but will not have an adverse impact on flight operations.

- The Project does not infringe any PANS-OPS surfaces at Ballarat Airport.

- The WTGs would not impact the two relevant Grid LSALTs.
- The WTGs would impact on two Air Route LSALTs:
  - Air route W291 minimum altitude will need to be raised by 100 ft to 3000 ft.
  - Air route W382 minimum altitude will need to be raised by 100 ft to 3000 ft.
- The Project is located within Class G airspace (outside controlled airspace), and outside Prohibited, Restricted and Danger areas.
- The WTGs would not have an impact on any aviation navigation and communication facilities.
- The WTGs would not have an impact on the Mount Macedon ATC surveillance radar systems.
- The WTGs must be reported to CASA and construction details provided to Airservices
- Details of the project will be provided to the Bureau of Meteorology for assessment of local meteorological equipment
- The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual contact with the ground and obstacles and can remain so, unless using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT.

Consultation

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

The formal consultation process with the aviation authorities will commence after approval of the Final Draft AIA and authorisation to proceed from the client. It will continue throughout review of the Development Application. Consultation with the Lethbridge Airport aerodrome management and locally based aircraft operators has been undertaken and feedback assessed in this AIA.

The risk assessment will be updated, and this report finalised based on the feedback received during the consultation process. Feedback will be documented in this report.

Summary of key recommendations

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

Notification and reporting

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. Final details of WTG coordinates and elevation should be provided to Airservices Australia at least 2 weeks prior to construction commencing, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-

0085_Vertical_Obstruction_Data_Form.pdf and to the following email address: vod@airservicesaustralia.com

3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    a. The planned operational timeframe and maximum height of the crane; and

    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.

5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs 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 pilots with all relevant information.

Marking of WTGs and WMTs

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

7. It is not mandatory to mark the WMTs however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:

    a. Obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour

    b. Marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and

    c. Guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation

Lighting of WTGs and WMTs

The existing WMT is marked according to the requirements set out in CASR MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D). The WMT is also equipped with a red, steady state medium intensity, obstacle light. Future WMTs will also be marked and lit if deemed necessary once final layout and approval has been received.

Micrositing

9. Providing the micrositing of the WTGs is within 100 m of the current proposed locations, it will not likely result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing, and the conclusions of this AIA would remain the same.

Transmission line

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

Aerial firefighting

11. The developer or operator should ensure that:

    a. Liaison with the relevant fire and land management agencies is ongoing and effective

    b. Access is available to the wind farm site by emergency services for on-ground firefighting operations in the event that weather or fire-conditions make aerial firefighting unavailable for a period of time.

    c. 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 around and underneath the blades and removes one of the blades as a potential obstacle.

Aviation Projects considers that it may be impractical and/or unsafe to lock the turbine blades in a Y configuration in the case of a bushfire emergency, if this would require personnel to climb the WTG tower as the fire approaches. WTGs can, however, be paused or shut down remotely, with blades feathered to halt or significantly reduce rotation within a matter of seconds.

Triggers for review

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

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

    b. Following any significant changes to the context in which the assessment was prepared

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

1. INTRODUCTION

1.1. Situation

Acciona is seeking planning approval under the Environmental Effects Act 1978 (EE Act) for the Tall Tree Wind Farm, a wind energy project located to the south of Meredith, north of Teesdale and west of Lethbridge in Central West Victoria, approximately 85 km west of Melbourne, and approximately 23 km north-west of Geelong, within the Golden Plains Shire. The Project area also abuts Bamganie State Forest to the north-west. The project is located within the proposed Central Highlands Renewable Energy Zone (REZ).

The Project extends over an area of approximately 5350 hectares (Ha). This excludes the Transmission line route which follows a corridor approximately 11km in length from Lower Plains Road to the connection point to the existing 220kV transmission network to the south-east of Meredith.

Acciona has engaged Aviation Projects to prepare an AIA to support the proposed application and formally consult with aviation agencies.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and support the development application.

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

- National Airspace Safeguarding Framework Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers effective July 2012*
- Civil Aviation Safety Regulation (CASR) Part 139 – Aerodromes
- CASR Part 91 – General Operating and Flight Rules
- Australian Aeronautical Information Publication (AIP)
- Planning Guidelines for Development of Wind Energy Facilities – September 2023
- Australasian Fire and Emergency Service Authorities Council (AFAC) – Wind Farms and Bushfire Operations Guideline 2018.

1.3. Methodology

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

- Confirm the scope and deliverables
- Review client material
- Conducted a site visit to properly investigate aviation safety aspects of the Project site and met with the Lethbridge Airport owner and local aircraft operators
- Review relevant regulatory requirements and information sources
- Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA includes an AIS and a qualitative risk assessment to determine need (or otherwise) for

obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators.

- Identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management – Guidelines.*
- Consult with aviation regulators, consisting of Airservices Australia (and other CASR Part 173 procedure designers if applicable), and the Department of Defence.
- Consult with aerodrome operators of the nearby certified aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable).
- Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
- Finalise the AIA report when response received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement (AIS)

The AIS included in this report (see Section 6) includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.6 km) of the Project site
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of 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.

Airspace:

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

Navigation/Radar:

- Nominate air traffic control radar with coverage overlapping the Project site
- Nominate aviation navigation systems in proximity to the Project site.

Cumulative impacts:

- There is not likely to be a cumulative impact to aviation as a result of the Project.

1.5. Material reviewed

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

- IPAUSVICXXTTR20241022.shp
- 20250103 TTWF OHTL.shp
- 20250120_TTWF_WTG_Elevations_Version2.xlsx
- TallTree_PCV_20240517.zip

2. BACKGROUND

2.1. Site Overview

The Project site is located west of the Midland Highway, approximately 4 km (2 nm) northeast of the township of Shelford and approximately 3.2 km (1.7 nm) southwest of the town Meredith – when measured from the town centre to the project boundary. It is within Golden Plains Shire local government area (LGA), and in the proposed Central Highlands Renewable Energy Zone (REZ). The Project area is approximately 18 km (9.7 nm) from the northern extent to the southern extent, and approximately 10 km (5.3 nm) from the eastern extent to the western extent.

An overview of the Project is shown in Figure 1 (source: Acciona, Google Earth).

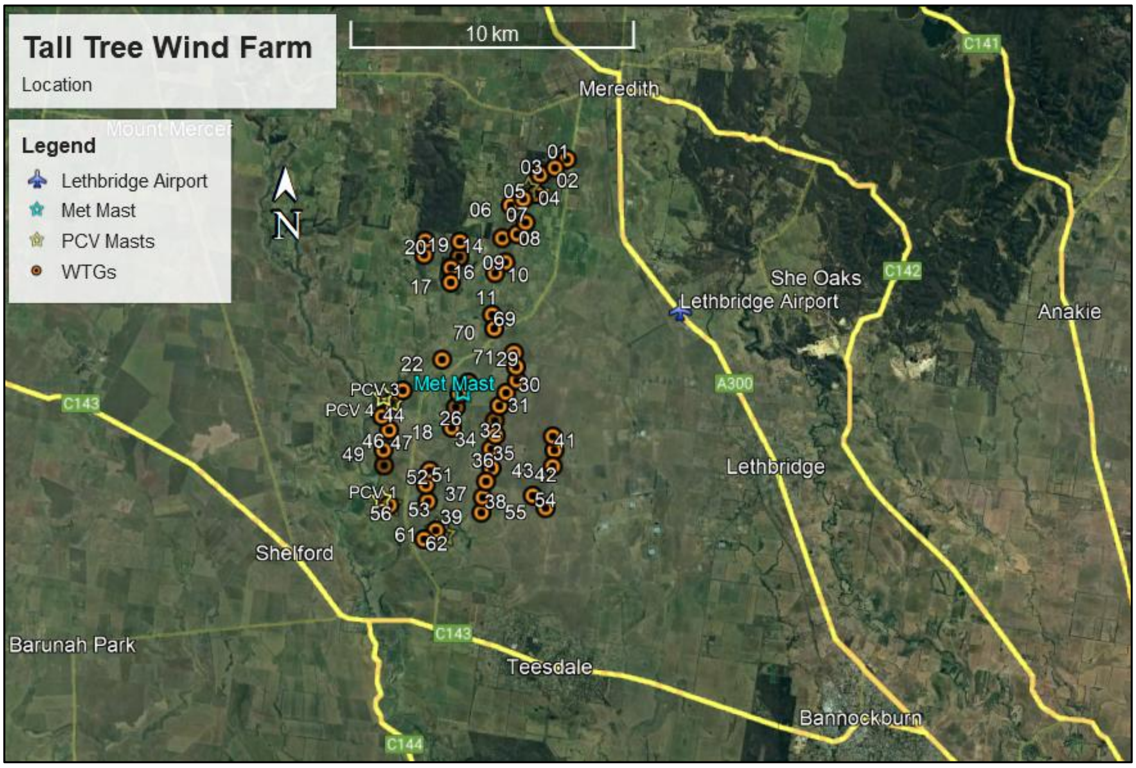


Figure 1 Project Site overview

2.2. Project Description

The Project involves constructing, operating, maintaining and decommissioning the Tall Tree Wind Farm.

The WTGs will have a rotor diameter of up to 183 m and a maximum tip height of 250.5 m AGL.

The ground elevation for the highest WTG location (WTG 5) is 337.3 m AHD, results in a maximum overall height of 592.8 m AHD (1944.9 ft AMSL), which includes a 5 m error allowance.

An overhead transmission line (OHTL) is proposed to run from near the middle of the wind farm, heading northeast to join an existing OHTL. The height of the OHTL towers is estimated to have a maximum height of up to 70 m, however the tower design, locations and final heights are subject to detailed engineering design and have not yet been specified.

3. EXTERNAL CONTEXT

3.1. National Airports Safeguarding Framework

The National Airports Safeguarding Advisory Group (NASAG) was established by Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts 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 WMTs.

The methodology for preparing the risk assessment is contained in Guideline D.

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

Guideline D strongly encourages consultation with aviation stakeholders in the early stages of wind farm development planning, including with aerodrome owners and operators, regional aircraft operators and CASA and Airservices.

3.2. Planning Context

Golden Plains Planning Scheme

The planning scheme applicable to the proposed Project site is the Golden Plains Planning Scheme, dated 26 May 2020.

The Planning Scheme outlines objectives, strategies and policy documents for airports and airfields.

In particular, the Objective of the Planning Scheme in relation to planning for airports and airfields is:

> *To strengthen the role of Victoria's airports and airfields within the state's economic and transport infrastructure, facilitate their siting and expansion and protect their ongoing operation.*

The Planning Scheme requires to consider the following policy documents for assessment of a proposed development near airports and airfields:

- *National Airports Safeguarding Framework (as agreed by Commonwealth, State and Territory Ministers at the meeting of the Standing Council on Transport and Infrastructure on 18 May 2012)*
- *Avalon Airport Master Plan (Avalon Airport Australia Pty Ltd, 2015)*

The purpose of schedule 3 to the special use zone for Lethbridge Airport is copied below:

- *To provide for a safe and efficient operational airport for the use of light aircraft and associated activities.*
- *To provide for the use and development of industries and activities associated with light aircraft.*
- *To allow for restricted commercial and retail activities related to the use of the land for light aircraft.*
- *To provide for aeronautical related training. To ensure use and development of the site is compatible with existing uses in the vicinity.*

The Planning Scheme notes requirements for use of land of Lethbridge Airport. The most relevant requirements to the context of this assessment are provided below:

The use of the land for airport and heliport must comply with the following requirements. Reference to aircraft includes helicopters.

- *Except with a permit the number aircraft movements must not exceed 17500 per annum. Each take-off, landing, or touch and go is an aircraft movement.*
- *The take-off weight of aircraft using the airport must not exceed 5700kg.*
- *No flights over houses within a 1 km radius of the land*
- *The operator of the airport must request Airservices Australia to publish a web address/link in En Route Supplement Australia (ERSA) to the airport website displaying the approved flight paths.*

The Country Fire Authority has a permanent office based at Lethbridge Airport.

It is considered unlikely that medical flying services, other than helicopters use Lethbridge Airport given the proximity of Avalon Airport and Ballarat Airport and reasonable transit times to Geelong and Melbourne based medical facilities.

Victorian Department of Transport and Planning – Wind Energy Guideline (September 2023)

These guidelines advise planning decisions about a wind energy facility proposal.

The guidelines set out:

- a framework to provide a consistent and balanced approach to assist the assessment of wind energy projects
- a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project
- guidance as to how planning permit application requirements might be met, and
- a framework for the regulation of wind turbine noise.

They provide a framework to ensure proposals for wind energy facilities are thoroughly assessed, including other considerations and approvals required in the planning process.

For aviation safety it includes:

> *4.3.5 Aircraft safety issues*
>
> *The height of wind energy turbines can be substantial, resulting in potential impacts on nearby airfields and air safety navigation. Applicants should address aircraft safety issues by considering the site's proximity to airports, aerodromes, or landing strips.*
>
> *Applicants should consult with the Civil Aviation Safety Authority (CASA) for wind energy facility proposals that:*
>
> *• are within 30 kilometres of a declared aerodrome or airfield*
>
> *• infringe the obstacle limitation surface around a declared aerodrome*
>
> *• include a building or structure that the top of which will be 110 metres or more above natural ground level (the height of a wind turbine is determined by the tip of the turbine blade when vertically above ground level).*
>
> *Early engagement with aviation safety organisations like CASA is encouraged as aviation safety is a complex area of wind energy facility assessment.*
>
> *In addition to CASA consultation, the following is relevant for anemometers and other pre-permit infrastructure.*
>
> *The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:*
>
> *• 30 metres or more above ground level for structures within 30km of an aerodrome, or*
>
> *• 45 metres or more above ground level for structures located elsewhere.*
>
> *Operators of certified aerodromes are required to notify CASA if they become aware of any development or proposed construction near the aerodrome that is likely to create an obstacle to aviation, or if an object will infringe the Obstacle Limitation Surfaces (OLS) or Procedures for Air Navigation Services –Operations (PANS-OPS) surfaces of an aerodrome. Operators of registered aerodromes should advise CASA if the proposal will infringe the OLS; CASA will ask Airservices to determine if there is an impact on published flight procedures for the aerodrome.*

Lethbridge Airport would be considered a "declared aerodrome" for the purposes of the above context as it has its details published in the AIP.

3.3. Civil Aviation Safety Authority (CASA)

The CASA is the government body responsible for civil aviation safety, that administers various Commonwealth Acts of Parliament and Regulations related to aviation safety in Australia.

CASA's main role is related to the safety of the public during air transport flight operations at/and in the vicinity of certified aerodromes. In other areas they can provide advice to planning authorities as to whether a tall structure may cause a hazard to aviation activities.

CASA as the regulator of civil aviation in Australia applies international standards determined by the International Civil Aviation Organisation (ICAO) and ensures they are adapted to best fit the civil aviation legislative landscape in Australia.

Lethbridge Airport is not certified under CASR Part 139. It is therefore an uncertified aerodrome.

The following CASA publications inform pilots of their obligations at uncertified aerodromes in non-controlled airspace.

Advisory Circular (AC) 91-02 V1.2, Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land, dated November 2022

This AC provides guidance for pilots of:

- Aeroplanes with maximum take-off weight (MTOW) not exceeding 5700 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 aeroplane pilots when determining the suitability of a place to safely take off and land. It provides an overview of pilot responsibilities, discusses the relevant circumstances recommended to be considered and includes 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.

4.2.2 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).

4.2.3 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.

4.2.4 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.

5 Permission to operate

5.1.1 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.

AC 91-10 v1.4, Operations in the vicinity of non-controlled aerodromes, dated May 2025

This AC provides guidance on procedures that, when followed, will improve situational awareness and safety for all pilots when flying with respect to CASR Part 91.

There are some uncontrolled aerodromes in the vicinity of the Project site, including Lethbridge Airport.

2 Introduction

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

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.

7.3 Circuit Heights

7.3.1 By convention, aircraft should fly the standard traffic circuit at the heights shown.

7.3.2 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.*

7.8 Final approach

7.8.1 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.*

Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.1. are shown in Figure 2 and Figure 3.

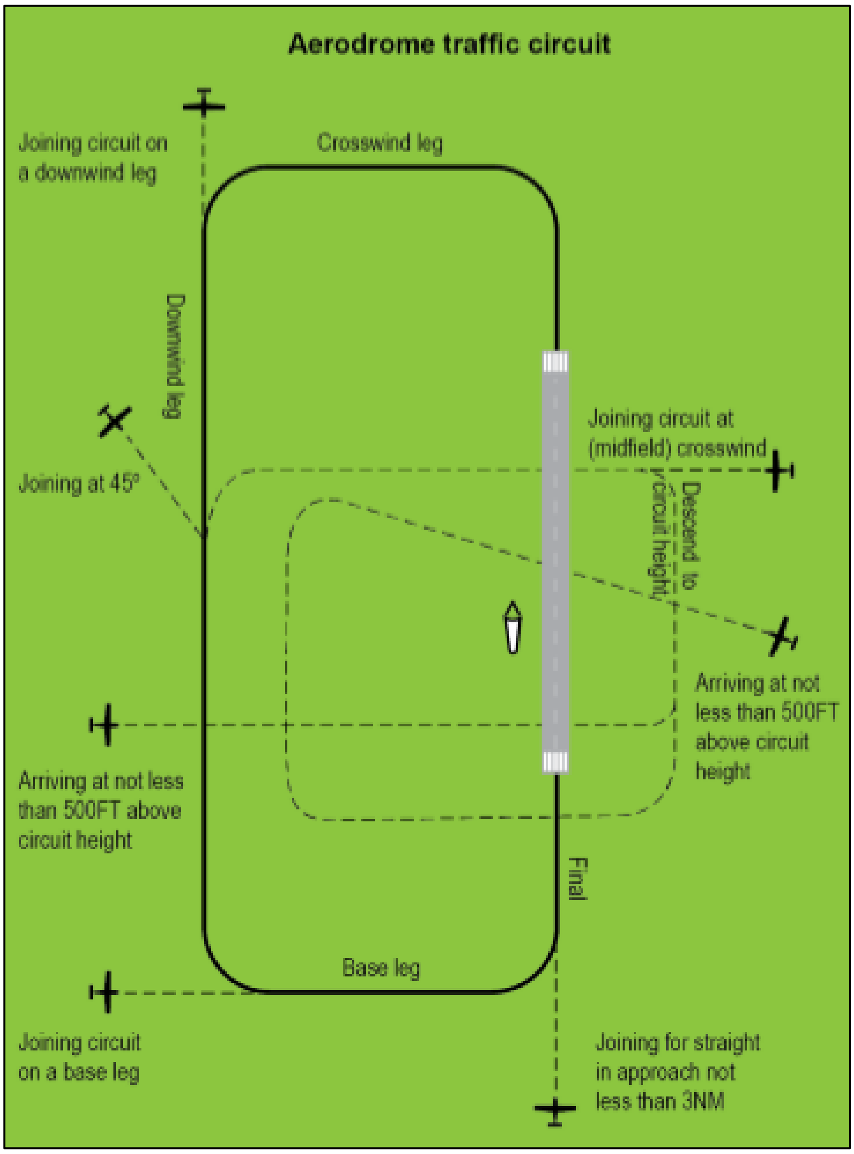


Figure 2 Standard aerodrome traffic circuit, showing arrival and joining procedures

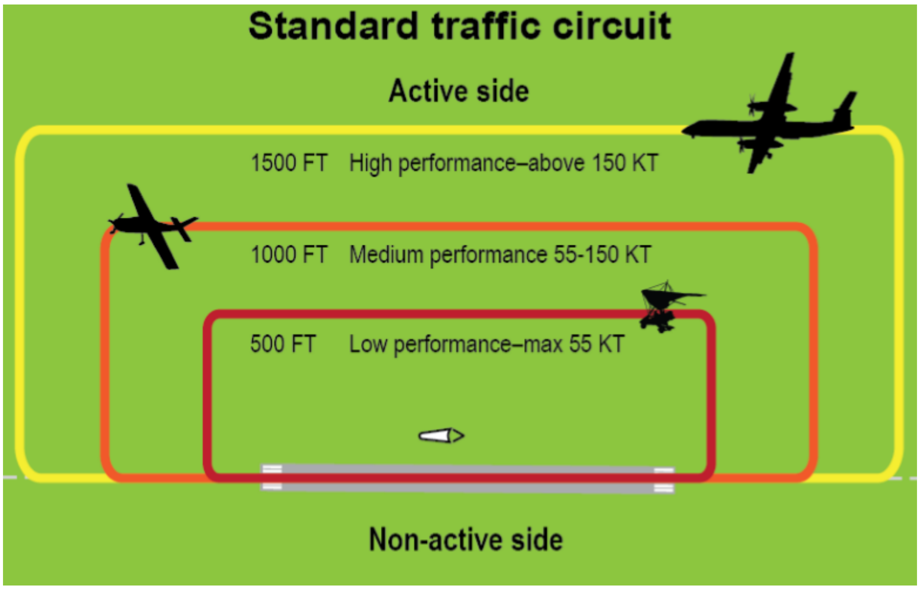


Figure 3 Aerodrome standard traffic circuit

AC 91-10 v1.4. paragraph 7.11 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:

> *7.11 Departing the circuit area*
>
> *7.11.1 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.*

3.4. Rules of flight

Flight under Day Visual Flight Rules (Day VFR)

Australia's Aeronautical Information Package (AIP) states that the meteorological conditions required for visual flight in 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 authorised by the CASRs such as aerial application, low flying training or firefighting activities.

Flight under Night Visual Flight Rules (Night VFR)

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.*

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

CASR 91 prescribes that 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 as obstacle clearance margins are taken into account in the design of the IFR procedures.

3.5. Aircraft operator characteristics

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

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the WTGs) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance. In VMC, the WTGs will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project site once WTGs are erected if operating at altitudes near the maximum height of the WTGs. VFR aircraft flying over the wind farm at normal and efficient cruising altitudes, several thousand feet high, will not be impacted by the wind farm.

Flight under day VFR is conducted above 500 ft above the highest point of the terrain and obstacles within a 300 m radius unless the operation is approved to operate below 500 ft above the highest point of the terrain, in which case they do not need to maintain a 300 m distance from obstacles. In fact, they may even fly through the wind farm if necessary.

It is expected that the proposed WTGs will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project 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.

3.6. Passenger transport operations

Air transport operations are generally operated under the IFR and therefore in accordance with minimum altitudes published on enroute charts and instrument approach charts. They may also operate VFR for the last route segment to aerodromes that are not provided with instrument approach procedures such as Lethbridge Airport.

3.7. 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 residential areas.

3.8. 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 5 for a detailed response from the Department of Defence.

3.9. 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 6.5 ft and 100 ft AGL.

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.

Aerial application flights are also conducted by remotely piloted vehicles. A similar risk management activity is likely to be conducted before such flight activities.

3.10. 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), now superseded by the AAAA Tall Structures Policy dated March 2024, which states in part:

> *The development of tall structures in agricultural and bush fire prone areas can pose a direct threat to aviation safety, particularly where fixed and rotary aircraft may be requested to operate for agricultural or bush/grass fire control.*
> *The absence of historical aircraft use in an area is considered an insufficient reason to discount the threat to Aviation Operations.*
>
> *The AAAA will oppose any development application or similar process unless the proponent has:*
> - *Identified the structure as posing a low-level flying risk that needs to be managed on an ongoing basis,*
> - *Consulted honestly and in detail with local aerial application operators or the AAAA where a local operator cannot be identified,*
> - *Consulted with adjoining landowners regarding the impact on adjacent properties,*

- *Included appropriate lighting and marking in the development proposal, consistent with providing a warning to low level flying,*
- *Identified the process for advising of the location height and presence of the structure to the relevant authorities, and*
- *Ensure that the proposal is in keeping with CASA requirements for structures near aerodromes, including temporary landing areas.*

3.11. 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 13.

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

The 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.

The use of remotely piloted vehicles for aerial application (currently used by some landowners within the vicinity of the site) generally takes place below the height of the rotor swept area of turbines and would therefore be largely unaffected by the Project.

3.12. Aeromedical services

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

Emergency aviation services organisations generally 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.

If a helicopter emergency medical service is required at a location other than an aerodrome or helicopter landing site (HLS), the pilot will engage with local emergency services personnel and/or landowners to discover what local hazards are in the vicinity of the proposed landing site and take appropriate mitigation action.

Ambulance helicopters operate at Lethbridge Airport when emergency circumstances dictate. They operate to the visual flight rules and within a similar circuit area as the locally based operators do. Airport management would be advised of the need to operate an ambulance flight at Lethbridge and provide appropriate local information to assist in the ambulances safe operation there.

3.13. 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.

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.*

Aviation Projects considers that it may be impractical and/or unsafe to lock the turbine blades in a Y configuration in the case of a bushfire emergency if this would require personnel to climb the WTG tower as the fire approaches. WTGs can, however, be paused or shut down remotely, with blade feathered to halt rotation within a matter of seconds.

4. INTERNAL CONTEXT

4.1. Wind farm site description

The Tall Tree Wind Farm site boundary is located west of the Midland Highway, approximately 4.5km (2.4 nm) northeast of the township of Teesdale and approximately 3.2 km (1.7 nm) southwest of Meredith, measured from the centre of each settlement. It is within the Golden Plains Shire local government area (LGA), and the proposed Central Highlands Renewable Energy Zone (REZ).

4.2. Project description

The Project consists of the following key components:

Up to 53 WTGs, each comprising:

- Three blades mounted to a rotor hub (up to a hub height of up to 169 m) on a nacelle above a tubular steel tower, with a blade tip height (half rotor diameter plus hub height) of up to 250.5 m AGL
- A rotor diameter up to 183 m;
- A gearbox and generator assembly housed in the nacelle; and
- Adjacent hardstands for use as crane pads, assembly and laydown areas;

Electrical infrastructure comprising:

- One (1) 220kV electrical substation, including control room, transformers, circuit breakers, switches and other ancillary equipment;
- Underground internal 33 kV electrical reticulation connecting the WTGs to the onsite substations (where practicable, these generally follow site access tracks);
- A battery energy storage system (BESS) of up to 800 MWh capacity; and
- A 220kV overhead transmission line of up to 11.3 km, connecting to the substation and to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment) to provide connection to the existing Moorabool to Ballarat 220kV transmission line.

Ancillary infrastructure:

- Operations and maintenance (O&M) facilities including office, carpark and warehouse;
- Internal access tracks (combined total length of approximately 134.2 km) connecting the WTGs and associated Project infrastructure with the public road network; and
- Decommissioning of one temporary WMT and installation of up to four semi-permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location and will have a maximum height of up to 170 m AGL; and

Temporary elements:

- Two temporary construction site compounds, comprising site buildings and facilities for construction contractors / equipment, site offices, car parking and amenities for the construction workforce;
- Two concrete batching plants to supply concrete for WTG footings and substation construction works;
- Earthworks for access tracks, WTG platforms and foundations;
- Two hardstand laydown areas for the storage of construction materials, plant, and equipment;
- Up to four temporary meteorological monitoring masts. The temporary monitoring masts will be located close to a WTG location with a maximum height of up to 170 m AGL;
- A quarry, or quarries, to source raw material required for construction;
- The transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure; and
- Beneficial reuse of materials won from within the development footprint during cut and fill and WTG foundation excavation works for use in access track, hardstands and foundation material.

The Project Area will be rehabilitated after decommissioning of the site.

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

1. Airservices Australia
2. Department of Defence
3. Avalon Airport Australia Pty Ltd
4. Ballarat Airport – City of Ballarat
5. Lethbridge Airport – G & T Baum
6. Victorian Ambulance Service
7. Victorian Country Fire Authority
8. Local Aerial operators – Field Air Ballarat
9. Bureau of Meteorology.

Details and results of the formal consultation activities will be provided in Table 1 when responses from the stakeholders are received.

The Lethbridge Airport operators have been engaged from late 2022. A series of meetings has been established with the stakeholders of Lethbridge airport and ACCIONA, with consultation to continue throughout development and all stages of the project.

Table 1 Stakeholder consultation details – to be populated when consultation is completed prior to AIA finalisation

Agency/Contact	*Activity/Date*	*Response/ Date*	*Items Raised During Consultation*	*Action Proposed*
Airservices Australia				
Department of Defence				
Avalon Airport				
Ballarat Airport				
Lethbridge Airport				
Vic Ambulance				
Vic CFA				
Field Air Ballarat				
Bureau of Meteorology				

6. AVIATION IMPACT STATEMENT

6.1. Overview

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

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.

> *The AIS must provide a detailed analysis covering, as a minimum:*
>
> *Airspace Procedures*
>
> 1. *Obstacles*
>   - *Co-ordinates in WGS84 or GDA94 (to 0.1 second of arc or better).*
>   - *Elevations in metres (m) Australian Height Datum (AHD) to 0.3 metres accuracy.*
> 2. *Drawings*
>   - *Overlayed on topographical base, at not less than 1:250,000 scale. Details of datum and level of charting accuracy to be noted.*
>   - *Electronic format compatible with Microstation version V8i.*
> 3. *Aerodromes*
>   - *Specify all registered/certified aerodromes that are located within 30NM (55.56km) from any obstacle referred to in (1) above.*
>   - *Identify all instrument approach and landing procedures at these aerodromes.*
>   - *Confirm that the proposed development (known as a potential "obstacle") does not penetrate the Annex 14 Obstacle Limitation Surface (OLS) for any aerodrome. If a potential obstacle does penetrate the OLS, the AIS should clearly specify the extent of the penetration.*
> 4. *Air Routes*
>   - *Identify air routes published in Airservices AIP Charts, Enroute Chart – Low (ERC-L) and Enroute Chart – High (ERC-H), which are located near or over any potential obstacle referred to in (3) above.*
>   - *Specify two waypoint names located on the routes that are located on either side of the potential obstacle.*
> 5. *Airspace*
>   - *Identify the airspace classification (i.e. A, B, C, D, E, G etc.) where the potential obstacles are located.*
>
> *Navigation/Radar*
>
> 1. *Detect the presence of dead zones.*
> 2. *False target analysis.*
> 3. *Target positional accuracy.*

4. *Probability of detection.*

5. *Radar coverage implications.*

6. *The AIS should follow the guidelines outlined in the latest version of the EUROCONTROL Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors.*

6.2. Nearby certified aerodromes

A certified aerodrome means an aerodrome regulated by CASA under CASR Part 139, with defined standards established in CASR Part 139 (Aerodromes) Manual of Standards (MOS).

A 30 nautical miles radius from the Project is used to assess potential impacts on certified aerodromes. The 30 nautical mile radius represents the 25 nautical mile minimum sector altitude (MSA) for aerodromes with terminal instrument flight procedures. The 25 nautical miles MSA minimum altitude is determined by assessing obstacles within 30 nautical miles (25 nautical miles plus 5 nautical miles buffer) of the aerodrome reference point (ARP) or navigational aid on which the MSA is based.

The area of 30 nm (55.56 km) from an airport's aerodrome reference point (ARP) is used to identify possible constraints from the Project.

The certified airports within 30 nm of the Project site include:

- Avalon Airport (YMAV) located approximately 33 km (18 nm) to the southeast
- Ballarat Airport (YBLT) located approximately 44 km (24 nm) to the northwest.

Other nearby significant airports that are beyond 30 nm from the Project are not impacted by it, including:

- Point Cook Airport (YMPC) located approximately 58 km (31 nm) to the east
- Melbourne Airport (YMML) located approximately 74 km (40 nm) to the northeast.

6.3. Avalon Airport

Avalon Airport Australia Pty Ltd operates the aerodrome on a long-term lease from the Department of Defence.

It is a major airport catering for interstate and international airlines and is also a Defence facility.

Avalon Airport's ARP is located approximately 38 km / 20 nm east from the nearest section of the Project.

An international airshow is held every two years.

Instrument Approach and Departure Procedures

A check of the AIP via the Airservices Australia website showed that Avalon Airport is served by precision and non-precision instrument flight procedures (source: Airservices Australia, effective 20 March 2025). The AIP content is updated every 8 weeks. The March update includes all aeronautical data available at that date, including previous content that remains current.

Table 2 Identifies Avalon Airport's instrument approach and departure charts, designed by Airservices Australia.

Table 2 Avalon Airport (YMAV) charts

Chart Title	Effective date
AERODROME CHART (ASA)	28 November 2024
SID Avalon Five Departure (RADAR)	24 March 2022
SID Justy Three Departure (RNAV)	12 June 2025
STAR Jaybi Six Arrival (RNAV)	12 June 2025
DME or GNSS Arrival	21 March 2024
RNP RWY 18	30 November 2023
ILS-Y or LOC-Y RWY 18	20 March 2025
ILS-Z or LOC-Z RWY 18	12 June 2025
VOR RWY 18	24 March 2022
RNP Z RWY 36	30 November 2023
RNP U RWY 36 (AR)	12 June 2025
VOR RWY 36	24 March 2022

MSA surfaces

The minimum sector altitude (MSA) applies to each instrument approach procedure at Avalon Airport. It provides a minimum altitude for IFR flight within 25 nm of the airport and determines the altitude that instrument approach procedures are commenced from.

An extract of the MSA published is shown in Figure 4 (source: Airservices Australia, 12 June 2025).

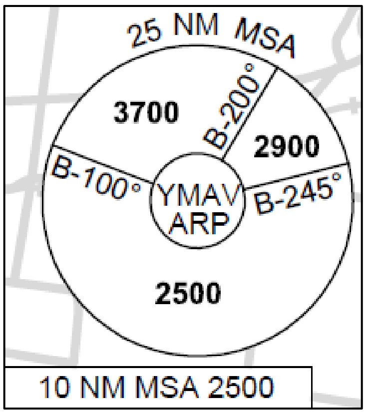


Figure 4 Avalon 25 nm MSA diagram

The CASR Part 173 Manual of Standards (MOS) requires a minimum obstacle clearance (MOC) of 984 ft to be applied above the highest terrain or obstacle within the applicable MSA segment.

Obstacles within the 25 nm of Avalon Airport define the minimum height at which an IFR aircraft can fly when not in visual flight conditions or intend to conduct an instrument flight procedure.

The Project area is located within the 25 nm MSA of the airport and completely outside of the 10 nm MSA protection area as shown in Figure 5 (Source: Airservices Australia, Google Earth, ACCIONA).

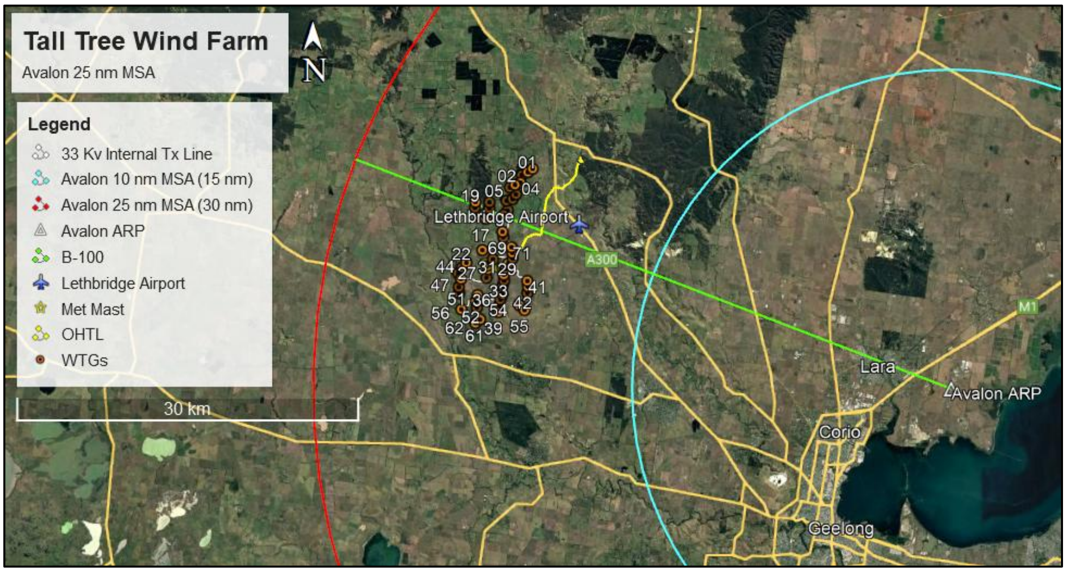


Figure 5 Avalon 25 nm MSA

The Project straddles the B-100 MSA sector boundary, but the southern sector remains relevant due to the 5 nm buffer applied outside the lowest MSA sector altitudes, north of the B-100 sector boundary.

The relevant MSA altitude is 2500 ft AMSL with a PANS-OPS surface of 1516 ft AMSL.

The highest WTG, #5, with a maximum elevation of 1944 ft infringes the PANS-OPS surface and requires the 25 nm minimum altitude of 2500 ft AMSL to be raised to 3000 ft AMSL or the B-100 sector boundary moved to eliminate the Project from the southern sector.

Airservices Australia will determine the most effective amendment in conjunction with Avalon Airport management.

Both options are unlikely to affect IFR flight operations in the area and at Avalon Airport.

IFR Circling areas

A circling approach is an extension of an instrument approach to the specified circling minima (lowest altitude permitted without visual reference to the ground) at which point the pilot will visually manoeuvre the aircraft to align with the runway for landing. Typically, a circling approach is only conducted where there is no runway-aligned instrument procedure or if the runway used for the approach procedure is not suitable for landing.

Circling areas are established by the instrument flight procedure designer based on ICAO specifications related to the performance category of the design aircraft. The circling area is determined by drawing an arc centred on the threshold of each usable runway and joining these arcs by tangents. Performance Category D is the most demanding aircraft category provided for in Avalon Airport's instrument approach and departure procedures.

The radii for each relevant category of aircraft are provided below:

- Category A – 1.68 nm/3.11 km
- Category B – 2.66 nm/4.93 km
- Category C – 4.20 nm/7.78 km
- Category D – 5.28 nm/9.79 km

The Project area is located 38 km / 20 nm from the runways and is, therefore beyond the circling area for all runways at Avalon Airport.

The Project will not impact circling areas established for instrument flight procedures at Avalon Airport.

PANS-OPS Surfaces

A detailed assessment of the PANS-OPS surfaces associated with the published instrument approach procedures was undertaken. Table 3 Details the assessment for each instrument approach procedure for Avalon Aerodrome.

Table 3 Avalon Airport PANS-OPS Assessment

Instrument Approach Title	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Impact on the procedure by WTG*	*Potential solution*	*Impact on aircraft ops*
SID Avalon Five Departure (RADAR)	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
SID Justy Three Departure (RNAV)	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
STAR Jaybi Six Arrival (RNAV)	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
DME or GNSS Arrival	3700	2700	Nil. The highest WTG is beneath the protection surface	N/A	N/A
RNP RWY 18	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
ILS-Y or LOC-Y RWY 18	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
ILS-Z or LOC-Z RWY 18	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
VOR RWY 18	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
RNP Z RWY 36	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A

Instrument Approach Title	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Impact on the procedure by WTG*	*Potential solution*	*Impact on aircraft ops*
RNP U RWY 36 (AR)	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
VOR RWY 36	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
25 nm MSA	2500	1516	Infringe	Raise MSA to 3000 or resectorise	Minor impact
Circling Areas	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A

The project will not affect instrument flight procedures at Avalon Airport.

Obstacle Limitation Surfaces

For the Code 4 precision approach runways at Avalon Airport, the maximum lateral extent of the OLS is up to 15 km.

The closest WTG in the Project site to Avalon Airport is approximately 38 km and therefore beyond the horizontal extent of the OLS.

6.4. Ballarat Airport

The City of Ballarat operates the aerodrome.

It is a regional aerodrome catering for smaller aircraft and emergency services aircraft.

It is located approximately 46 km / 25 nm north from the nearest section of the Project.

Instrument Approach and Departure Procedures

A check of the AIP via the Airservices Australia website showed that Ballarat Airport is served by non-precision instrument flight procedures (source: Airservices Australia, effective 12 June 2025).

Table 4 Identifies Ballarat Airport’s instrument approach and departure charts, designed by Airservices Australia (AsA) as indicated.

Table 4 Ballarat Airport (YBLT) charts

Chart Title	*Effective date*
AERODROME CHART (ASA)	30 November 2023
RNP RWY 18	30 November 2023
RNP RWY 36	20 March 2025

MSA surfaces

The minimum sector altitude (MSA) applies to each instrument approach procedure at Ballarat Airport. It provides a minimum altitude for IFR flight within 25 nm of the airport and determines the altitude that instrument approach procedures are commenced from.

An extract of the MSA published for Ballarat Airport is shown in Figure 4 (source: Airservices Australia, 12 June 2025).

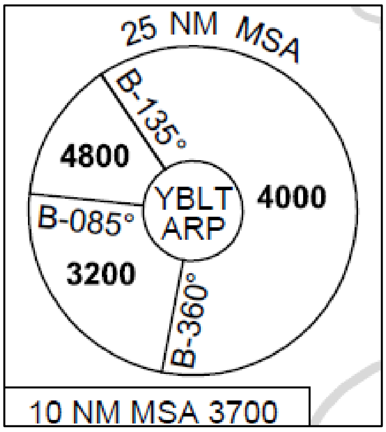


Figure 6 Ballarat 25 nm MSA diagram

The CASR Part 173 Manual of Standards (MOS) requires a minimum obstacle clearance (MOC) of 984 ft to be applied above the highest terrain or obstacle within the applicable MSA segment.

Obstacles within the 25 nm of Ballarat Airport define the minimum height at which an IFR aircraft can fly when not in visual flight conditions or intend to conduct an instrument flight procedure.

The Project is located within the eastern sector boundary of the 25 nm MSA.

The relevant MSA altitude is 4000 ft AMSL with a PANS-OPS surface of 3016 ft AMSL.

The highest WTG, #5, with a maximum elevation of 1944 ft does not infringe the PANS-OPS surface.

The Project does not affect flight operations at Ballarat Airport.

The Project area is located within the 25 nm MSA of the airport as shown in Figure 7 (Source: Airservices Australia, Google Earth, ACCIONA).

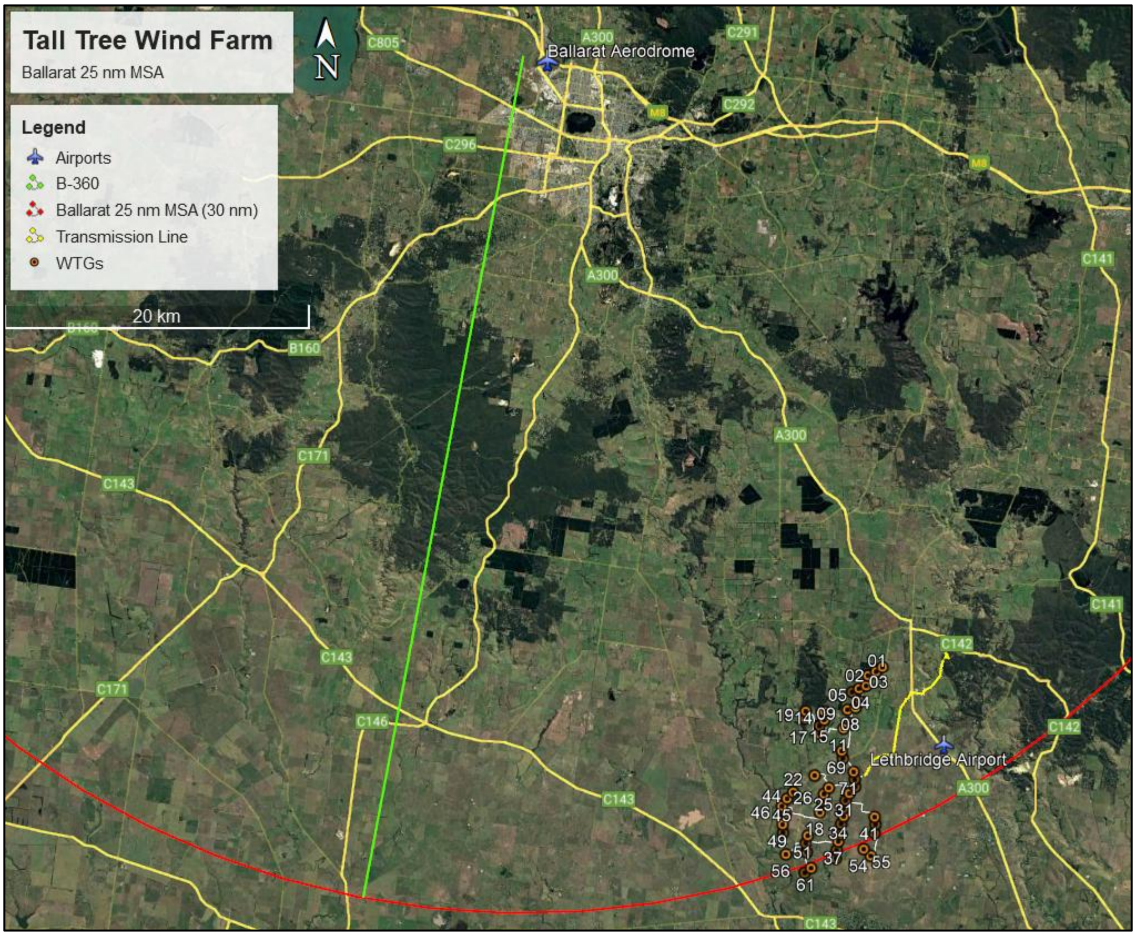


Figure 7 Ballarat 25 nm MSA

IFR Circling areas

A circling approach is an extension of an instrument approach to the specified circling minima (lowest altitude permitted without visual reference to the ground) at which point the pilot will visually manoeuvre the aircraft to align with the runway for landing. Typically, a circling approach is only conducted where there is no runway-aligned instrument procedure or if the runway used for the approach procedure is not suitable for landing.

Circling areas are established by the instrument flight procedure designer based on ICAO specifications related to the performance category of the design aircraft. The circling area is determined by drawing an arc centred on the threshold of each usable runway and joining these arcs by tangents. Performance Category B is the most demanding aircraft category provided for Ballarat Airport's instrument approach and departure procedures.

The radii for each relevant category of aircraft are provided below:

- Category A – 1.68 nm/3.11 km
- Category B – 2.66 nm/4.93 km

The Project area is located 46 km / 25 nm from the runways and is, therefore beyond the circling area for all runways at Ballarat Airport.

The Project will not impact circling areas established for instrument flight procedures at Ballarat Airport.

PANS-OPS Surfaces

A detailed assessment of the PANS-OPS surfaces associated with the published instrument approach procedures was undertaken. Table 5 Details the assessment for each instrument approach procedure.

Table 5 Ballarat Airport PANS-OPS Assessment

Instrument Approach Title	*Minimum Altitude over Project (ft AMSL)*	*PANS-OPS Surface (ft AMSL)*	*Impact on the procedure by WTG*	*Potential solution*	*Impact on aircraft ops*
RNP RWY 18	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
RNP RWY 36	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A
25 nm MSA	4000	3016	No Infringement	N/A	N/A
Circling Areas	Project not located within protection area	N/A	Nil – Outside the protection surface	N/A	N/A

The Project will not affect instrument flight procedures at Ballarat Airport.

Obstacle Limitation Surfaces

For the Code 3 precision approach runways at Ballarat Airport, the maximum lateral extent of the OLS is up to 15 km.

The closest WTG in the Project site to Ballarat Airport is approximately 46 km and therefore beyond the horizontal extent of the OLS.

6.5. Grid and Air routes LSALT

CASR Part 173 MOS requires that the published lowest safe altitude (LSALT) for a particular airspace grid or air route provides a minimum of 1000 ft clearance above the controlling (highest) obstacle within the relevant airspace grid or air route tolerances.

Grid LSALT

The Project is located within an area that covers two Grids with a LSALT of 1432.6 m AHD (4700 ft AMSL) with a protection surface of 1127.8 m AHD (3700 ft AMSL) to the east of 144° East and a LSALT of 1463 m (4800 ft) with a protection surface of 1158.2m AHD (3800 ft AMSL) to the west of 144° east.

Figure 8 shows the grid LSALT in proximity to the Project site (source: ERC Low National, OzRunways, May 2025).

The highest WTG, at an elevation of 592.8 m (1949.9 ft) AMSL would not infringe the LSALTS.

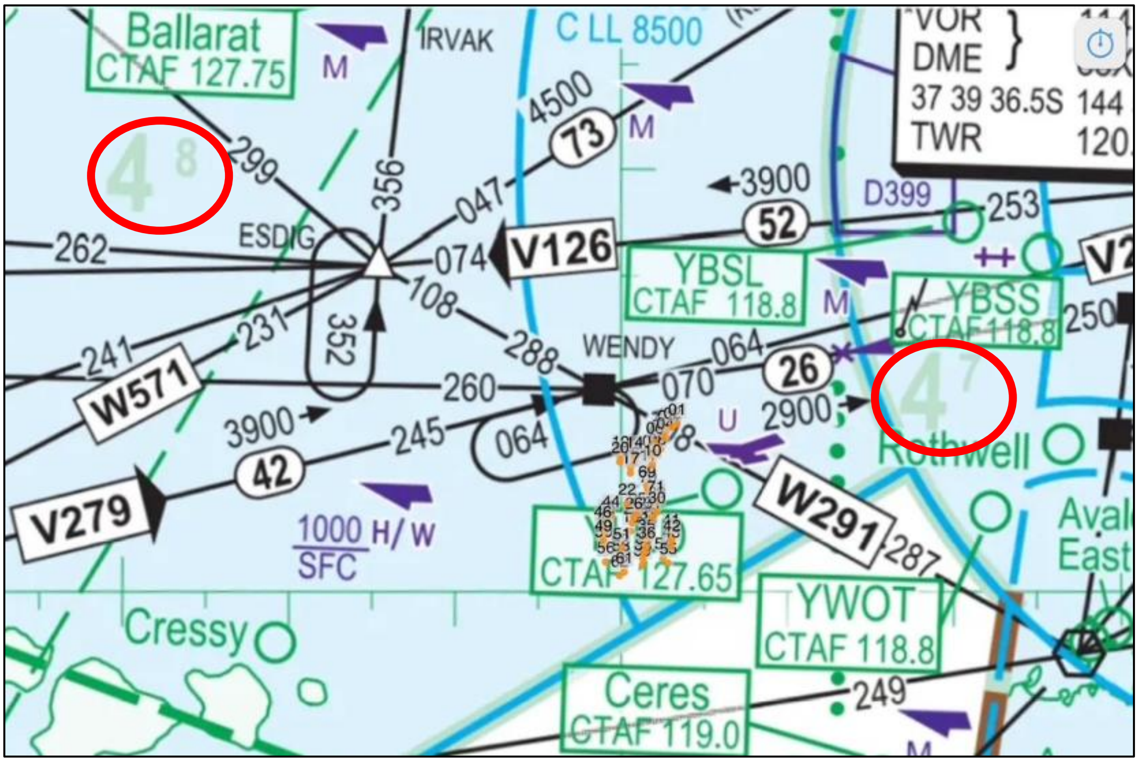


Figure 8 Grid and Air Routes

The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual contact with the ground and obstacles and can remain so, or unless a pilot is using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft above the wind farm when within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT when they confirm that they are within 25 nm of Avalon or Ballarat, by reference to the appropriate ARP, or navigation aid that the MSA is based upon.

Air Route LSALTs

A protection area of 7 nm laterally on either side of an air route is used to assess the LSALT for the air route. There are three air routes within 7 nm of the Project site. An impact analysis of the surrounding air routes is provided in Table 6.

Table 6 Air Route Impact Analysis

Air route	Waypoint pair	Route LSALT (ft AMSL)	Protection Surface (ft AMSL)	Infringement on protection area	Impact on airspace design	Potential solution	Impact on aircraft ops
W291	WENDY - YMAV	2900	1900 ft	44.9 ft	LSALT must be raised by 100 ft to accommodate the Project	Request Airservices Australia to raise LSALT by 100 ft to 3000 ft	Minor
W382	WENDY – IGNES	2900	1900 ft	44.9 ft	LSALT must be raised by 100 ft to accommodate the Project	Request Airservices Australia to raise LSALT by 100 ft to 3000 ft	Minor
V279	WENDY – YMML	3900	2900	No infringement	Nil	Nil	N/A
Holding Pattern at Wendy		3900	2900	No infringement	Nil	Nil	N/A

6.6. Airspace Protection

The Project site is located outside of controlled airspace (wholly within Class G airspace) and is not located in any Prohibited, Restricted or Danger areas. Therefore, the Project will not impact controlled or designated airspace.

6.7. Aviation navigation and communication facilities

NASF Guideline G - *Protection Aviation Facilities - Communication, Navigation and Surveillance (CNS)* and CASR Part 139 MOS specify the area where the development of buildings and structures has the potential to cause unacceptable interference to CNS facilities.

The closest aviation navigation facility is located at Avalon Airport. This navigation aid has a protection area of 300 m surrounding it. The closest WTG to Avalon VOR is about 37 km / 20 nm from it.

The Project is located a sufficient distance away from nearby aviation navigation and communication facilities and will not have an impact.

6.8. Air Traffic Control Surveillance Radar installations

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

The closest radar to the Project is the Mt Macedon Radar (PSR) and the Mt Macedon Secondary Surveillance Radar (SSR), which is located about 70 km to the northeast of the Project.

EUROCONTROL guidelines for assessing the potential impact of wind turbines on radar surveillance sensors stipulate the following assessment requirements:

Primary Surveillance Radar (PSR)

Zone 1–0 - 500 m: Not permitted

Zone 2 500 m – 15 km: Detailed assessment

Zone 3: Further than 15 km but within maximum instrumented range and in radar line of sight: Simple assessment

Zone 4: Anywhere within maximum instrumented range but not in radar line of sight or outside the maximum instrumented range: No assessment.

Secondary Surveillance Radar (SSR)

- Zone 1: 0- 500 m: Not permitted
- Zone 2: 500–m - 16 km but within maximum instrumented range and in radar line of sight: Detailed assessment
- Zone 4: Further than 16 km or not in radar line of sight: No assessment.
- (Zone 3 is not established for secondary surveillance radar).

The Project is outside the line-of-sight range of those radars and will not impact those facilities and therefore no assessment is required).

6.9. AIS Summary

Based on the WTG layout and maximum blade tip height of up to 250.5 m AGL, the blade tip elevation of the highest WTG, which is WTG 5, will not exceed 592.8 m AHD (1944.9 ft AMSL);

- There are two certified aerodromes located within 30 nm (56 km) of the Project – Avalon Airport (YMAV) and Ballarat Airport (YBLT).
  - The Project would infringe the 25 nm MSA of Avalon Airport but would not have an adverse impact on flight operations there
  - The Project would not infringe any PANS-OPS surfaces at Ballarat Airport.
- The WTGs would not impact the two relevant Grid LSALTs.
- The WTGs would impact on two Air Route LSALTs:
  a. Air route W291 minimum altitude will need to be raised by 100 ft to 3000 ft.
  b. Air route W382 minimum altitude will need to be raised by 100 ft to 3000 ft.
- The Project is located within Class G airspace (outside all controlled airspace) and outside Prohibited Restricted and Danger areas.
- The WTGs would not have an impact on any aviation navigation facilities.
- The WTGs would not have an impact on the Mount Macedon ATC surveillance radar systems.
- The WTGs must be reported to CASA and construction details provided to Airservices.
- The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual

contact with the ground and obstacles and can remain so, or unless a pilot is using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft above the wind farm when within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT when they confirm that they are within 25 nm of Avalon or Ballarat, by reference to the appropriate ARP, or navigation aid that the MSA is based upon.

7. UNCERTIFIED AERODROMES

Uncertified aerodromes are defined by CASA as those aerodromes that are not certified under CASR Part 139. The operations of uncertified aerodromes are not regulated by CASA; instead, the suitability to land and operate an aircraft on or surrounding the uncertified aerodrome is the sole responsibility of the pilot in command of the aircraft.

A search of various aviation datasets last checked on the 28 January 2025, identified a number of uncertified aerodromes in the area.

The aviation datasets used for the search are:

- AIP aeronautical charts, effective 20 March 2025
- OzRunways - which sources its data from Airservices Australia AIP. The aeronautical data provided by OzRunways is approved under CASR Part 175
- Australian Government National Map online
- Visual search of satellite mapping surrounding the Project.

An area within a 3 nm radius of an uncertified aerodrome is used to assess the potential impacts of the Project site on aircraft operations at or within the vicinity of the ALA. It is the area where aircraft are configuring the aircraft after take-off whilst departing the circuit area and prior to joining the circuit area for landing.

The only uncertified aerodrome within 18 km / 10 nm of the Project boundary is Lethbridge Airport, located 5.93 km / 3.2 nm from the ARP, and 5.55 km / 3 nm from the end of the nearest runway.

7.1. Lethbridge Airport

Lethbridge Airport is the nearest aerodrome to the Project site. The aerodrome is not certified, and therefore not subject to regulatory oversight by the Civil Aviation Safety Authority (CASA).

According to information published in En Route Supplement Australia (ERSA), the aerodrome operator is Garry and Trish Baum.

The website nominated in ERSA (www.lethbridgeairport.com.au) appears to be the operative source of information for the aerodrome provided to pilots intending to operate there.

There is no mention in the ERSA entry of aerodrome lighting being provided at the aerodrome. It is therefore unlikely that night operations are conducted by fixed wing aircraft. Appropriately equipped helicopters, including emergency services helicopters, may be able to operate to a pre-planned location on the aerodrome.

Lighting is provided at the helicopter refuelling point, but not mentioned in aviation publications, nor on their website.

From the noted restrictions, it is mentioned that no flights are permitted over residential houses outside of 1 km of the airfield boundary.

Aircraft operating at Lethbridge Airport are restricted to those with a maximum take-off weight of less than 5700 kg which are expected to use the facility including helicopters and range from:

- Twin engine 8-seater aircraft to;
- Single engine four or six seaters to single seat planes, some of which would be described as “ultralights” which are operated under Recreation Aviation Australia (RAAUS) regulations.

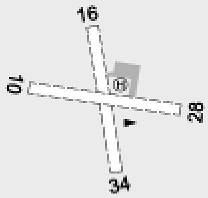
Based on the information provided on the Lethbridge Airport's website, all 4 runways are 1200 m long and 18 m wide.

The AIP ERSA entry is shown at Figure 9.

AIP Australia 12 JUN 2025 FAC YLED - 1

LETHBRIDGE AIRPORT **ELEV 790**

FULL NOTAM SERVICE NOT AVBL



VIC		UTC +10	YLED
375508S	1440604E	VAR 11 DEG E	UNCR

AD OPR G & T Baum, 3429 Midland Highway, Lethbridge, VIC, 3332. PH 0456 688 468. Website: www.lethbridgeairport.com.au.

REMARKS

1. PPR FM AD OPR.
2. Landing and parking fees apply for all ACFT. See website.

HANDLING SERVICES AND FACILITIES

AVGAS, MOGAS, JET A1. Credit Cards Swipe Bowsers only. CTC AD OPR.

PASSENGER FACILITIES

WC/Refreshments

PHYSICAL CHARACTERISTICS

10/28	39a	5700 kg Unrated. Sealed. RWY LEN 1,200M.	WID 18	RWS 60
16/34	33c	5700 kg Unrated. Grass. RWY LEN 1,000M. Unusable in wet conditions. Slope level.	WID 18	RWS 60

ATS AND AERODROME COMMUNICATION FACILITIES

FIA MELBOURNE CENTRE 126.8

LOCAL TRAFFIC REGULATIONS

1. No intersection DEP allowed - use full RWY length.
2. In nil wind conditions preferred RWY 28.

FLIGHT PROCEDURES

Circuit HGT is 1,000FT AGL. No 500FT circuit AVBL.

CTAF 127.65

NOISE ABATEMENT PROCEDURES

1. Avoid flights over houses within 1KM of airfield.
2. Avoid overflying Lethbridge township at less than 2,500FT AMSL.
3. To assist with noise minimisation, pilots are encouraged to climb to altitude as quickly as possible after take-off and if possible operate at a reduced engine rotations per minute within the circuit area.
4. Fly friendly policy in effect - refer website for more information.

ADDITIONAL INFORMATION

Animal hazard may exist.

CHARTS RELATED TO THE AERODROME

WAC 3469, 3470.

Figure 9 Lethbridge Airport data

Aircraft based at Lethbridge Airport operate under a Runway Usage Licence Agreement and itinerant aircraft must obtain permission to operate there.

The airport website provides details of "advisory circuit patterns":

> *They are designed to show that avoiding direct overflying of all nearby houses, neighbouring the airfield, is possible and you need only extend the downwind leg (ie turn a late base) in order to adhere to fly neighbourly procedures. Please also note that during times of nil significant weather, the preferred runway is 28. Minimum circuit height is 1000 FT AGL.*

The website also includes indicative diagrams showing these circuit patterns overlaid on a topographic base. They have been prepared by St. Quentin Consulting.

It is noted that Runway 10 is indicated as runway 11 in the diagram below.

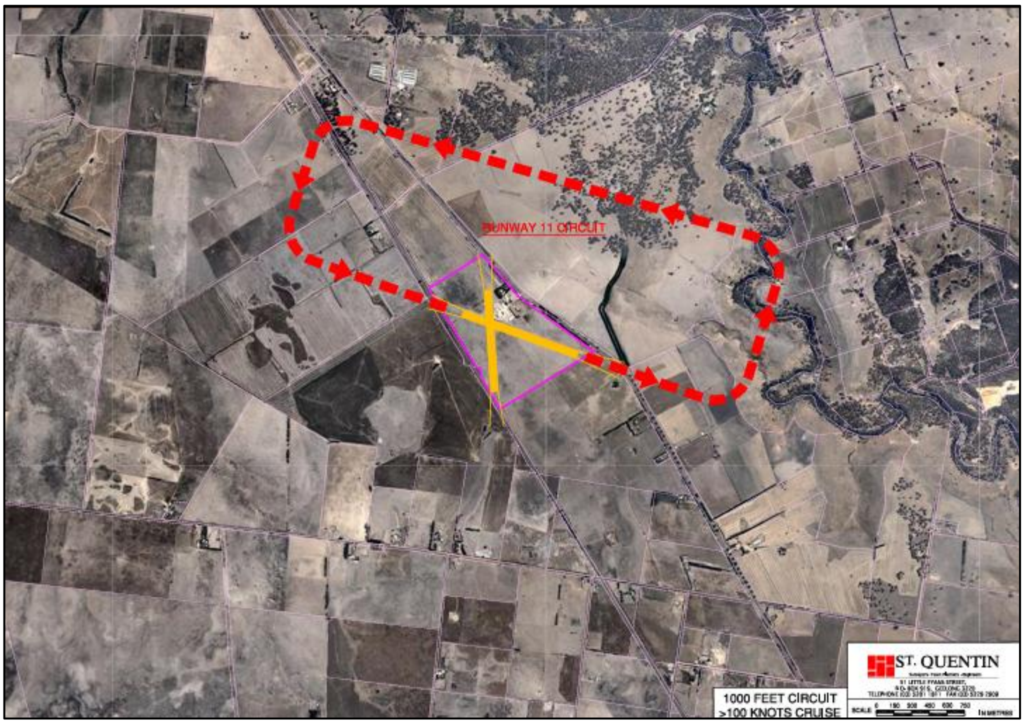


Figure 10 Runway 10 circuit pattern

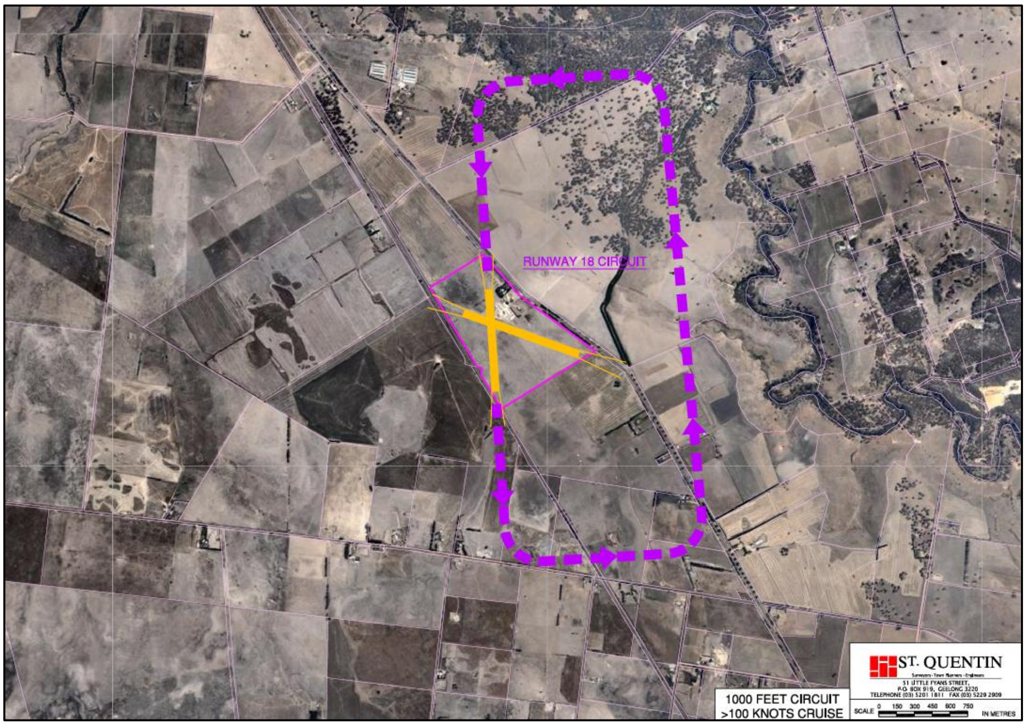


Figure 11 Runway 18 circuit pattern

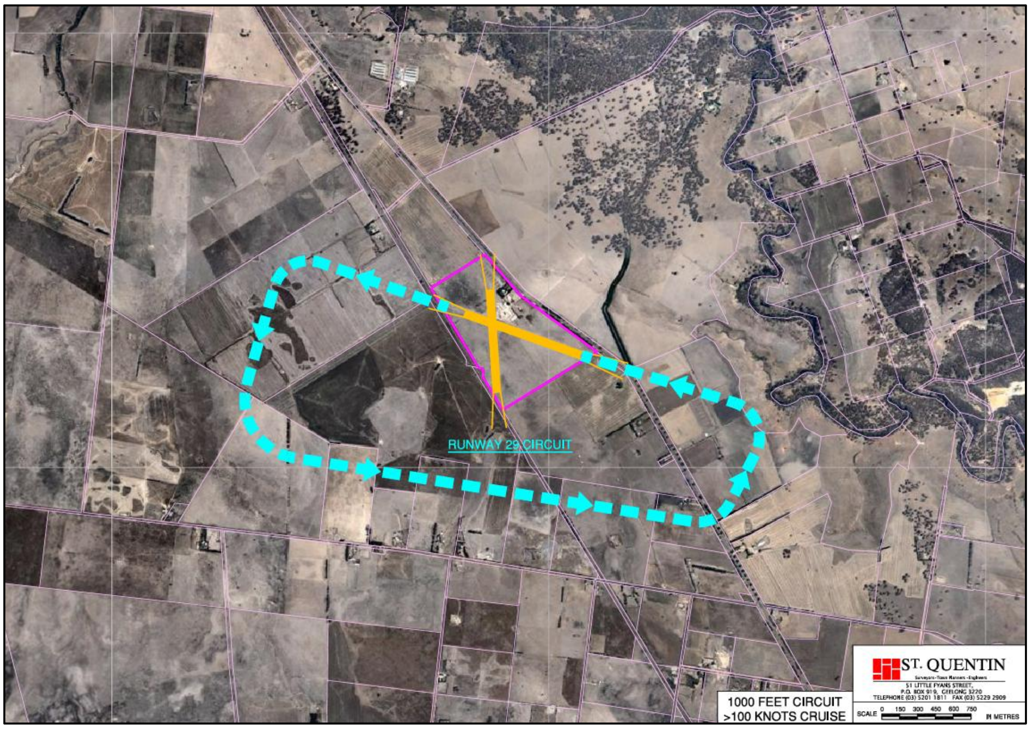


Figure 12 Runway 28 circuit pattern

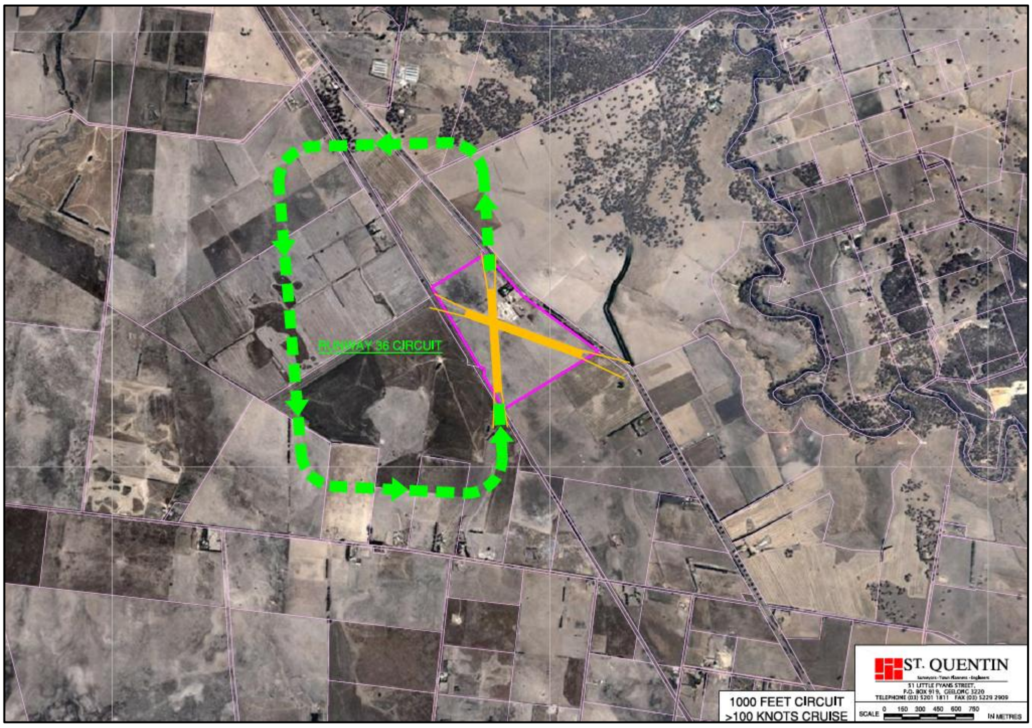


Figure 13 Runway 36 circuit pattern

The specified flight paths are attached as Appendices to the Air Operations Management Plan published by the airport owners on their website. They note:

- *The basis of the designated flight paths is that they reflect the two existing runways, and use both directions of each runway. In practice the flight path used generally depends on wind direction therefore both directions of each runway are made available. There are therefore four flight paths;*
- *The flight paths do not go directly above any dwellings. It is noted that the broader planning controls already specify that no flights may occur over houses within 1 kilometer of the land.*
- *Take offs and landings and circuit flights must be generally in accordance with these plans. This requirement will be conveyed to airport users by both the Airpark website and by ERSA information and publications.*
- *Safety is paramount and aircraft may depart from these flight paths for strict safety or weather related reasons. The responsible authority may require the aircraft operator to explain any such occurrence.*[1]

The circuit patterns are replicated on a Google Earth image that shows the indicative circuit patterns are not in proximity to the Project WTGs.

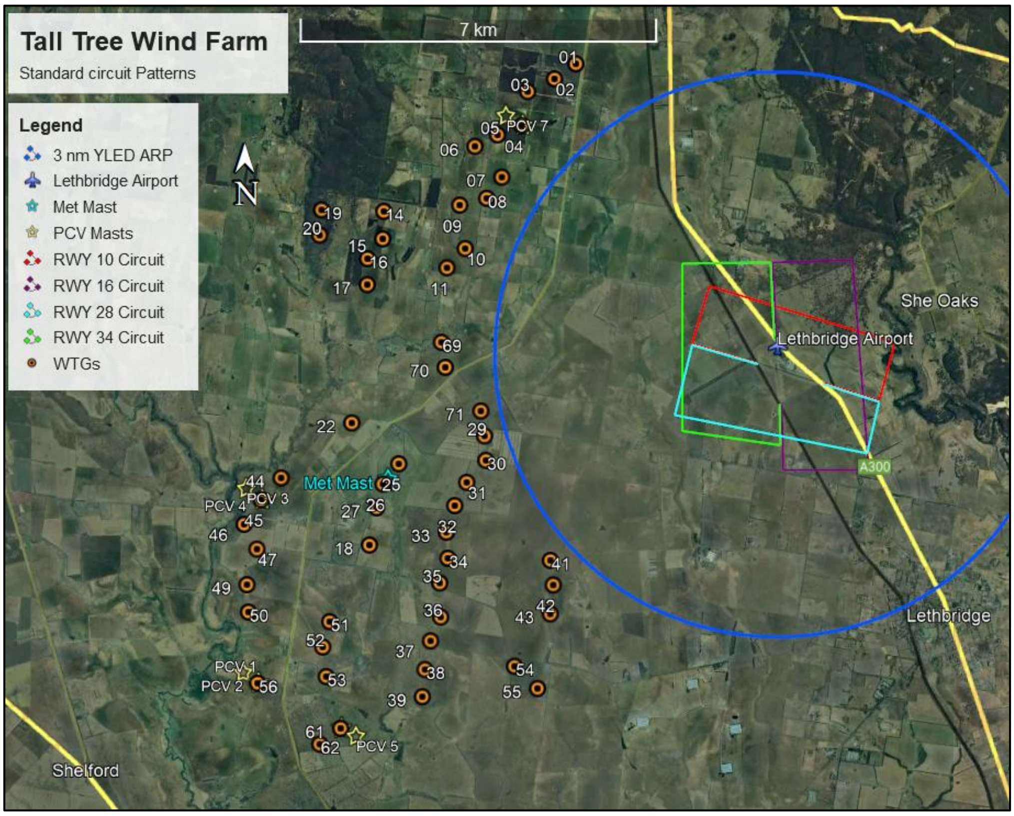


Figure 14 Lethbridge standard circuit patterns

[1] Air Operations Management Plan – Lethbridge Airpark (St. Quentin Consulting Pty Ltd)

The standard procedure for aircraft operating in the circuit area of an uncertified aerodrome, as described in Figure 2 and Figure 3 is as follows:

- After taking off from a runway, climb straight ahead on the upwind leg to 500 ft above the aerodrome
- Turn left onto a cross-wind leg whilst still climbing to the appropriate circuit height
- Turn left onto a downwind leg, maintaining the appropriate circuit height and completing pre-landing checks
- At the appropriate position, at an approximate angle of 45° from the landing runway end, turn onto the base leg and commence descent to the runway
- Continue descending and when ready turn left to align with the landing runway and land.

For aircraft that are departing Lethbridge to fly to other locations AC 91-10 v1.3 applies. It 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:

> *7.11 Departing the circuit area*
>
> *7.11.1 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.*

For a take-off and intended departure from RWY 28, i.e. heading west toward the proposed wind farm, a pilot would climb straight ahead and if they are able to reach an altitude above the wind farm, by the time they reach it, they would be able to continue straight ahead and depart in any direction toward their destination.

If the pilot determines that the aircraft would not be able to climb above the wind farm before reaching it, they would need to continue in the circuit until reaching a suitable altitude above the circuit and then, if they need to fly over the wind farm, reach a suitable height above the wind farm prior to reaching it.

For aircraft arriving at Lethbridge Airport from a direction over the wind farm, they would need to maintain a minimum altitude of at least 500 ft above the published height of the WTGs until they are established past the WTGs before descending to the appropriate circuit altitude.

Aircraft operating at Lethbridge are required by the airport owner to comply with the Air Operations Management Plan which includes:

> *Use of the airpark for aeronautical activities is permitted on the following basis:*
>
> - *Except with a permit the number aircraft movements must not exceed 17500 per annum. Each take-off, landing, or touch and go is an aircraft movement.*
>   - *The take-off weight of aircraft using the airport must not exceed 5700kg. By way of explanation the types of aircraft which fit within this weight limit and which are expected to use the facility include helicopters and range from*
>   - *Twin engine 8 seaters to;*
>   - *Single engine, single seat planes.*

- *No flights over houses are permitted within a 1 km radius of the airpark site, except for strict reasons of aviation safety.*
- *Except with the written consent of responsible authority the number of airshows, fly-ins and similar events must not exceed six per annum.*
- *Aircraft movements must, except with the written consent of the responsible authority, be limited to:*
    - *45 minutes after first light and 45 minutes before last light during Daylight Savings Time and*
    - *30 minutes after first light and 30 minutes before last light during Eastern Standard Time.*

"First light" and "Last light" refer to civil twilight as defined in the CASA Visual Rules Flight Guide.

The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual contact with the ground and obstacles and can remain so, unless using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT.

Aircraft take-off performance

Using a single engine typical CASA registered light aircraft capable of carrying 4 people as an example, it would be expected that on a normal day with a comfortable temperature in nil wind conditions, the aircraft would get airborne in approximately 600 m from start of roll. Climbing at a best rate of climb speed of 76 nautical miles per hour (knots) it would achieve approximately 750 ft per minute climb rate. It would take approximately 2.3 minutes to reach 3 nm from the take off point and therefore reach approximately 1725 ft above the runway. The aircraft would not reach the height of the WTGs (approximately 1743 m AMSL) and would be required to remain in the designated circuit area, continuing to climb until it reached 1500 ft above the aerodrome before departing from the aerodrome. From there it could turn towards the wind farm, continuing to climb to ensure the aircraft can reach an altitude above the area of the wind farm related to the departure flight path.

Any head wind would increase the amount of climb achieved over the distance due to a slower ground speed achieved. The climb rate would not decrease.

Alternatively, these aircraft could depart on the crosswind leg while continuing to climb until above the wind farm before turning towards it.

The wind farm will not require aircraft to consider any additional climb within the circuit area if the departure flight path will avoid overflying the wind farm.

It is likely that ultra-light aircraft registered under RAAUS would have inferior performance to the typical light CASA registered aircraft and so if they intend to fly over the wind farm, they too would have to remain in the circuit or depart on the crosswind leg until reaching a suitable height to be able to fly over the wind farm.

The higher performance single engine aircraft and twin-engine aircraft could achieve a higher performance and may be able to achieve an altitude above the nearest WTG without having to turn beforehand.

Only three WTGs are near the 3 nm distance from the end of runway 28, so more climb distance is therefore available for all other departure directions. The nearest WTG that is within 15 degrees of the runway centreline, (considered to a straight departure) is located approximately 3.5 nm from the end of the runway.

The Noise Abatement Procedures published in ERSA encourage pilots *"climb initially to altitude as quickly as possible after take-off"* to assist with noise minimisation. This is normally accomplished at a "maximum rate of climb speed" and aircraft configuration, which reduces the distance to climb to a particular altitude.

7.2. Lethbridge Flying Training Area

The flying training area for aircraft based at Lethbridge that surrounds the Project area is not published in aeronautical publications. It is only available to pilots based at Lethbridge Airport or who directly request it from the aerodrome operator. It is shown in Figure 15 along with the Project. (Source: Lethbridge Airport Manager)

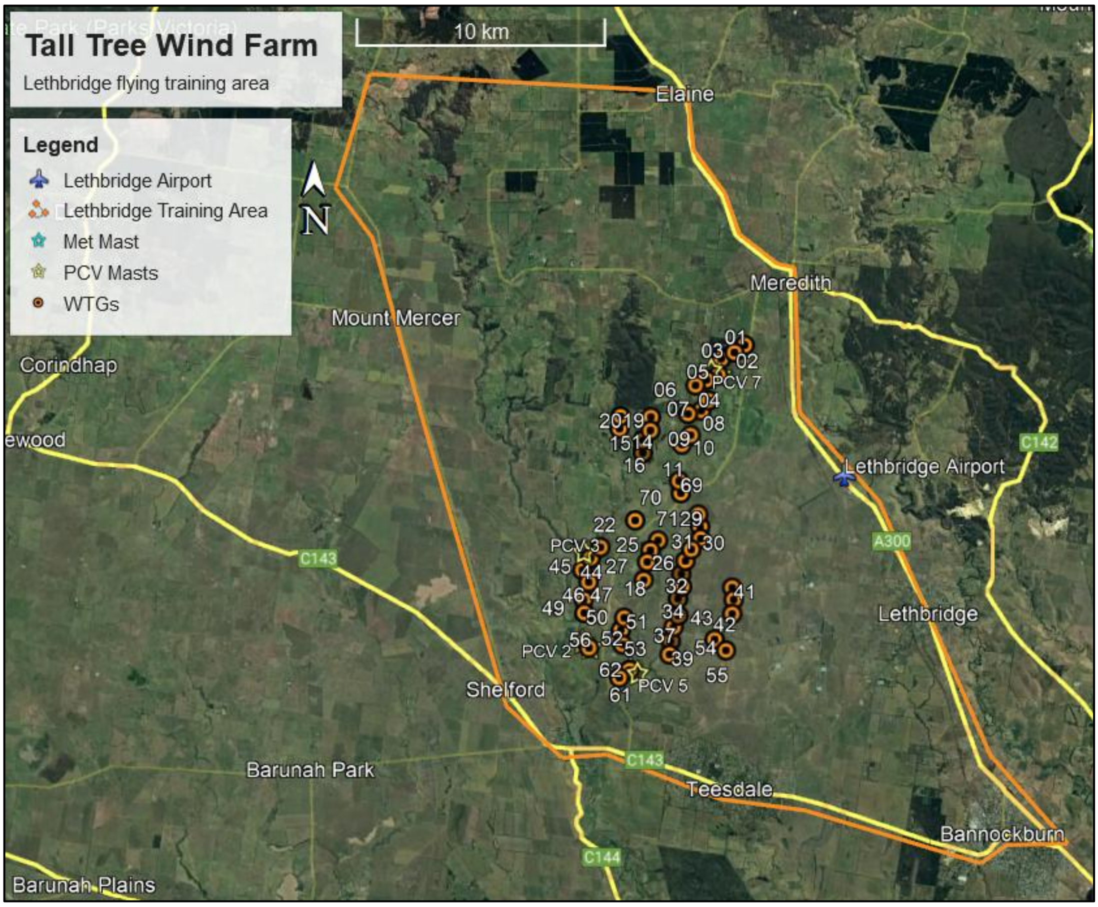


Figure 15 Lethbridge flying training area

The proposed wind farm will occupy a material proportion of the flying training area within which the local aircraft operators conduct the majority of their initial and advanced flying training. The early phase of flying training involving emergency procedures, practice engine failure and forced landing practice are conducted prior to students being sent solo in the training area or for solo circuit practice as they advance towards their licence tests. Area familiarisation is also carried out to ensure that the student pilot understands any likely hazards within the training area, the boundaries and identifying features to enable them to remain safely within the flying training area.

It can be seen from Figure 15 that the Project will limit the area that low altitude flight operations can take place when the wind farm is operating, relative to flight operations that currently take place. It should not impact upper air work above the Project by the prescribed 500 ft margin within 300 m of the Project.

The length and orientation of the Project presents a barrier that would need to be cleared between the airport and parts of the training area. It also means that a portion of the southern part of the training area (where turbines are proposed) would be suitable only for higher altitude training operations.

Initial flying training involves the instructor teaching the inexperienced student pilot how to control the aircraft. This is conducted at altitudes well above terrain and obstacles so that handling errors can be rectified at a safe altitude above the ground or obstacles.

When the student is proficient at controlling the aircraft accurately, training then normally progresses to take-off and landing practice at the aerodrome with circuits, in the patterns previously described, being conducted. Circuit training would not be affected by the wind farm.

The training then progresses to emergency procedures which involves simulated engine failures immediately after take-off and to practice forced landing onto the airfield or adjacent paddocks with the aim to simulate landing in a suitable paddock. The practice landing in a paddock does not actually take place, as the aircraft are not allowed to descend below 500 ft AGL unless the instructor holds a CASA approved low-level flying endorsement. Even then, permission from the paddock owner must be obtained prior to the event.

Low level flying training, an advanced activity for qualified and experienced pilots and conducted by highly qualified instructors with the appropriate low level training authorisation, also requires the permission of landowners over which the flight is intended at altitudes below 500 ft AGL.

Pilots authorised for low-level flight may operate in close proximity to a WTG, but all other pilots must either fly at least 500 ft above the Project or be displaced laterally by at least 300 m from any WTG.

The Project will limit the areas over which practice forced landings and low-level flying training without being affected by the proposed wind farm. There is sufficient training area away from the Project to conduct these flight training operations.

A further feature of flying training is to practice engine failures after take-off. An engine failure after take-off is a critical incident that requires quick and correct actions that generally lead to a forced landing in paddocks very close to the aerodrome and near the end of the runway. Such failure practice occurs either very soon after take-off (the most critical event) or somewhere in the standard circuit area within 1 nm of the runway. The Project will not create an adverse impact to such training, or real-world situations where an aircraft suffers a critical failure immediately after take-off and lands in a paddock or road between the aerodrome and the wind farm site.

VFR aircraft returning to Lethbridge from the west of the aerodrome, in conditions of low cloud that may be below the top of the WTGs, may descend to no lower than 500 ft AGL, to remain below the cloud. These aircraft would need to fly around the Project in order to return to Lethbridge, whereas currently they can fly directly to the aerodrome. In such conditions the pilot would still be able to see the white WTG towers at a sufficient distance to avoid them by the 300 m margin to obstacles, as prescribed in CASR 91.267.

In conditions where the cloud base is below the top of the WTGs, pilots should not be returning to Lethbridge due to the fact that:

1. The terrain rises to the west as you approach Lethbridge and cloud heights generally remain at the same height, meaning the margin between the ground and the cloud will reduce, creating a serious safety hazard involving the aircraft getting even closer to the ground to avoid the cloud, often resulting in a crash; and

2. The conditions of use of Lethbridge aerodrome, as described in the ERSA entry Flight Procedures, state that the circuit height is 1000 ft AGL and that no 500 ft circuit is available. This precludes aircraft returning to Lethbridge aerodrome in conditions where an extensive cloud base exists below 1000 ft, the required circuit altitude to avoid noise nuisance to the local community. A cloud base of

approximately 900 ft AGL will be above the WTGs but will preclude a circuit altitude of less than 1000 ft AGL.

The Project will not in itself preclude flights returning to Lethbridge aerodrome in conditions where a consistent cloud base exists below 1000 ft AGL. The local flying procedures currently preclude such low-level flight back to or from the aerodrome in any case.

The proposed electricity transmission line is located outside of the standard and published circuit areas; therefore, aircraft would have either reached 500ft above the runway and be well above the transmission line or they would have turned crosswind prior to reaching it.

Summary

Whilst the Project will be a prominent feature and an obstacle to the west of Lethbridge Airport, which will be required to be considered by pilots operating nearby, it is not considered to create a material adverse impact to flight safety at Lethbridge Airport in relation to:

- Take-off and landings
- Engine failure after take-off practice or real situations
- Forced landing or low-level flying training within the training area
- Initial flying training above the Project
- VFR aircraft returning to Lethbridge in conditions of low cloud below the nominated minimum circuit height of 1000 ft AGL
- The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual contact with the ground and obstacles and can remain so, or unless a pilot is using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft above the wind farm when within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT when they confirm that they are within 25 nm of Avalon or Ballarat, by reference to the appropriate ARP, or navigation aid that the MSA is based upon.

8. POTENTIAL WAKE TURBULENCE IMPACTS

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

NASF Guideline D provides guidance regarding WTG wake turbulence which states:

> *Wind farm operators should be aware that wind turbines may create turbulence which is noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 150 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm…*

The key wording in the NASF guidance is "*noticeable*" and that "*the level of turbulence in the vicinity is not known with certainty."*

There are many situations in aviation where pilots "notice" their aircraft moving away from the desired flight path or altitude and take appropriate action to maintain control of the aircraft with minimal input.

Pilot training standards are regulated by CASA to ensure that all qualified pilots have demonstrated to a suitably qualified and authorised check pilot that they can maintain control of their aircraft along the chosen flight path within prescribed accuracy standards, across a significant range of atmospheric conditions that can cause the aircraft to deviate from the pilot's chosen flight path.

Aircraft are designed to withstand a significant variation in atmospheric disturbances to ensure airframe integrity is maintained. The limits of the airframe's integrity are known by the pilot and considered in every flight activity. Significant weather events such as thunderstorms are avoided because of the likelihood of airframe limits being exceeded by the strong wind shear type conditions within, beneath and surrounding thunderstorm cells.

Wind turbines have been assessed in a limited number of studies, in which the highest classification of hazard is considered to be medium only within about 7 rotor diameters (RD) downwind of the wind turbine. There are no assessments that assessed that the downwind turbulence is significant and outside the ability of the aircraft to endure the impacts and for the pilot to be able to control the aircraft using normal control inputs.

There have been no reported aircraft accidents or incidents involving an aircraft encounter with the turbulence downwind of a wind turbine.

Assessment

A 183 m rotor diameter (larger than those used in the two studies referred to below) has been used for the wake turbulence analysis here. Based on this scenario, NASF Guideline D suggests the effects of wake turbulence could be noticeable from the WTGs within 2928 m (16 RD) of the WTG. The published circuit area at Lethbridge Airport is located approximately 3850 m from the nearest WTGs and the nearest WTG (WTG41) to a runway is approximately 5552 m from the southern end of runway 18 and approximately 5581 m (WTG 71) from the western end of runway 10.

Based on the results of published scientific studies, referenced below, which indicate that any medium level of turbulence would in most circumstances be confined to within 7 RD of a WTG, Aviation Projects considers that a conservative area of 10 RD is likely to be the maximum area where wake turbulence from WTGs would be noticed by pilots of light aircraft operating downstream of a WTG.

These studies also indicated that where any such turbulence is experienced, the pilot would be able to control the aircraft using normal control inputs.

Two of those studies are referred to below.

The *European Academy of Wind Energy* published an open access report titled "*Do wind turbines pose roll hazards to light aircraft?*" dated 2 November 2018. This study concluded:

> *In neutral conditions, the largest of these hazards are classified as medium hazards and exist 6.5 D downwind of the turbine in the bottom-left portion of the rotor disk. The highest hazards in the stable case also remained within the medium threshold and are located in two separate regions of the wake: approximately 4 D downwind in the bottom-right quadrant of the rotor and 6 D downwind in the top-left quadrant of the rotor.*

The United Kingdom (UK) Civil Aviation Authority commissioned the University of Liverpool to conduct a *Wind Turbine Wake Encounter Study*, the results of which were published in March 2015.

> *At University of Liverpool, a full CFD method [4] was used with the HMB solver to study wind turbine wakes. The CFD results showed good agreement for the blade surface pressure distributions and flow field velocities with the wind tunnel measurements. The wake was then solved on a very fine mesh able to capture the wake vortices up to 8 radii downstream of the blades on the MEXICO wind turbine rotor.*
>
> *In general, the LIDAR measurements captured the regular wake mean velocity patterns. Statistic LIDAR data indicate that the effects of wind turbine rotor wake, in term of velocity deficit, are limited within a downwind distance of 5D. This is generally in agreement with the results of the full CFD method and the velocity deficit models.*
>
> *For a wind turbine with size similar to the WTN250, and using the Beddoes circulation formula, the off-line simulation results indicate that the wind turbine wake did not pose any hazards to the encountering aircraft 5 diameters further from the wind turbine. The dominant upset that the wake generated is a yawing moment on the aircraft. The wake generated crosswind, is smaller than the maximum crosswind of 17.75 ft/s for an airport (codes A-I or B-I) that is expected to accommodate single engine aircraft. These conclusions are in line with that found in the piloted flight simulation.*

These two studies are the only major studies of their kind.

Wind farm designers and developers recognise the impact of downwind changes in wind strength and direction when designing the overall wind farm to ensure that the turbines are located at minimum distances from each other in order to prevent turbulence from one or more turbines affecting the operational efficiency of a downwind turbine or causing damage to the downwind turbine blades primarily due to fatigue loading from turbulence over time. The minimum distance between turbines in wind farms is typically 800 m, a significantly shorter distance than either 16 RD or 10 RD presents.

The turbulence from a wind turbine could be described as a shear type turbulence which is caused by the difference of the free flow wind speed at the edge of the turbine rotor (the blade tip) being disrupted by the turbine blade being rotated by the wind and altering the wind speed within the rotor diameter moving downwind from the turbine. This shear type turbulence descends and weakens as it gets further away from the turbine. It is not a stream of turbulence being generated by the blades being turned by a mechanical force such as occurs with an aircraft propellor or ceiling fan in a house or factory.

The WTG blades change pitch, dependent on the wind strength, to maintain a consistent rotor speed, to maximise efficiency and minimise noise emissions. They interfere with the natural wind flow and cause some degree of turbulence downwind of the WTG. A consistent theme among the studies was that the higher turbulence exists very close to the WTG and rapidly dissipates due to the effect of convection, mechanical turbulence from other sources such as the wind flowing over trees, buildings and terrain undulations.

The studies indicate that turbulence is likely to dissipate to below a level that could be felt by pilots within 7 rotor diameters (RD) from the WTG. Aviation Projects considers that a more conservative value of 10 RD is best used to assess areas where the likely turbulence created downwind of a WTG will not be felt by or impact pilots of light aircraft.

The studies referenced above also indicate that aircraft controllability is maintained when experiencing the likely turbulence when the aircraft is approximately 6 RD from a WTG.

Table 7 Wake Turbulence Distances

1 RD (m)	*7 RD (m)*	*10 RD (m)*	*16 RD (m)*
183	1281	1830	2928

In conditions of extremely high wind speed the WTGs are “parked” with the blades in a “feathered” condition to reduce the wind loading upon them. Turbulence from the “feathered” blades still exists but would be less than when the turbine is rotating. Other mechanical turbulence generated by trees, hills and other objects during high winds would significantly exceed and break up any minor turbulence from a stationary WTG.

Aircraft are designed to withstand significant turbulence according to aviation meteorological standards that are recognised and accepted worldwide. Even in circumstances where an airliner experiences severe turbulence which may injure passengers, the aircraft remains controllable (except for the first part of the event where it may descend rapidly at high altitude) and does not suffer any significant damage (although it will undergo a major inspection).

The downwind turbulence from WTGs beyond 7 RD may be felt by the pilot of a light aircraft but the pilot will only need to make minor control adjustments to maintain control of the aircraft’s attitude, altitude and heading. Such turbulence is likely to be classified as Light on an intensity scale published by the Australian Bureau of Meteorology shown in Figure 16.

The UK study assessed that the turbulence within 7 RD is considered to create a medium hazard which is likely to equate to pilots experiencing “Moderate” turbulence in which the *“Pilot remains in control at all times.”* (refer to Figure 16)

Intensity	Airspeed Fluctuat-ions (kt/s)	Vertical Gust (ft/s)	G Load	Aircraft Reaction	Reaction Inside Aircraft
Light	5 – 14	5 - 19	0.15 – 0.49	Momentary slight and erratic changes in attitude and/or altitude. Rhythmic bumpiness.	Little effect on loose objects.
Moderate	15 – 24	20 - 35	0.50 – 0.99	Appreciable changes in attitude and/or altitude. Pilot remains in control at all times. Rapid bumps or jolts.	Unsecured objects move. Appreciable strain on seatbelts.
Severe	≥ 25	36 -49	1.0 – 1.99	Large abrupt changes in attitude and/or altitude. Momentary loss of control.	Unsecured objects are tossed about. Occupants violently forced against seatbelts.
Extreme	≥ 25	≥ 50	> 2.0	Very difficult to control aircraft. May cause structural damage.	

Figure 16 Turbulence intensities[2]

Light and moderate turbulence can be generated by lines of trees near runways.

> *Turbulence may disturb an aircraft's attitude about its major axis, and cause rapid bumps or jolts to be experienced, but in most cases it does not significantly alter the aircraft's flight path.*[3]

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. The research studies indicate that adverse or severe turbulence is not created by wind turbines outside the 5 RD distance.

Figure 17 shows the area within the NASF guideline 16 RD (2928 m) of the closest WTGs in relation to the published circuit areas for each runway at Lethbridge Airport (source: Google Earth, ACCIONA).

[2] Bureau of Meteorology – Hazardous Weather Phenomena – Turbulence
[3] Bureau of Meteorology – Hazardous Weather Phenomena – Turbulence

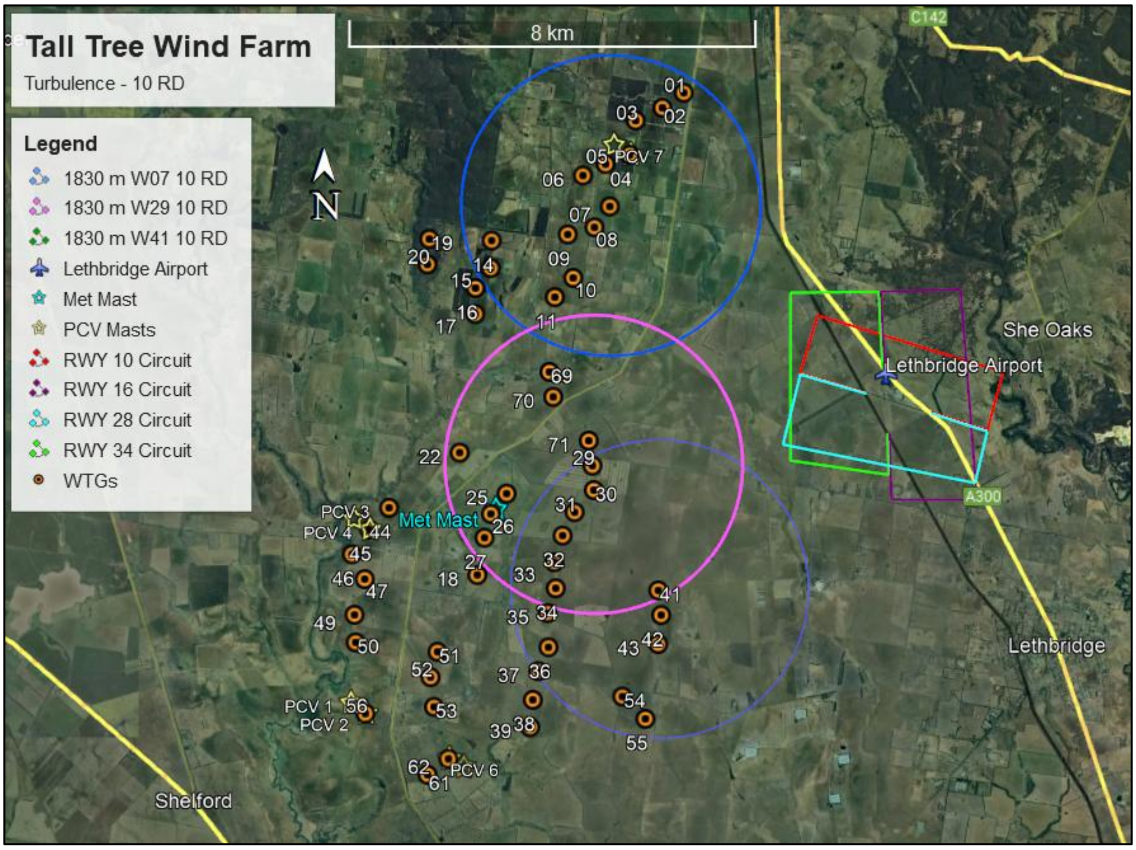


Figure 17 NASF downwind turbulence @ 16 RD (2928 m)

It is clear from the NSAF guideline commentary that the turbulence that they report could be felt within 16 RD does not impinge on the standard and published circuit areas at Lethbridge Airport and has no impact on circuit area and take-off and landing operations.

The 10 RD radii are shown in Figure 18.

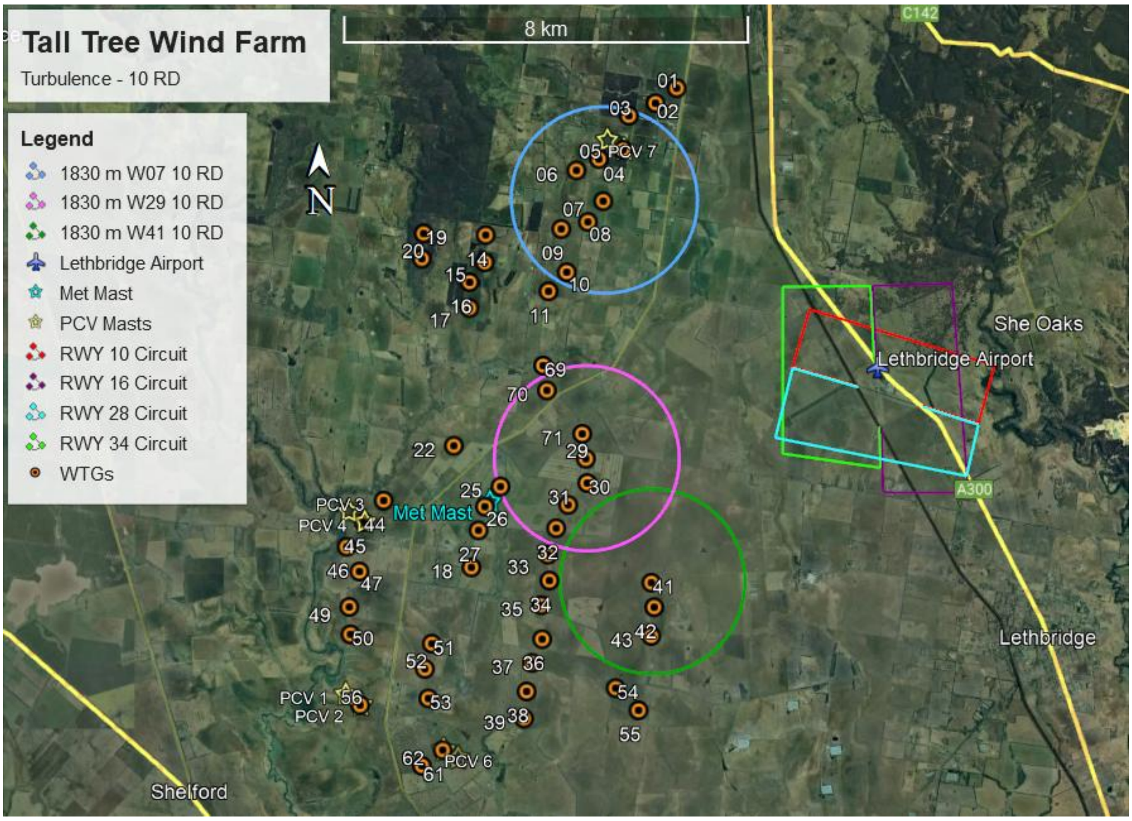


Figure 18 Possible extent of downwind turbulence @10RD (1830 m)

Aviation Project's assessment that turbulence is unlikely to be felt outside 10 RD is even further away from the standard and published circuit areas for each runway, providing more room for aircraft to manoeuvre away from any area that light turbulence could exist.

The degree of turbulence likely to be experienced is well within the capability of a pilot to maintain control of the aircraft and well within the limits of the aircraft's structure to withstand, should any be experienced at all.

8.1. Bureau of Meteorology Weather Stations

A weather reporting station is located on a property at She Oaks, approximately 8.3 km east of the nearest WTG within the Project and 2.7 km east of Lethbridge Airport.

It is unlikely that any impact from the Project would exist at this site due to terrain, trees, road users and buildings nearby to the weather reporting station.

The Bureau of Meteorology will be provided with this AIA to consider Aviation Projects' assessment.

8.2. Assessment recommendations

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

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).

2. Final details of WTG coordinates and elevation should be provided to Airservices Australia at least two weeks prior to construction beginning, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com

3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    a. The planned operational timeframe and maximum height of the crane; and

    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

4. Details of the wind farm should be provided to local operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.

5. To facilitate the flight planning of aerial application operators, details of the Project, including the final location and height information of WTGs 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.

Marking of WTGs and WMTs

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

7. It is not mandatory to mark the WMTs however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:

    a. Obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour

    b. Marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and

    c. Guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation

Lighting of WTGs and WMTs

8. There is no regulatory requirement to provide obstacle lighting on a WMT that is not within the vicinity of a certified aerodrome. Generally, for WMT that will be installed prior to WTG installation and WMT that are not in close proximity to a WTG, the voluntary provision of obstacle lighting should be considered to ensure visibility in low light and deteriorating atmospheric conditions. CASA will review the WMTs for potential hazards to aircraft operations and may recommend lighting the WMT.

Micrositing

9. Providing the micrositing of WTGs during construction is within 100 m of the planned WTGs it will not be likely to result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing, and the conclusions of this AIA would remain the same.

Transmission line

10. 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 application operators and marked in accordance with CASR Part 139 MOS.

Aerial firefighting

11. The developer or operator should ensure that:

    a. Liaison with the relevant fire and land management agencies is ongoing and effective

    b. Access is available to the wind farm site by emergency services response for on-ground firefighting operations

    c. Wind turbines are shut down immediately during fire 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.

Aviation Projects considers that it may be impractical and/or unsafe to lock the turbine blades in a Y configuration in the case of a bushfire emergency, if this would require personnel to climb the WTG tower as the fire approaches. WTGs can, however, be paused or shut down remotely, with blades feathered to halt rotation within a matter of seconds.

Triggers for review

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

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

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

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

9. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 11 it has been concluded that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WTGs or WMTs, without obstacle lighting on the WTGs and WMTs of the Project.

For completeness, lighting standards and guidelines are summarized in Annexure 3.

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

Consideration should be given to marking any WMTs according to the requirements set out in Part 139 MOS 2019 Chapter 8 Division 10 Obstacle Markings: specifically:

> *8.109 Obstacles and hazardous obstacles*
>
> *(1) The following objects or structures at an aerodrome are obstacles and must be marked in accordance with this Division unless CASA determines otherwise under subsections (3) and (5):*
>
> *any fixed object or structure, whether temporary or permanent in nature, extending above the obstacle limitation surfaces. Note an ILS building is an example of a fixed object;*
>
> *any object or structure on or above the movement area that is removable and is not immediately removed.*
>
> *8.110 Marking of hazardous obstacles*
>
> *(5) long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that:*
>
> *(a) the darker colour is at the top; and*
>
> *(b) the bands:*
>
> > *i. are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and*
> >
> > *ii. have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of:*
> >
> > > *(A) 1/7 of the height of the structure; or*
> > >
> > > *(B) 30 m.*
>
> *(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.*
>
> *(8) The objects mentioned in subsection (7) must:*
>
> > *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
> >
> > *(b) be spaced 30 m apart along the length of the wire or cable.*

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

- *the top 1/3 of wind monitoring towers to be painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the*

Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;

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

The WMT is painted according to the NASF Guideline D recommendations and therefore does not require a flashing strobe light during daylight hours. The WMT is equipped with a red obstacle light to ensure it is visible at night.

Figure 19 shows the wind monitoring tower installed within the proposed wind farm boundary.

Figure 19 Installed wind monitoring tower

9.1. National Airport Safeguarding Framework Guideline D

NASF Guideline D: *Managing the Risk To Aviation Safety of Wind Turbine Installation (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.

> *When wind turbines over 150 metres above ground level are to be built within 30 kms of a certified or registered aerodrome, the proponent should notify the Civil Aviation Safety Authority (CASA) and Airservices. If the wind farm is within 30km of a military aerodrome, Defence should be notified.*
>
> *The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:*
>
> - *30 metres or more above ground level for structures within 30km of an aerodrome; or*
> - *45 metres or more above ground level for structures located elsewhere.*
>
> *Marking and lighting of wind monitoring towers*
>
> *Before developing a wind farm, it is common for wind monitoring towers to be erected for anemometers and other meteorological sensing instruments to evaluate the suitability or otherwise of a site. These towers are often retained after the wind farm commences operations to provide the relevant meteorological readings. These structures are very difficult to see from the air due to their slender construction and guy wires. This is a particular problem for low flying aircraft including aerial agricultural operations. Wind farm proponents should take appropriate steps to minimise such hazards, particularly in areas where aerial agricultural operations occur. Measures to be considered should include:*
>
> - *the top 1/3 of wind monitoring towers to painted in alternating contrasting bands of colour. Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;*
> - *marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;*
> - *ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or*
> - *a flashing strobe light during daylight hours.*

9.2. Civil Aviation Safety Authority - regulatory context

The CASA regulates aviation activities in Australia. Applicable requirements include the AC 139 E 0.1-v1.0 and AC.139 E 0.5-v1.1. Relevant provisions are outlined in further detail in the following section.

AC 139.E-01 v1.0—Reporting of Tall Structures

AC 139.E-01 v1.0—*Reporting of Tall Structures*, CASA guides 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.

2.2.1 The hazards that such buildings or structures may pose to aircraft requires assessment. CASA routinely performs such assessments however needs to be first notified of the obstacle, structure of source of a hazardous plume. The need to report such hazards is outlined in this AC.

2.2.2 If you are the person who owns, controls or operates the object, structure or a source of a hazardous plume which is either present, imminent or has been approved for erection/construction, details need to be provided about:

– the construction, extension or dismantling of tall structures if the top is:

o 100 m or more above ground level

or

o affects the obstacle limitation surface of an aerodrome as defined in

2.2.3 In addition, tall structures may pose a specific hazard for the operation of low-flying Defence aircraft or to the flight paths of arriving/departing aircraft (refer Paragraph 2.1.3). Therefore, the RAAF and Airservices Australia require information on structures that are 30 m or more above ground level—within 30 km of an aerodrome or 45 m or more above ground level elsewhere for the RAAF, or 30 m or more above ground level elsewhere for Airservices Australia.

2.2.4 Information provided for the database should be accurate and readily interpreted. The tall structure report form has been designed to help owners and/or developers in this respect. The form is available on the Airservices Australia website (including a spreadsheet for reporting multiple structures) at: https://www.airservicesaustralia.com/industry-info/airport-development-assessments/

AC 139.E-05-v1.1 Obstacles including wind farms outside the vicinity of a CASA certified aerodrome – October 2022

AC 139.E-05-v1.1 provides advice about the lighting and marking of wind farms and other tall structures in submissions to planning authorities who are considering a wind farm or tall structure proposal.

2.1.2 Regardless of CASA advice, planning authorities make the final determination whether a wind farm or a tall structure not in the vicinity of a CASA regulated aerodrome will require lighting or marking.

2.2.1 All wind turbine developments and tall structures should be assessed to determine whether they could be a risk to aviation safety. This AC augments the information in the National Aerodromes Safeguarding Framework (NASF) Guideline D and provides additional guidance on the assessment of wind farm developments and guidance for establishing what reasonable measures may be put in place to mitigate any adverse effect the wind farm development could be to aviation safety.

2.2.2 For the purposes of this AC, navigable airspace is considered to be the airspace above the minimum altitudes of VFR and IFR flight, including airspace required to ensure the safe take-off and landing of an aircraft. Generally, minimum altitude limits equate to 500 ft (152 m) or 1 000 ft (305 m) above ground level depending on the situation, i.e., whether or not the flying is over a populous area. The presence of wind turbines, wind monitoring masts and other tall obstacles may create a risk to the safety of flight, due to the risk of collision. An entity that is proposing to introduce a hazard into navigable airspace, such as a wind farm, must mitigate the risk of the hazard on airspace users to ensure an acceptable level of safety is maintained.

2.2.4.1 Part 139 of the Civil Aviation Safety Regulations 1998 (CASR) regulates obstacles within the vicinity of certified aerodromes. This is supported by Part 139 (Aerodromes) Manual of Standards

(MOS) which provides the definition of an obstacle as well as the standards for marking and lighting of an obstacle. Any wind turbine (where the height is defined to be the maximum height reached by the tip of the turbine blades), wind monitoring mast or other tall structure that penetrates an Obstacle Limitation Surface (OLS) of an aerodrome will be assessed in accordance with the provisions of Part 139 of CASR and the MOS.

2.2.6.1 Outside the vicinity of an aerodrome, which is defined as being outside the OLS of an aerodrome, wind farms and other tall structures may constitute a risk to low-flying aviation operations which may be conducted down to 500 ft above ground level (AGL) over non-populous areas. Additionally, wind monitoring masts can also be hazardous to aviation, given they are very thin and difficult to see. Wind farms can also affect the performance of communications, navigation and surveillance (CNS) equipment operated by Airservices or the Department of Defence.

2.5 Aviation hazard lighting - International best practice

2.5.2 Australian regulations state that aircraft in uncontrolled airspace may operate under visual flight rules (VFR), which requires the pilot to remain clear of clouds and to adhere to visibility minima.

> *- in Class G airspace below 3000 ft Above Mean Sea Level (AMSL) or 1000 ft AGL (whichever is the higher) – remain clear of cloud with minimum visibility of 5000 m.*
>
> *– in Class G airspace below 10 000 ft AMSL (subject to the above) – remain 1000 ft vertically and 1500 m horizontally from cloud and with 5000 m visibility.*

Note: Helicopters may be permitted to operate in lower visibility and that further exemptions may apply to special cases such as military, search and rescue, medical emergency, agricultural and fire-fighting operations.

2.5.4 2000 candela medium intensity obstacle lighting recommendation satisfies the 5000 m VFR visibility requirements, according to practical exercises undertaken by the FAA and documented in AC 70/7460-1L (FAA, 2015).

2.5.5 In Australia, CASA has accepted the use of 200 candela lighting in some circumstances due to a lack of back lighting in rural and remote areas, meaning that a lower intensity light is still visible to pilots at an acceptable distance to permit a pilot to see and avoid the obstacle.

2.6 Hazard Lighting

2.6.1 This describes the reasoning behind CASA's preference to recommend aviation hazard lighting for tall structures and aircraft detection systems for wind farms.

2.6.2 Hazard lighting for wind farms and other tall structures is intended to alert pilots, flying at low altitude, to the presence of an obstacle allowing them sufficient awareness to safely navigate around or avoid it. The pilot is responsible for avoiding other traffic and obstacles based on the "alerted" see-and-avoid principle.

2.6.3 Unless the wind farm or tall structure is located near an airport, it is not expected to pose a risk to regular public transport operations. The kind of air traffic that is usually encountered at low altitude in the vicinity of a wind farm or tall structure includes light aircraft (private operators, flight schools, sport aviation, agricultural, survey, fire spotting and control) and helicopters (military, police, medical emergency services, survey, fire spotting and control). Hazard lights are therefore designed to provide pilots with sufficient awareness about the presence of the structure(s), so they can avoid it. This means that the intensity of the hazard lights should be such that the acquisition distance is sufficient for the pilot to recognise the danger, take evasive action and avoid the obstacle by a safe margin in all visibility conditions. This outcome considers the potential speed of an aircraft to *determine the distance by which the pilot must become aware of the obstacle to have enough time and manoeuvrability to avoid it.*

2.7 CASA's commitment to aviation safety

2.7.1 CASA will consider the lighting intensity management and systems that achieve an acceptable level of aviation safety on a case-by-case basis during its assessment.

2.7.2 A CASA determination will consider the environmental setting when determining the need and level of lighting required on a wind farm or tall structure. This may include consideration of lower lighting intensities for obstacles away from an aerodrome. The backlighting of some locations is almost non-existent, meaning the risk of an aviation hazard light being compromised by background lighting from a rural and remote town is lower than would otherwise apply in a residential area closer to a city.

9.3. Transmission Line

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 application operators and marked in accordance with the CASR Part 139 MOS, 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.

10. 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.

10.1. 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 and non-scheduled passenger (air transport operations) 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.

10.2. 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.

10.3. National aviation occurrence statistics 2010-2019

The ATSB has 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 air transport 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 per cent) occurred in the GA 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 1.77:1. Whilst it can be inferred from the data that the majority of fatal accidents are single person fatalities, it is reasonable to assert that the worst credible effect of an aircraft accident in the general aviation category will be multiple fatalities.

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

Table 8 Number of fatalities by 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 20 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.

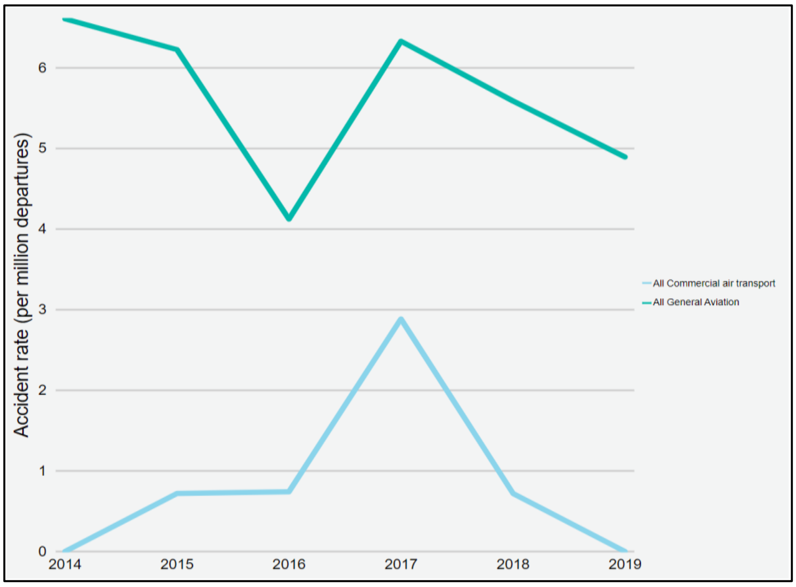


Figure 20 Fatal Accident Rate (per million departures) by Operation Type

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

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

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

Sub-category	*Fatal accidents*	*Fatalities*
Agricultural spreading/spraying	13	13
Agricultural mustering	11	12
Other agricultural	1	1
Survey and photographic	5	10
Search and rescue	2	2
Firefighting	2	2
Other aerial work	3	4
Instructional flying	11	19
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	115	174

Over the 10-year period and since, 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 per cent) were terrain collisions.

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

Whilst there have been more fatal accidents involving GA operations since 2019, none have involved a collision with a wind farm or harsh manoeuvring to avoid one.

10.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of 5 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 5 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 2023, approximately 77.6 GW of wind power had been installed worldwide around the world at the end of 2022.

Based on Australia's Clean Energy Council statistics there were 110 wind farms in Australia in 2023. 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 5 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident occurred in Texas, United States in October 2019 resulting in minor aircraft damage no injury to the pilot and significant injury to a person on the ground. The aircraft, an Air Tractor AT502, was returning from a local aerial application flight and was flown deliberately at low-level in close vicinity to a wind turbine generator (WTG) because the pilot believed his friend was working on the turbine. The aircraft collided with a tagline rope that was attached to a blade of the WTG, and which was being held by a person working on the ground. The worker was thrown about 20 ft in the air and experienced significant non-life-threatening injuries. The aircraft sustained minor damage however the pilot landed the aircraft without further incident.
- 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. 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 2024, approximately 1,000 GW of wind power had been installed worldwide.[4]

A summary of the 5 accidents is provided in Table 10.

[4] www.ourworldindata.org 25 February 2025.

Table 10 Summary of accidents involving collision with a WTG

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
1	Air Tractor AT502 N9143F collided with a tagline rope attached to wind turbine generator blade while being flown deliberately in close proximity to the WTG.	22 October 2019	Dawson County, Texas	0	Day VFR	Not specified	Not specified	The pilot's improper decision to manoeuvre at a low altitude and in close proximity to a wind turbine undergoing maintenance, which resulted in a collision with a tagline rope being held by a worker on the ground and serious injury to the worker.	Not applicable
2	Diamond DA320-A1 D-EJAR Collided with a WTG approximately 20 m above the ground, during the day in good visibility. The mast was grey steel lattice, rather than white, although the blades were painted in white and red bands.	02 Feb 2017	Melle, Germany	1	Day VFR No cloud and good visibility	Not specified	Not specified	Not specified	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
3	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.

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	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	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
5	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

11. 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 shown in Table 11 and Table 12

Table 11 Aviation Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC 5
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

Table 12 Actions Required

8-10	Unacceptable Risk	Immediate action required by either treating or avoiding risk. Refer the risk 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.

The risk event description is provided in **Annexure 4.**

11.1. 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 Project.

Based on an extensive review of accident statistics data (see summary in Section 10 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 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 Transport, Regional Development, Communications and the Arts (Airspace and Air Traffic Management Risk Management Policy Statement). 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.

11.2. 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 Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 13 through to Table 17.

Table 13 Aircraft collision with wind turbine generator (WTG)

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

Discussion

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

There have been 5 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 10. 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 (ie 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 only a very small chance that it would hit a WTG.

Refer to the discussion of worldwide accidents in Section 10.

Aerial application operations are not conducted at night in the vicinity of the Project 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 Project 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 5 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 • The Project site is clear of the obstacle limitation surfaces (OLS) of all certified aerodromes. • 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 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will have a maximum height of 250.5 m (821.9 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 98.1 m (321.9 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • 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.	
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: a) Details of the Project should be communicated to local and regional aircraft operators prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically: b) The final layout 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. c) Because the 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 d) 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 Project site. e) Arrangements should be made to publish details of the 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**. In the circumstances, the level of risk under the proposed treatment plan is considered **as low as reasonably practicable** (ALARP). **Aviation Project's assessment is that, with the implementation of the recommendations of the AIA, there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine.**	
Residual Risk	7 - Tolerable

Table 14 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 final location of the WMTs will be determined as part of the final construction design and the details will be reported to Airservices Australia. One WMT is installed within the Project boundary. It is appropriately marked and lit and all reporting action has been undertaken. Aerial application operations are not 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 will 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 • 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 300 m in visual flight during the day when not in the vicinity of built-up areas. • 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.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 - Unacceptable

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

Recommended Treatments

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

- The temporary and permanent WMT locations will be advised to CASA and Airservices Australia prior to construction.
- As 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.
- 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.

- WMTs that are installed prior to WTG installation (Temporary WMTs) and WMTs that are not in close proximity to a WTG, should be fitted with a medium intensity steady red obstacle light at the top of the tower to ensure visibility in low light and deteriorated atmospheric conditions. Characteristics of medium-intensity lights are specified in MOS 139 Section 9.33:

  1) *Medium-intensity obstacle lights must:*
     a) *be visible in all directions in azimuth; and*
     b) *if flashing — have a flash frequency of between 20 and 60 flashes per minute.*
  2) *The peak effective intensity of medium-intensity obstacle lights must be 2 000 ± 25% cd with a vertical distribution as follows:*
     a) *for **vertical beam spread** — a minimum of 3 degrees;*
     b) *at -1 degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*
     c) *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*
  3) *For subsection (2), **vertical beam spread** means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*

4) *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m² or greater.* • Ensure details of any additional WMTs at the Project 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**. Under these circumstances, the level of risk under the proposed treatment plan is considered **ALARP.** **For temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG, there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision provided obstacle lighting is fitted to ensure visibility in low light and deteriorating atmospheric conditions.**	
Residual Risk	7 - Tolerable

Table 15 Harsh manoeuvring leading to controlled flight into terrain

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

Discussion

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

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

The Project is clear of the OLS of all certified aerodromes.

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 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum height of 250.5 m (821.9 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 98.1 m (321.9 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).

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

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

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

Assumed risk treatments

- The WTGs are typically coloured white so they should be visible during the day.
- Installation of obstacle lighting will ensure the WTGs are visible during the night
- The final layout details of the 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 WTG 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 • The Project is clear of the OLS of all certified aerodromes. • 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 300 m in visual flight during the day when not in the vicinity of built-up areas. • The proposed WTGs will be a maximum height of 250.5 m (821.9 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 98.1 m (321.9 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs. • If cloud descends below the WTG hub, obstacle lighting would be obscured and therefore ineffective. • Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 – Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart. • 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 WTGs to CASA. • Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.	

• Although there is no statutory requirement to do so, the Proponent may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the Project site.	
With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is Aviation Project's assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine.**	
Residual Risk	7 – Tolerable

Table 16 Effect of the 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.

Aerial application operations are not conducted at night in the vicinity of the Project 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

- The Project is clear of the OLS of all certified aerodromes.
- 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 300 m in visual flight during the day when not in the vicinity of built-up areas.
- The proposed WTGs will be a maximum height of 250.5 m (821.9 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 98.1 m (321.9 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- The WTGs and masts will be shown on aeronautical charts at the next publication cycle date available and NOTAMS prior to the publication date. This allows pilots to be aware of the existence of the wind farm at the pre-flight planning stage and during flight with reference to the aeronautical chart.
- 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.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.

The WTGs are typically coloured white so they should be visible during the day.

Level of Risk The level of risk associated with a Possible likelihood of a Moderate consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 6 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 Project site, there is likely to be little additional safety benefits to be gained by installing obstacle lighting for WTGs and Permanent WMTs which are in close proximity to WTGs. WMTs installed prior to WTG installation and those that are not in relatively close proximity to a WTG should be lit to ensure they are visible in low light and deteriorating atmospheric conditions. (see Risk ID: 2) The following additional treatments will provide an additional margin of safety: • The final layout 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 WTGs to CASA. • Ensure details of the 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 Project 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 **Tolerable.** **It is Aviation Project's assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew.**	
Residual Risk	5 – Tolerable

Table 17 Effect of obstacle lighting on neighbours

Risk ID:	5. **Effect of obstacle lighting on neighbours**

Discussion

This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm.

Installation and operation of obstacle lighting on WTGs or WMT can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions.

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

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

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

In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Consequence

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

- Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Design and mitigation measures may ameliorate some consequences.

This would be a Moderate consequence.

Consequence	Moderate

Untreated Likelihood

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

Untreated Likelihood	Almost certain

Current Treatments

If the WTGs or WMTs 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 considered by local residents may be a Moderate consequence with a rating of 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 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. For temporary WMTs installed prior to WTG installation and WMTs that are not in close proximity to a WTG, obstacle lighting is recommended to ensure visibility in low light and deteriorating atmospheric conditions. If CASA or a 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 with obstacle lights • Specifying an obstacle light that minimises light intensity at ground level • Specifying an obstacle light that matches light intensity to meteorological visibility • Mitigating light glare from obstacle lighting through measures such as baffling. 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 Project 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 If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is Aviation Project's assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.

Residual Risk	7 - Tolerable

12. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

12.1. Planning considerations

The Project as proposed will not create incompatible intrusions or compromise the safety of existing airports and associated navigation and communication facilities.

12.2. Aviation Impact Statement

Based on the WTG layout and maximum blade tip height of up to 250.5 m AGL, the blade tip elevation of the highest WTG, which is WTG 5, will not exceed 592.8 m AHD (1944.9 ft AMSL);

- There are two certified aerodromes located within 30 nm (56 km) of the Project – Avalon Airport (YMAV) and Ballarat Airport (YBLT).
  - The Project would infringe the 25 nm MSA of Avalon Airport requiring an amendment to accommodate the Project but will not have an adverse impact on flight operations.
  - The Project would not infringe any PANS-OPS surfaces at Ballarat Airport.
- The WTGs would not impact the two relevant Grid LSALTs.
- The WTGs would impact on two Air Route LSALTs:
  - Air route W291 minimum altitude would need to be raised by 100 ft to 3000 ft.
  - Air route W382 minimum altitude would need to be raised by 100 ft to 3000 ft.
- The Project is located within Class G airspace (outside all controlled airspace), and outside Prohibited, Restricted and Danger areas.
- The WTGs would not have an impact on any aviation navigation facilities.
- The WTGs would not have an impact on the Mount Macedon ATC surveillance radar systems.
- The WTGs must be reported to CASA and construction details provided to Airservices
- The lowest altitude that an IFR aircraft can fly when arriving at Lethbridge Airport or when transiting over the wind farm is 4700 ft AMSL, in accordance with the Grid LSALT, unless the aircraft is in visual contact with the ground and obstacles and can remain so, unless using a pilot calculated LSALT, in which case the wind farm would require them to remain 1000 ft within 5 nm of the wind farm unless in visual contact with the wind farm and other terrain. Complying with the Avalon or Ballarat 25 nm MSA may provide descent to a lower altitude than the Grid LSALT.

12.3. Aircraft operator characteristics

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

Aircraft flying at night in visual conditions are permitted to descend or climb to or from an appropriate minimum altitude when within 3 nm of the aerodrome.

WTGs are generally not a safety concern to aerial agricultural operators due to pre-flight planning and risk assessment activities prior to arriving at the location, that would identify the WTG and WMT locations. The conspicuous nature of the off-white colouring of the large WTGs and marking and/or lighting of the WMTs would enable aerial agricultural pilots to identify the wind farm in sufficient time to avoid it by the appropriate margins.

12.4. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139 Division 139.E. - the proposed WTGs must be reported to CASA.
- With respect to the marking of WTGs, a non-reflective off-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.
- It is not mandatory to mark the WMTs, however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    - Obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour
    - Marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and
    - Guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation.

The existing WMT is appropriately marked and lit and has been notified to Airservices Australia. A NOTAM has been issued prior to the next publication of the aeronautical charts.

12.5. Bureau of Meteorology Weather Station

The Project is unlikely to create an adverse impact to the weather station at She Oaks. BoM will be consulted to confirm.

12.6. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented, is provided in Table 18.

Table 18 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 Project WTGs to aviation authorities, 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 aviation authorities, 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 Project WTGs and WMTs to aviation authorities, local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	**Acceptable without obstacle lighting (ALARP)** Communicate details of the Project WTGs and WMTs to aviation authorities, local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	**Acceptable without obstacle lighting** If lights must be installed, design the lighting layout to minimise impact.

13. RECOMMENDATIONS

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

Notification and reporting

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).
2. Final details of WTG coordinates and elevation should be provided to Airservices Australia at least 2 weeks prior to construction commencing, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:
    a. The planned operational timeframe and maximum height of the crane; and
    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.
4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.
5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs 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.

Marking of WTGs and WMTs

6. The rotor blades, nacelle and the supporting mast of the WTGs should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.
7. It is not mandatory to mark the WMTs however the following markings are recommended to be implemented in consideration of potential day VFR aerial work operations in accordance with NASF Guideline D:
    a. Obstacle marking for at least the top 1/3 of the mast and be painted in alternating contrasting bands of colour
    b. Marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires; and
    c. Guy wire ground attachment points in contrasting colours to the surrounding ground/vegetation

Lighting of WTGs and WMTs

8. The existing WMT is marked 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.

The WMT is also equipped with a red obstacle light.

Micrositing

9. Providing the micrositing is within 100 m of the planned WTGs it is not likely to result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Transmission line

10. 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 application operators and marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8).

Aerial firefighting

11. The developer or operator should consider the guidance contained in the National Council for Fire and Emergency Services, Wind Farms and Bushfire Operations to ensure:

    a. Liaison with the relevant fire and land management agencies is ongoing and effective

    b. Access is available to the wind farm site by emergency services for on-ground firefighting operations.

    c. 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.

Aviation Projects considers that it may be impractical and/or unsafe to lock the turbine blades in a Y configuration in the case of a bushfire emergency, if this would require personnel to climb the WTG tower as the fire approaches. WTGs can, however, be paused or shut down remotely, with blades feathered to halt rotation within a matter of seconds.

Triggers for review

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

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

b. Following any significant changes to the context in which the assessment was prepared

a. 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. WTG coordinates and heights
6. WMT coordinates and heights

ANNEXURE 1 – REFERENCES

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

- Airservices Australia, Aeronautical Information Package; dated 12 June 2025
- Civil Aviation Safety Authority
    - Civil Aviation Regulations 1988 (CAR)
    - Civil Aviation Safety Regulations 1998 (CASR)
    - CASR Part 173 Manual of Standards– *Standards Applicable to Instrument Flight Procedure Design*, version 1.8
    - CASR Part 139 (*Aerodromes*) Manual of Standards 2019
    - AC 91-02 v1.2, *Guidelines for aeroplanes with MTOW not exceeding 5700 kg – suitable places to take off and land*
    - AC 91-10 v1.4: *Operations in the vicinity of non-controlled aerodromes*
    - AC 139.E-01 v1.0—*Reporting of Tall Structures*
    - AC 139.E-05 v1.1 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome*
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- ICAO Standards and Recommended Practices, Annex 14 — *Aerodromes*
- International Civil Aviation Organization (ICAO) Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations* (PANS-OPS)
- OzRunways, dated May 2025
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*
- Victorian Department of Transport and Planning, *Planning Guidelines for Development of Wind Energy Facilities.*

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.
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.

Term	Definition
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

CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed timeframe for construction. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether 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.E-01 v1.0—Reporting of Tall Structures

In Advisory Circular (AC) 139.E-01 v1.0—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. RAAF and Airservices Australia require information on structures which are:

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 or more 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 WTGs must be reported to Airservices Australia. This action should occur once the final layout after micrositing is confirmed and prior to construction.

International Civil Aviation Organisation

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

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

6.2.4 Wind turbines

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

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

Note 2. — See 4.3.1 and 4.3.2

Markings

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

Lighting

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

a) to identify the perimeter of the wind farm;

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

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

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and *e) at locations prescribed in a), b) and d), respecting the following criteria:*

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

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

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

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

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

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

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

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

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

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and

a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

The characteristics of the obstacle lights should be in accordance with the applicable standards in Part 139 MOS 2019.

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

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.32 outlines Characteristics of Low Intensity Obstacle Lights.

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

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

2. *To indicate the following:*
   a. *taxiway obstacles;*
   b. *unserviceable areas of the movement area; low-intensity obstacle lights must have a peak intensity of at least 10 cd.*

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

1. *Medium-intensity obstacle lights must:*

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

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

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

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

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

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

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

4. *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m^2 or greater.*

Visual impact of night lighting

Annex 14 Section 6.2.4 and Part 139 MOS 2019 Chapter 9 are specifically intended for WTGs and recommends that medium intensity lighting is installed.

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

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness;
- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
  - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal; and
  - such that no light is emitted at or below 10 degrees below horizontal;
- If a light would be shielded in any direction by an adjacent object or structure, the light so shielded may be omitted, provided that such additional lights are used as are necessary to retain the general definition of the object or structure.
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously; and
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall WTG.

Marking of WTGs

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

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

Wind monitoring towers

Consideration could be given to marking any WMTs according to the requirements set out in Part 139 MOS 2019 Chapter 8 Division 10 Obstacle Markings; specifically:

> *8.110 Marking of Hazardous Obstacles*
>
> *(5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of: 1/7 of the height of the structure; or 30 m.*
>
> *(7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables. Note: Spheres and pyramids are examples of 3-dimensional objects.*
>
> *(8) The objects mentioned in subsection (7) must:*
>
> > *(a) be approximately equivalent in size to a cube with 600 mm sides; and*
> > *(b) be spaced 30 m apart along the length of the wire or cable.*

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

- the top 1/3 of 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 application 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.

Temporary WMTs installed prior to WTG installation and WMTs not in close proximity to a WTG should be lit with medium-intensity steady red obstacle lighting at the top of the WMT mast. Characteristics of medium-intensity obstacle lighting is contained in MOS 139, Section 9.33

Overhead transmission lines

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8):

8.110 Marking of hazardous obstacles

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

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

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

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

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 5
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 the risk 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 – PROJECT TURBINE COORDINATES AND HEIGHTS

Reference file: 20250120_TTWF_WTG_Elevations_Version2.xlsx

WTG ID	*Latitude*	*Longitude*	*Ground Elevation (m AHD)*	*Tip Height (m AGL)*	*Max Height (m AHD)*	*Max Height (ft AMSL)*
1	768863	5804491	321.4	250.5	571.9	1876.3
2	768435	5804210	316.5	250.5	567	1860.4
3	767902	5803979	331.6	250.5	582.1	1909.9
4	767765	5803317	322.3	250.5	572.8	1879.2
5	767288	5803149	342.3	250.5	592.8	1944.9
6	766836	5802942	331.3	250.5	581.8	1908.9
7	767341	5802326	317	250.5	567.5	1862
8	767026	5801927	318.8	250.5	569.3	1868
9	766492	5801812	294.3	250.5	544.8	1787.6
10	766566	5800964	273.7	250.5	524.2	1719.7
11	766196	5800598	275.8	250.5	526.3	1726.7
14	765001	5801737	306.4	250.5	556.9	1827.3
15	764959	5801203	290.3	250.5	540.8	1774.2
16	764644	5800827	276	250.5	526.5	1727.5
17	764617	5800323	256.8	250.5	507.3	1664.5
18	764476	5795226	195.9	250.5	446.4	1464.8
19	763774	5801810	287.5	250.5	538	1765.1
20	763714	5801320	272.6	250.5	523.1	1716.4
22	764215	5797629	222.6	250.5	473.1	1552.2
25	765109	5796798	214	250.5	464.5	1524
26	764785	5796411	208.4	250.5	458.9	1505.5
27	764644	5795950	204.1	250.5	454.6	1491.5
29	766817	5797288	233.8	250.5	484.3	1588.9
30	766829	5796810	226.7	250.5	477.2	1565.6
31	766434	5796391	216	250.5	466.5	1530.5
32	766182	5795942	206.8	250.5	457.3	1500.5

WTG ID	Latitude	Longitude	Ground Elevation (m AHD)	Tip Height (m AGL)	Max Height (m AHD)	Max Height (ft AMSL)
33	765998	5795426	201.1	250.5	451.6	1481.8
34	766010	5794915	196.9	250.5	447.4	1467.8
35	765832	5794436	189.3	250.5	439.8	1443
36	765826	5793765	181	250.5	431.5	1415.8
37	765612	5793304	176.7	250.5	427.2	1401.7
38	765481	5792745	170.4	250.5	420.9	1381
39	765413	5792213	169	250.5	419.5	1376.3
41	768027	5794809	204.4	250.5	454.9	1492.5
42	768067	5794324	197.7	250.5	448.2	1470.7
43	767989	5793760	194.3	250.5	444.8	1459.4
44	762780	5796597	194.7	250.5	445.2	1460.7
45	762372	5796183	193.9	250.5	444.4	1458
46	762019	5795710	189.5	250.5	440	1443.7
47	762256	5795215	188.2	250.5	438.7	1439.2
49	762025	5794523	178.3	250.5	428.8	1407
50	762031	5793984	173.5	250.5	424	1391.1
51	763640	5793747	184.9	250.5	435.4	1428.5
52	763487	5793254	182.1	250.5	432.6	1419.4
53	763532	5792671	169.7	250.5	420.2	1378.6
54	767248	5792753	173.4	250.5	423.9	1390.8
55	767687	5792303	173.3	250.5	423.8	1390.5
56	762175	5792584	171.6	250.5	422.1	1385
61	763781	5791643	163.7	250.5	414.2	1358.9
62	763360	5791346	165.9	250.5	416.4	1366.4
69	766033	5799148	234.8	250.5	485.3	1592.2
70	766092	5798657	240	250.5	490.5	1609.4
71	766762	5797780	235	250.5	485.5	1593

AVIATION PROJECTS

(+61) 7 3371 0788
enquiries@aviationprojects.com.au

www.aviationprojects.com.au