April 2025

AVIATION IMPACT ASSESSMENT

CLEVE WIND FARM

Prepared for AECOM

AVIATION PROJECTS

DOCUMENT CONTROL

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AVIATION PROJECTS

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ACRONYMS

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

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

AECOM has been engaged by Vestas to manage the planning and environmental approvals process for the proposed Cleve Wind Farm (the Project). The Project is located approximately 8 km (4.3 nm) northwest of the town of Cleve to the nearest proposed WTG site, in the Eyre Peninsula region of South Australia.

The Project is proposed to consist of up to 80 wind turbine generators (WTGs) with a maximum tip height of up to 236 m above ground level (AGL).

This Aviation Impact Assessment (AIA) has been prepared to support the planning and approvals processes by AECOM for the Project.

The AIA has been prepared in response to the Civil Aviation Safety Regulations 1998 (CASR), associated Manuals of Standards and other guidance material provided by the Civil Aviation Safety Authority (CASA), the National Airports Safeguarding Framework (NASF) Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers,* and specific requirements as advised by Airservices Australia for an Aviation Impact Statement (AIS).

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

This AIA report includes a qualitative risk assessment to determine the need for obstacle lighting and marking for client review and acceptance before submission to external aviation regulators.

Project description

The Cleve Wind Farm will comprise the following infrastructure relevant to this aviation impact assessment:

- Up to 80 wind turbines with a maximum overall height (tip height) of up to 236 m above ground level (AGL)
- The highest proposed wind turbine is WTG 58 with a ground elevation of 384.85 m Australian Height Datum (AHD) and overall height of 620.85 m AHD (2036.91 ft AMSL).

Conclusions

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

Certified airports

1. The Project is located within 30 nm of two certified aerodromes at Cleve and Kimba.

Uncertified Aerodromes

2. There are no active verified uncertified aerodromes located within 3 nm of the Project.

Air Routes and Lowest Safe Altitude

3. The Project would infringe air route and grid lowest safe altitude but an increase would only create a minor impact to flight operations

Aviation Facilities

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

ATC Surveillance Radar

5. Due to the distance and intervening terrain between the Project and the primary and secondary radar facilities located at Adelaide airport, it is anticipated there will be no impact to radar facilities. Airservices Australia may conduct a simple assessment on the potential impact of the Project on the Adelaide airport primary radar facility.

Aviation Impact Statement (AIS)

6. Based on the Project WTG layout and maximum blade tip height of up to 236 m AGL, the blade tip elevation of the highest WTG will not exceed 620.85 m AHD (2036.91 ft AMSL), and:
    - Would be located within 30 nm of certified aerodromes at Cleve and Kimba
    - Some infringements to the PANS-OPS surfaces have been identified and detailed in Sections 6.4 and 6.5
    - Would not infringe any OLS surfaces
    - Would infringe nearby designated air routes requiring the LSALTs to be raised as identified and detailed in Section 6.6
    - Would infringe the grid LSALT requiring it to be raised as identified and detailed in Section 6.6
    - Would not have an impact on operational airspace
    - Would be located within Class G airspace (uncontrolled)
    - Is outside the clearance zones associated with civil aviation navigation aids, ATC surveillance radar systems and communication facilities.

Obstacle lighting risk assessment

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

Consultation

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

Summary of key recommendations

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

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

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. Details of the Project should be provided to the managers of the identified certified aerodromes.

3. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, 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

4. Any obstacles higher than 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.

5. 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.

6. 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

Lighting of WTGs

7. Aviation Projects has assessed that installing obstacle lights on WTGs is not required to maintain an acceptable level of safety to aircraft.

Micrositing

8. The potential micrositing of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the WTG positions. Providing the micrositing is within 100 m of the WTGs, it is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Triggers for review

9. 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.

1. INTRODUCTION

1.1. Situation

AECOM has been engaged by Vestas to manage the planning and environmental approvals process for the proposed Cleve Wind Farm (the Project). The Project is located approximately 8 km (4.3 nm) northwest of the town of Cleve to the nearest proposed WTG site, in the Eyre Peninsula region of South Australia.

The Project is proposed to consist of up to 80 wind turbine generators (WTGs) with a maximum tip height of up to 236 m above ground level (AGL).

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

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

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

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and support a development application to be submitted to the State Commission Assessment Panel under the Planning, Development and Infrastructure Act 2016.

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

- Government of South Australia, PlanSA, Planning and Design Code, Version 2024.17, 12 September 2024
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR) and associated advisory material
- NASF Guideline D: *Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers*
- Other specific requirements as advised by Airservices Australia to assess wind farm developments in the form of an Aviation Impact Statement (AIS).

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

1.3. Methodology

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

1. Confirm the scope and deliverables with the Proponent (or representative)
2. Review client material
3. Review relevant regulatory requirements and information sources

4. 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
5. Prepare an AIS for Airservices Australia and a qualitative risk assessment to determine need for obstacle lighting and marking
6. 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*
7. Consult with relevant Councils (if required), CASR Part 173 procedure designers (if required) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
8. Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
9. Finalise the AIA report for client acceptance when responses 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 (55.56 km) of the project site
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s)

Air Routes:

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

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

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

- WTG_Elevation.xlxs
- Design Update 20240907.kmz
- Turbine Overview Drawing_0120-2640_R01.pdf.

2. BACKGROUND

2.1. Site overview

The Project is located approximately 8 km (4.3 nm) northwest of the town of Cleve to the nearest proposed WTG site, in the Eyre Peninsula region of South Australia.

An overview of the Project Area is provided in Figure 1 (source: AECOM, Google Earth).

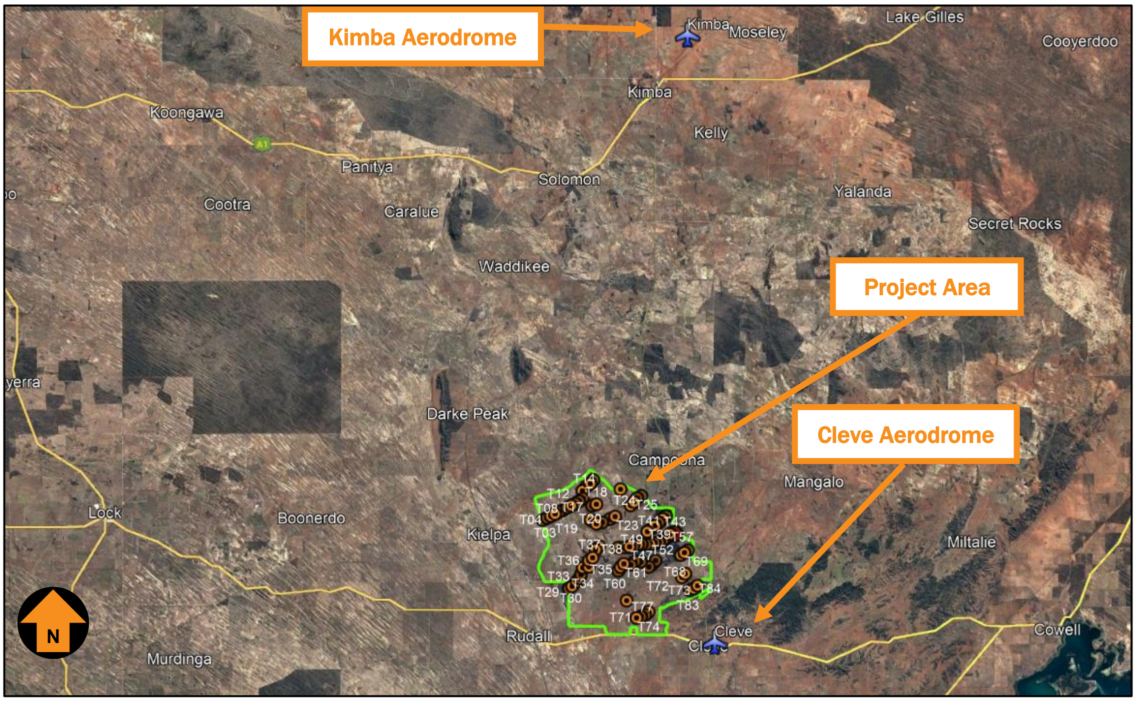

Figure 1 Project Site Overview

2.2. Project description

The Project is proposed to consist of up to 80 wind turbine generators (WTGs) with a maximum tip height up to 236 m above ground level (AGL).

The highest WTG (#58) has a maximum elevation of 620.85 m/2036.91 ft above mean seal level (AMSL).

The Project layout is shown in Figure 2 (Source: AECOM, Google Earth).

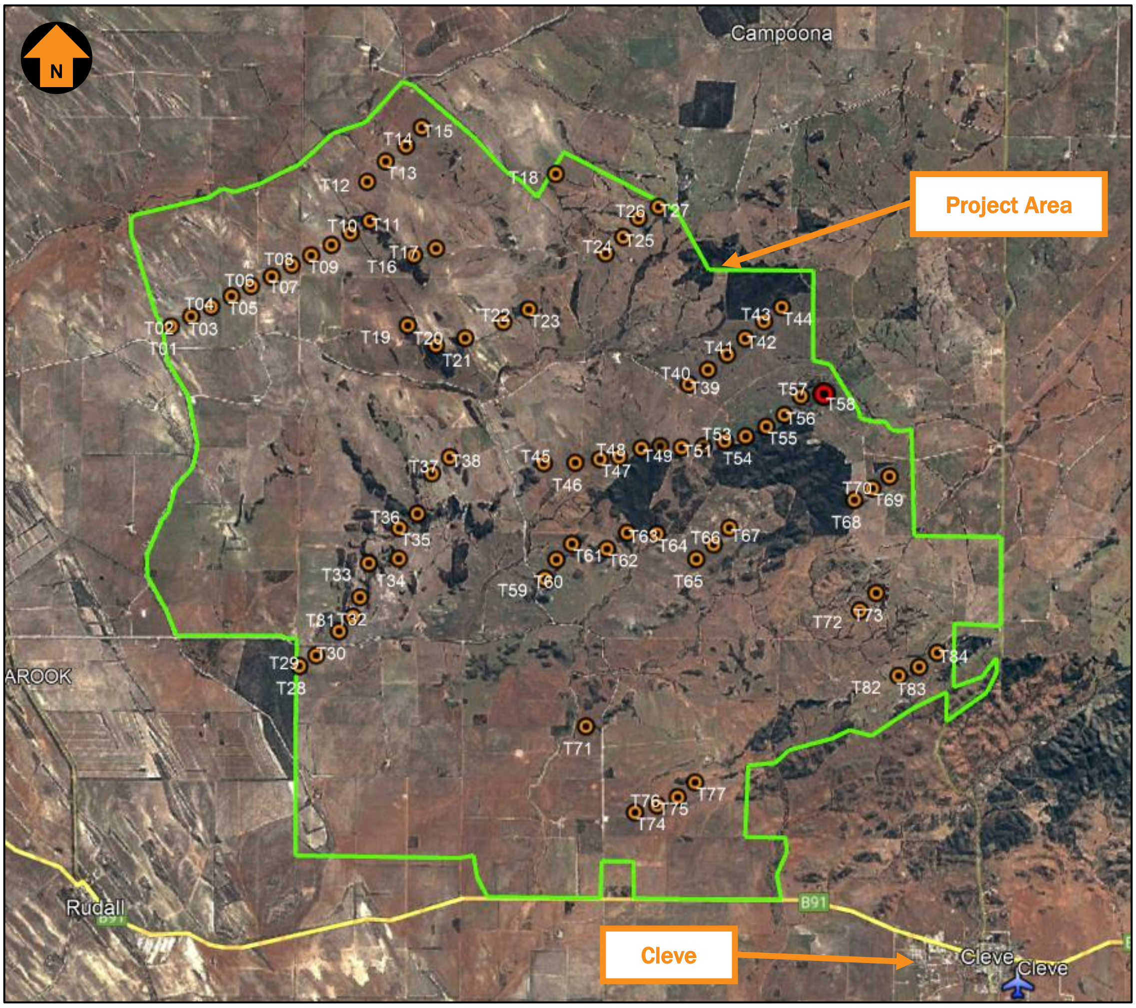

Figure 2 Project Layout

3. EXTERNAL CONTEXT

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

3.1. South Australian Government – planning context

The Project will be subject to the South Australian Planning and Design Code, made under the Planning, Development and Infrastructure Act 2016.

The Code divides development into categories based on its classification under the Code as either:

a) accepted development

b) deemed-to-satisfy development

c) restricted development

d) performance assessed

Relevant to the development of renewable energy facilities is the performance outcome specified in the Infrastructure and Renewable Energy Facilities General Development Policy PO 4.1:

> *Infrastructure and renewable energy facilities and ancillary development located and operated to not adversely impact maritime or air transport safety, including the operation of ports, airfields and landing strips.*

This aviation assessment will examine the impact of the Project on air transport safety. There are no Airport-related overlays applicable to the Project Area.

3.2. National Airports Safeguarding Framework

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

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

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

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

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

NASF 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.

3.3. Aircraft operations at non-controlled aerodromes

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

The aerodromes at Cleve and Kimba are non-controlled aerodromes.

A conventional circuit pattern and heights are provided in AC 91-10 v1.1. The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.1. are shown in Figure 3 and Figure 4.

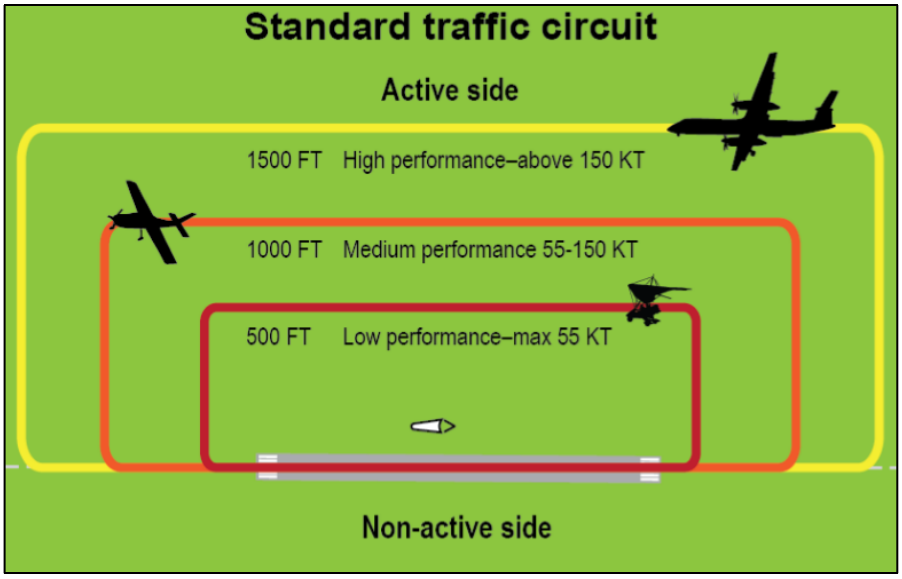

Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

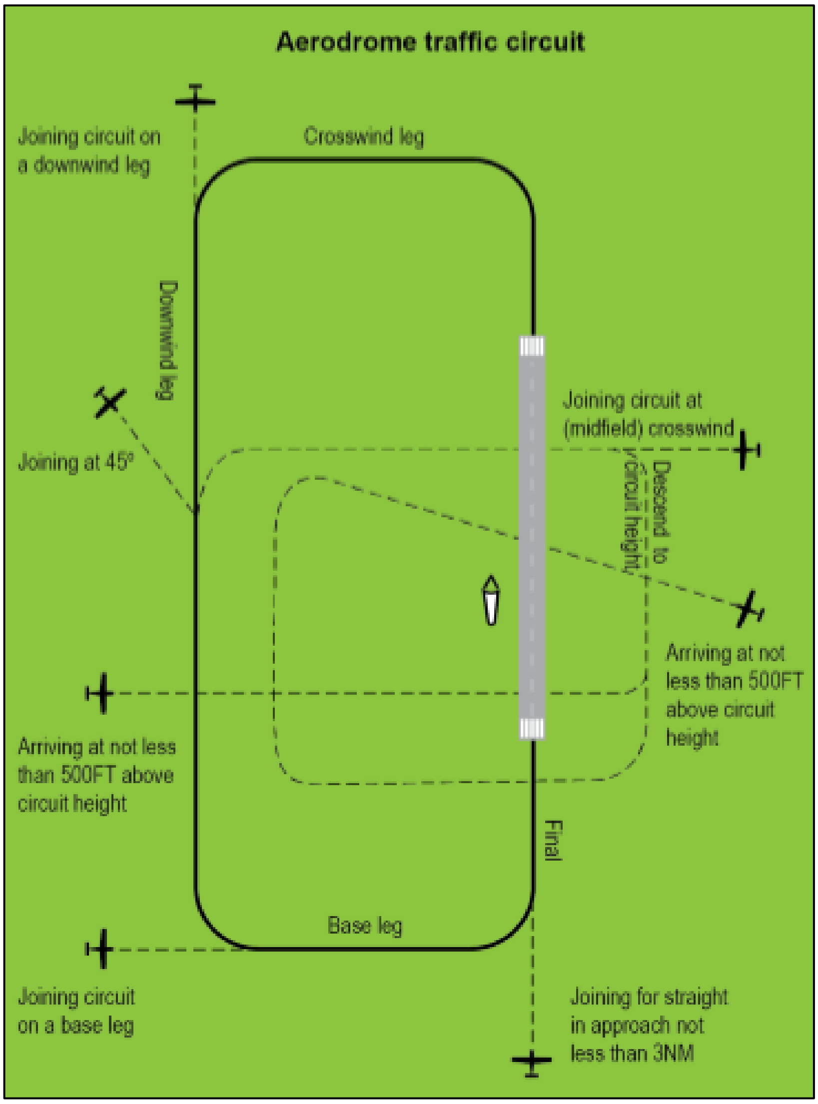

Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures

AC 91-10 v1.1. paragraph 7.10 makes reference to a distance that is “normally” well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *7.10 Departing the circuit area*
>
> *7.10.1 Aircraft should depart the aerodrome circuit area by extending one of the standard circuit legs or climbing to depart overhead. However, the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 NM from the departure end of the runway, but may be less for aircraft with high climb performance. In all cases, the distance should be based on the pilot’s awareness of traffic and the ability of the aircraft to climb above and clear of the circuit area.*

3.4. Rules of flight

3.4.1. Flight under Day Visual Flight Rules (VFR)

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

CASR 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 height be maintained.

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

3.4.2. Night VFR

> *With respect to flight under the VFR at night, Civil Aviation Safety Regulations (1998) 91.277 requires that the pilot in command of an aircraft flying VFR at night must not fly below the following heights (unless during take-off and landing operations, within 3 nm of an aerodrome, or with an air traffic control clearance):*
>
> - *the published lowest safe altitude for the route or route segment (if any);*
> - *the minimum sector altitude published in the authorised aeronautical information for the flight (if any);*
> - *the lowest safe altitude for the route or route segment;*
> - *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;*
> - *the lowest altitude for the route or route segment calculated in accordance with a method prescribed by the Part 91 Manual of Standards for the purposes of this paragraph.*

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

According to CASR Part 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method.

Generally, a minimum height of 1000 ft above terrain and objects is maintained by IFR aircraft, except during take-off and climb to cruising altitude, or during the conduct of an instrument approach procedure prior to landing.

3.5. Aircraft operator characteristics

Aircraft operations in the vicinity of the Project area are likely to be mostly private and recreational aircraft, aerial application aircraft and military aircraft.

Air transport operations are generally conducted under the instrument flying rules (IFR), while aerial work and private and recreational activities are likely to be conducted under visual flying rules (VFR).

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance.

In visual meteorological conditions (VMC), the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project Area once wind turbines are erected.

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

3.6. Military operations

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

3.7. 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 (2 m) and 100 ft (30.5 m) AGL.

The standard response from the Aerial Application Association of Australia in relation to wind farms has been included in Section 3.8 (below) for reference. Objections to windfarms are generally related to large scale wind farm projects in active areas of agriculture located in the vicinity of aerial agriculture operations.

There may be aerial application operations associated with fertiliser, pest and crop spraying in the area.

3.8. Aerial Application Association of Australia (AAAA)

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

> *As a result of the overwhelming safety and economic impact of wind farms and supporting infrastructure on the sector, AAAA opposes all wind farm developments in areas of agricultural production or elevated bushfire risk.*
>
> *In other areas, AAAA is also opposed to wind farm developments unless the developer is able to clearly demonstrate they have:*
>
> > *1. consulted honestly and in detail with local aerial application operators;*
> >
> > *2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development;*
> >
> > *3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;*
> >
> > *4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and*
> >
> > *5. adequately marked any wind farm infrastructure and advised pilots of its presence.*

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

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

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

This AIA has been prepared in consideration of the National Windfarm Operating Protocols, noting there are likely to be aerial application operations associated with fertiliser, pest and crop spraying in the area.

3.9. Local aerial application operators

Aerial application operators consulted in previous studies undertaken by Aviation Projects have stated that a wind farm would not, in all likelihood, prevent aerial agricultural operations in that particular area. The landholder would need to consider this when agreeing to have WTGs located on their property.

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

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

The use of helicopters and drones 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.

It is possible that fixed wing aerial agriculture operations will be conducted in the vicinity of the Project.

3.10. Aeromedical services – Royal Flying Doctor Service

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

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

RFDS have previously indicated to Aviation Projects that wind farm development more than 3 nm from an aerodrome to be used for RFDS operations is not a concern.

3.11. Aerial firefighting

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

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

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

Of specific interest in this document is the section extracted verbatim 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.*

Fixed wing aerial firefighting operations may be conducted in the vicinity of the Project.

4. INTERNAL CONTEXT

4.1. Wind farm description

The Project will be located on rural cropping and pastoral land.

The main permanent wind farm components of the proposed Project will include the following:

- A maximum of 80 WTGs with a maximum tip height of up to 2236 m AGL
- Hard standing areas for WTG construction
- Access tracks
- On-site substation and terminal substation
- Overhead cabling and unground cabling as required (linking WTGs to site sub-station)

Design elements are subject to detailed design over the course of development.

4.2. Wind turbine generator (WTG) description

The maximum blade tip height of the proposed wind turbines will be up to 220 m AGL.

Figure 5 shows the configuration of the proposed WTGs.

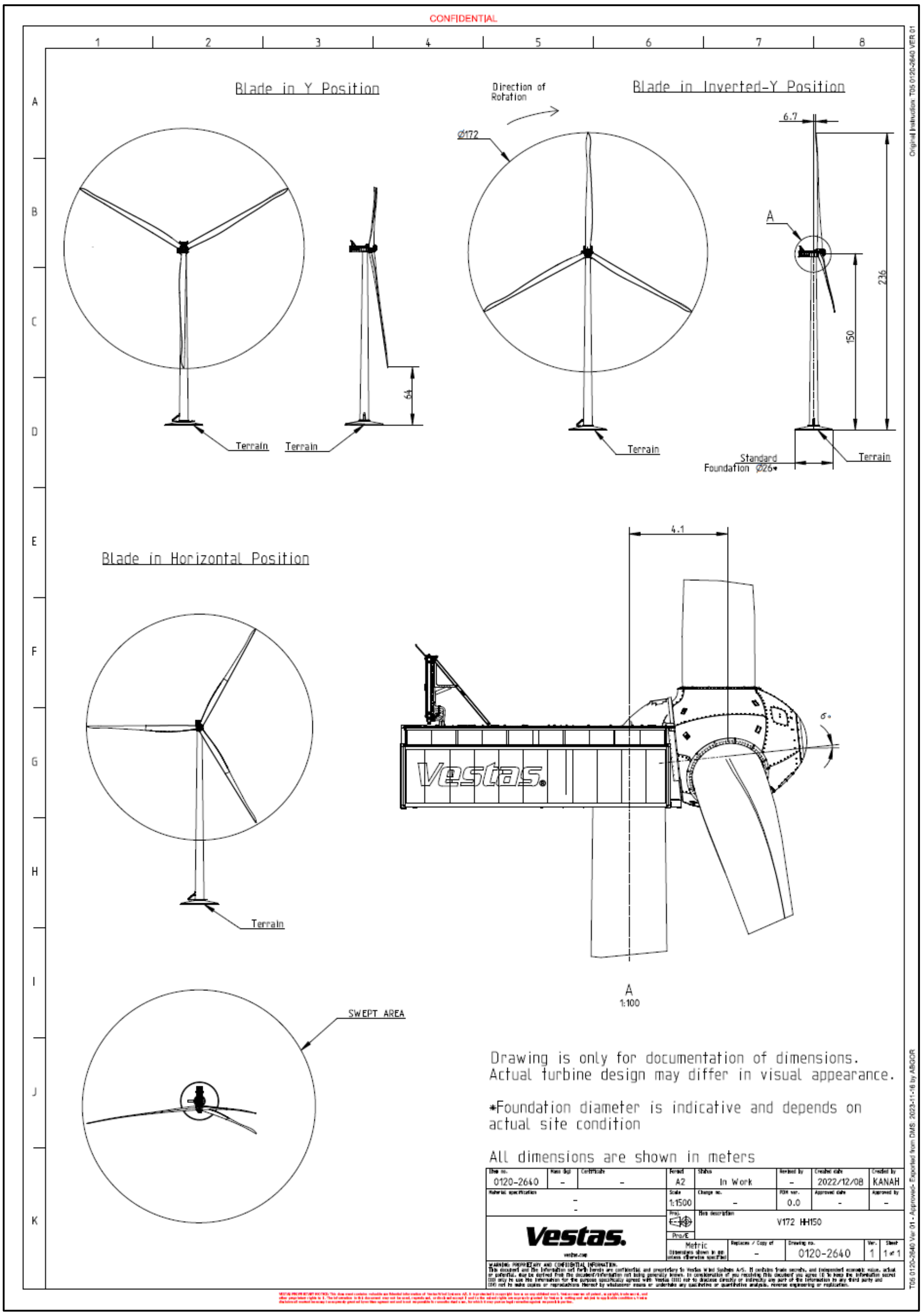

Figure 5 Vestas WTG configuration

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

- Airservices Australia
- Royal Flying Doctor Service
- Department of Defence
- Cleve Aerodrome operator – District Council of Cleve
- Kimba Aerodrome operator – Kimba District Council

Details and results of the consultation activities will be provided in Table 1 upon receipt of feedback from the stakeholders.

Table 1 Stakeholder consultation details

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
Airservices Australia	Email sent on 22 January 2025 to Airservices Australia	Email received on 17 March 2025 from Kwanele Diallo (Airport Development)	**Airspace Procedures** With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a height of 620.85m (2037ft) AHD the Wind Farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Cleve aerodrome. Note: procedures not designed by Airservices at Cleve aerodrome were not considered in this assessment. **Grid lowest safe altitude (LSALT)** The proposed activity will penetrate the current Airservices-designed Grid LSALT, which will need to increase by 100ft. Please refer to attached Grid LSALT Assessment. Please advise the Vertical Obstacle Data (VOD) team at VOD@airservicesaustralia.com of any need to increase Grid LSALT heights at least two (2) weeks before construction commencing by supplying the below information: • Approved wind turbine locations • Elevations at the top of the highest point of the turbine in metres AHD • A copy of this email	**Vertical Obstacle Notification** As this proposed activity is more than 30m (99ft) AGL, please follow the below notification process: 1. Complete the Vertical Obstacle Notification Form: ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf (airservicesaustralia.com) 2. Submit completed form to: VOD@airservicesaustralia.com as soon as the development reaches the maximum height. For further information regarding the reporting of tall structures, please contact the VOD team: • Phone - (02) 6268 5622 • Email - VOD@airservicesaustralia.com • Or refer to: Civil Aviation Safety Regulation Part 175 — Airservices and You - Airservices (airservicesaustralia.com)

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			Communications/Navigation/Surveillance (CNS) Facilities We have assessed the proposed activity to the above specified height for any impacts to Airservices Precision/Non-Precision Navigation Aids, Anemometers, HF/VHF/UHF Communications, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links and have no objections to it proceeding. Note: Meteorological instruments not owned by Airservices were not considered in this assessment. Please consult with the Bureau of Meteorology to ensure that the proposed activity does not adversely impact their equipment. **Air Traffic Control (ATC) Operations** There are no additional instructions or concerns from ATC. **Summary** It is our view that the proposed Wind Farm impacts Airservices designed airspace procedures, CNS facilities or ATC operations at Cleve aerodrome.	
Department of Defence	Email sent on 22 January 2025 to Department of Defence	Awaiting response		
Royal Flying Doctor Service	Email sent on 22 January 2025 to	Awaiting response		

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
	Royal Flying Doctor Service			
Cleve Aerodrome Operator	Email sent on 22 January 2025 to Cleve Aerodrome Operator	Awaiting response		
Kimba Aerodrome Operator	Email sent on 22 January 2025 to Kimba Aerodrome Operator	Awaiting response		

6. AVIATION IMPACT STATEMENT

6.1. Overview

The NASF Guideline D: *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation* provides information to proponents and planning authorities to help identify any potential safety risks posed by WTG and wind monitoring installations from an aviation perspective.

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

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

This analysis considers the aeronautical impact of the WTGs on the following:

- The operation of nearby certified aerodromes
- The operation of nearby aircraft landing areas (uncertified aerodromes)
- Grid and air route Lowest Safe Altitudes (LSALTS)
- Airspace protection
- Aviation facilities
- ATC surveillance radar installations
- Local aircraft operations.

6.2. Nearby certified aerodromes

The area of 30 nm (55.6 km) from a certified airport's aerodrome reference point (ARP) is used to identify possible constraints from the Project.

The 30 nm radius represents the 25 nm minimum sector altitude (MSA) for aerodromes with terminal instrument flight procedures. The 25 nm MSA minimum altitude is determined by assessing obstacles within 30 nm of the reference point.

There are two certified aerodromes located within 30 nm (55.6 km) of the Project area. They are:

- Cleve (YCEE) – 4.3 nm (7.9 km) to the southeast
- Kimba (YIMB) – 50 km (27 nm) to the north.

The location of the Project Area relative to the nearest certified aerodromes shown in Figure 6 (Source: AECOM, Google Earth).

Figure 6 Project location in relation to certified aerodromes

6.3. Cleve Aerodrome

Cleve Aerodrome is provided with one instrument approach procedure which is aligned with runway 26.

An analysis is presented in Table 2.

Table 2 Cleve PANS-OPS Analysis

RNP RWY 26 Procedure Segments	Minimum Altitude (ft AMSL)	PANS-OPS Surface (ft AMSL)	Max height of WTGs (ft AMSL)	Result	Impact
25 nm MSA	2800	1816	2036.91	Infringement. Increase minimum altitude to 3100 ft or sectorise to eliminate the Project from one sector.	Minor. Flight paths not impacted.
10 nm MSA	2800	1816	2036.91	Infringement. Increase minimum altitude to 3100 ft.	Minor.
Holding @ CE2EB	2800	1816	2036.91	Infringement. Increase minimum holding altitude to 3100 ft.	Minor.
Final and Missed Approach	N/A	N/A	N/A	Project is outside PANS-OPS surfaces	Nil
All other Segments	N/A	N/A	N/A	Project is outside PANS-OPS surfaces	Nil
IFR Circling	N/A	N/A	N/A	Project is outside PANS-OPS surfaces (No Circling north of RWY 08/26.)	Nil

The Project infringes the 25 nm MSA and 10 nm MSA PANS-OPS surfaces which requires the minimum altitude to be increased to 3100 ft to accommodate the Project.

This will require commensurate increases to the commencement altitude of the approach procedure and the minimum holding altitude.

The increase will only cause a minor impact to IFR flight operations but will not change the 3° approach path as there is sufficient distance within the procedure to allow aircraft to intercept the final approach path appropriately.

Approval from the Cleve Airport Manager to amend the instrument approach procedures will be required by Airservices Australia prior to committing to make the recommended changes.

6.3.1. Obstacle Limitation Surfaces

The OLS at Cleve Aerodrome extend to approximately 5.5 km from runway ends.

The Project is located at least 7.9 km from the runway ends and therefore does not impact the Cleve Aerodrome OLS.

Approval from the Cleve Airport Manager to amend the instrument approach procedures will be required by Airservices Australia prior to committing to make the recommended changes.

6.4. Kimba Aerodrome

Kimba Aerodrome is provided with two instrument approach procedure which is aligned with runway 03 and runway 21.

An analysis is presented in Table 3.

Table 3 Kimba PANS-OPS Analysis

RNP RWY 03 and RWY 21 Procedure Segments	Minimum Altitude (ft AMSL)	PANS-OPS Surface (ft AMSL)	Max height of WTGs (ft AMSL)	Result	Impact
25 nm MSA	2800	1816	2036.91	Infringement. Increase minimum altitude to 3100 ft or sectorise to eliminate the Project from one sector.	Minor. Flight paths not impacted.
10 nm MSA	N/A	N/A	N/A	Project is outside PANS-OPS surfaces	Nil
Holding @ IMBSB and IMBSNE	N/A	N/A	N/A	No Infringement. Increase minimum holding altitude to 3100 ft commensurate with 25 nm MSA.	Minor.
Final and Missed Approach	N/A	N/A	N/A	Project is outside PANS-OPS surfaces	Nil
All other Segments	N/A	N/A	N/A	Project is outside PANS-OPS surfaces	Nil
IFR Circling	N/A	N/A	N/A	Project is outside PANS-OPS surfaces.	Nil

The Project infringes the 25 nm MSA surface which requires the minimum altitude to be increased to 3100 ft to accommodate the Project.

This will require commensurate increases to the commencement altitude of the approach procedure and the minimum holding altitude.

The increase will only cause a minor impact to IFR flight operations but will not change the 3° approach path as there is sufficient distance within the procedure to allow aircraft to intercept the final approach path appropriately.

Approval from the Kimba Airport Manager to amend the instrument approach procedures will be required by Airservices Australia prior to committing to make the recommended changes.

6.4.1. OLS

The OLS at Kimba Aerodrome extend to approximately 5.5 km from runway ends.

The Project is located at least 7.9 km from the runway ends and therefore does not impact the Kimba Aerodrome OLS.

6.5. Nearby uncertified aerodromes

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

A search of various aviation datasets was undertaken to identify ALAs in the vicinity of the Project. The aviation datasets used are:

- Aeronautical Information Publication (AIP)
- Google Earth
- 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.

As a guide, an area of interest within a 3 nm radius of an ALA is used to assess the potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA. There are no specified obstacle protection surfaces established for ALAs, and a 3 nm radius from an ALA generally represents the distance beyond which normal aircraft operations that are anticipated to occur at ALAs would not be adversely affected.

No ALA's have been identified within the Project area or within 3 nm of the Project boundary.

6.6. Air routes and LSALT

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

Grid LSALTs are specified for grid squares formed by the parallels and meridians at 1° intervals for low-level charts and 2° intervals for the high-level chart applicable to the Project Area.

The proposed WTGs are located in a grid identified in the EnRoute Chart – Low. (ERCL 7) The grid LSALT applicable to the proposed WTG locations is 3000 ft AMSL. The Project is located in the vicinity of two low-level air routes, A585 and V621 As shown in Figure 7 (source: ERC Low National, AECOM).

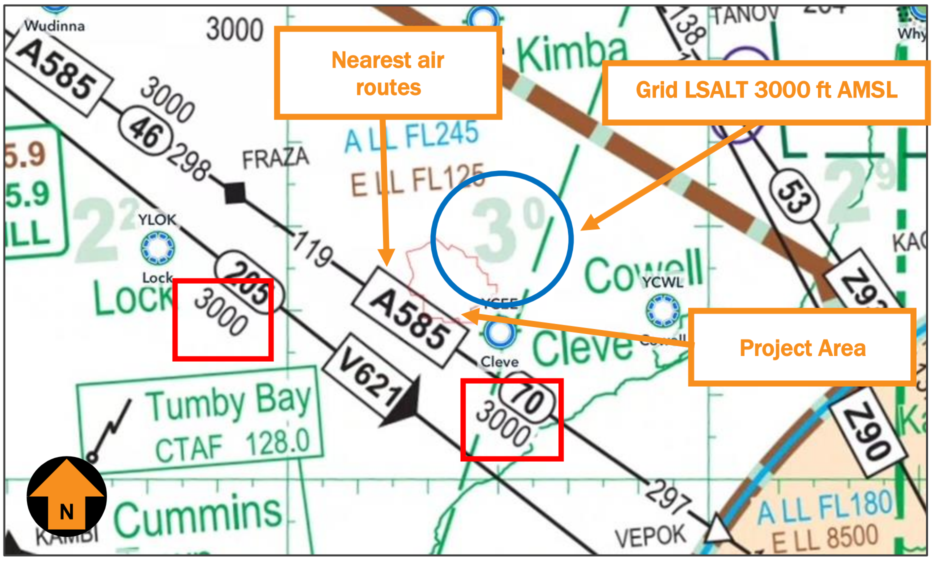

Figure 7 Low-level air routes and Grid LSALT in relation to the Project site

The Project is identified in a grid in the EnRoute Chart – High (ERC H3 South). The applicable grid and route LSALTs are identical to those shown in Figure 7

An impact analysis of the LSALTs applicable to the Project Area is provided in Table 4, based on the maximum Project height of 620.85 m AHD (2036.91 ft AMSL).

Table 4 LSALT analysis

Air route	*Waypoint Pair*	*LSALT (ft AMSL)*	*Protection surface (ft AMSL)*	*Impact on LSALT of maximum project elevation (2036.91 ft AMSL)*	*Impact on aircraft ops*
A585	FRAZA - VEPOK	3000	2000	Infringement – Increase LSALT to 3100 ft AMSL	Minor
V621	CDU - SPENA	3000	2000	Infringement – Increase LSALT to 3100 ft AMSL	Minor
Grid	N/A	3000	2000	Infringement – Increase LSALT to 3100 ft AMSL	Minor

The Project would infringe the LSALT protection surfaces by 38.91 ft, therefore requiring the LSALTs to be raised by 100 ft to 3100 ft AMSL.

There will be a minor to any grid or route LSALT caused by the Project, based on the proposed WTG configuration.

6.7. Airspace Protection

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

The Project is not located within the lateral limits of any Special Use Airspace.

6.8. Aviation facilities – Communication, Navigation and Surveillance Systems (CNS)

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

There are no aviation CNS located in the vicinity of the Project and will not infringe any protection areas associated with CNS facilities as specified in CASR Part 139 MOS and the NASF guidelines.

6.9. ATC Surveillance Radar

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

With respect to aviation radar facilities, the closest radar to the Project Area is the Adelaide Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR) which are located at Adelaide Airport approximately 237 km (128 nm) southeast of the nearest proposed WTG.

EUROCONTROL guidelines for assessing the potential impact on WTGs 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)

Due to the distance and terrain profile of the Project Area from the facilities, it is anticipated that the Project will not impact the Adelaide Primary and Secondary Surveillance Radar facilities.

Airservices Australia will review the potential impact of the Project on these radar facilities once notified of the Project.

6.10. AIS Summary

Based on the Project WTG layout and maximum blade tip height of up to 236 m AGL, the blade tip elevation of the highest WTG will not exceed 620.85 m AHD (2036.91 ft AMSL), and:

- Would be located within 30 nm of certified aerodromes at Cleve and Kimba
- Some infringements to the PANS-OPS surfaces have been identified and detailed in Sections 6.4 and 6.5
- Would not infringe any OLS surfaces
- Would infringe nearby designated air routes requiring the LSALTs to be raised as identified and detailed in Section 6.6
- Would infringe the grid LSALT requiring it to be raised as identified and detailed in Section 6.6
- Would not have an impact on operational airspace
- Would be located within Class G airspace (uncontrolled)
- Is outside the clearance zones associated with civil aviation navigation aids, ATC surveillance radar systems and communication facilities.

6.11. Uncertified aerodrome analysis summary

There are no verified active uncertified aerodromes located within 3 nm of the Project.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it is concluded that aviation lighting is not required for WTGs.

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

8. ACCIDENT STATISTICS

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

8.1. General aviation operations

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

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

8.2. ATSB occurrence taxonomy

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

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

8.3. National aviation occurrence statistics 2010-2019

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

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

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

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

Table 5 Number of fatalities by General Aviation sub-category – 2010 to 2019

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

Figure 8 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.

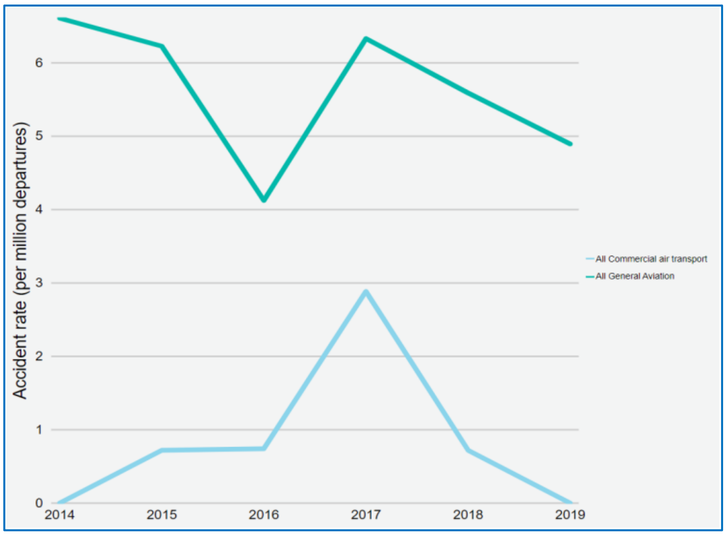

Figure 8 Fatal Accident Rate (per million departures) by Operation Type

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

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 6 (source: ATSB).

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

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

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

8.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of five 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 five accidents and the relevant factors applicable to this assessment is incorporated in this section.

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

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

The five 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.

9. RISK ASSESSMENT

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

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

9.1. Risk Identification

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

Based on an extensive review of accident statistics data (see summary in Section 8 above) and stakeholders who were consulted during the preparation of this AIA (see Section 5), 5 identified risk events associated with WTGs 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 a pilot to initiate manoeuvring in order to avoid colliding with a WTG resulting in collision with terrain (related to aviation safety).
3. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew (related to aviation safety).
4. 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. 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 four risk events identified here are assessed in detail in the following section.

9.2. Risk Analysis, Evaluation and Treatment

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

A summary of the level of risk associated with the Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 7 through to Table 10.

Table 7 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 five reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 8. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

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

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

Refer to the discussion of worldwide accidents in Section 8.

There may be aerial application operations during the day in the vicinity of the Project site.

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

If a proposed object or structure will be 100 m or more AGL, 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.

CASA don't have the regulatory authority to mandate obstacle lighting as the Project is clear of the obstacle limitation surfaces (OLS) of any aerodrome.

CASA generally may recommend obstacle lighting for objects over 200 m AGL.

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 five reports of aircraft collisions with WTGs worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others (see Section 8). Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project does not infringe any PANS-OPS surfaces.
- The Project site is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome.
- There are no WTGs proposed to be located within 3 nm of any active uncertified aerodrome.
- Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations.
- 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 of 236 m (774.3 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 83.6m (274.3 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- The WTGs will be coloured light grey which should be visible to pilots during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts.
- Because the 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. CASA will review the Project for potential hazards to aircraft operations.

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 which will provide an acceptable level of safety:

- Details of the Project should be communicated to local and regional aircraft operators (refer to Section 5) prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly (regional aircraft operators will be consulted with during this aviation impact assessment).

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**. The level of risk with the implementation of the Recommended Treatments is considered **As Low As Reasonably Practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a Project WTG without obstacle lighting on the WTGs.**	
Residual Risk	7 - Tolerable

Table 8 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	2. Harsh manoeuvring leads to controlled flight into terrain (CFIT)

Discussion

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

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

The Project is clear of the OLS of any aerodrome.

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

The proposed WTGs will be a maximum of 236 m (774.3 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 83.6m (274.3 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.

At night aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight 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 will be coloured light grey and should be visible during the day.
- The ‘as constructed’ details of WTGs are required to be notified to Airservices Australia so that the location and height of WTGs can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the 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 (without lighting)

- The Project site is clear of the obstacle limitation surfaces (OLS) of any aerodrome.

• Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. • Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations • . The proposed WTGs will be a maximum of 236 m (774.3 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 83.6m (274.3 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 authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.

Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 – Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments The following treatments which can be implemented which will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators (refer to Section 5) prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly (regional aircraft operators will be consulted with during this aviation impact assessment). • Ensure details of the Project WTGs have been communicated to Airservices Australia prior to construction, for publication in relevant aeronautical publications.	
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**. The level of risk with the implementation of the Recommended Treatments is considered **As Low As Reasonably Practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a Project WTG without obstacle lighting on the WTGs.**	
Residual Risk	7 - Tolerable

Table 9 Effect of the Project on operating crew

Risk ID:	3. Effect of the Project on operating crew	
Discussion Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew. There are no known aerial application operations 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 (without lighting) • The Project site is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome. • Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations • 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 of 236 m (774.3 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 83.6m (274.3 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs. • The WTGs will be coloured light grey and should be visible to pilots during the day. • The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts. • Because the 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. CASA will review the Project for potential hazards to aircraft operations and may recommend the use of obstacle lighting, however this will not be mandatory.		

Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct cost benefit analysis
Recommended Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the immediate vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting. The following treatment, which can be implemented at little cost, will provide an additional margin of safety: • Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs.**	
Residual Risk	5 – Tolerable

Table 10 Effect of obstacle lighting on neighbours

Risk ID:	4. 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 can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions. Details of the relevant proposal (for objects 100 m AGL or above) 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 should be lit with obstacle light(s) that is essential for the safety of aircraft operations. In general, objects outside an OLS and above 200 m would be recommended by CASA to have obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Consequence The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be: • Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences. This would be a Moderate consequence.	
Consequence	Moderate
Untreated Likelihood The likelihood of moderate site impact, minimal local impact is Almost certain - the event is likely to occur many times (has occurred frequently).	
Untreated Likelihood	Almost certain
Current Treatments If the WTGs 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 200 m may be recommended by CASA to have obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.	
Level of Risk The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.	
Current Level of Risk	8 - Unacceptable

Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments Not installing obstacle lighting would completely remove the source of the impact. As per the above safety risk assessment, the provision of lighting for the WTGs and WMTs is not considered necessary to provide an acceptable level of safety. 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 Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact. If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is our assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.	
Residual Risk	7 - Tolerable

10. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

10.1. Project description

The Cleve Wind Farm will comprise the following infrastructure relevant to this aviation impact assessment:

- Up to 80 wind turbines with a maximum overall height (tip height) of up to 236 m above ground level (AGL)
- The highest proposed wind turbine is WTG 58 with a ground elevation of 384.85 m Australian Height Datum (AHD) and overall height of 620.85 m AHD (2036.91 ft AMSL).

10.2. Aviation Impact Statement

Based on the Project WTG layout and maximum blade tip height of up to 236 m AGL, the blade tip elevation of the highest WTG will not exceed 620.85 m AHD (2036.91 ft AMSL), and:

- Would be located within 30 nm of certified aerodromes at Cleve and Kimba
- Some infringements to the PANS-OPS surfaces have been identified and detailed in Sections 6.4 and 6.5
- Would not infringe any OLS surfaces
- Would infringe nearby designated air routes requiring the LSALTs to be raised as identified and detailed in Section 6.6
- Would infringe the grid LSALT requiring it to be raised as identified and detailed in Section 6.6
- Would not have an impact on operational airspace
- Would be located within Class G airspace (uncontrolled)
- Is outside the clearance zones associated with civil aviation navigation aids, ATC surveillance radar systems and communication facilities.

10.3. Uncertified aerodrome analysis summary

There are no active verified uncertified aerodromes located within 3 nm of the Project.

10.4. Aircraft operator characteristics

Aircraft operators flying in vicinity of the Project may include private and recreational (including gliding) activities.

Aerial firefighting and aerial application operations may be possible in the vicinity of the Project Area.

There are no regular high-capacity air transport operations that would be conducted in the immediate vicinity of the Project Area.

10.5. Potential Wake Turbulence impacts

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

> *Wind farm operators should be aware that wind turbines may create turbulence which noticeable up to 16 rotor diameters from the turbine. In the case of one of the larger wind turbines with a diameter of 125 metres, turbulence may be present two kilometres downstream. At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty. However, wind farm operators should be conscious of their duty of care to communicate this risk to aviation operators in the vicinity of the wind farm…*

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, across a significant range of atmospheric conditions that 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.

Downwind turbulence created by 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 approximately 7 rotor diameters (RD) downwind of the wind turbine. There are no assessments that consider 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.

Impacts by higher levels of turbulence created by any source can create a significant hazard to aircraft operation during take-off, landing and the preparation for take-off and landing within the circuit area of an aerodrome. Pilots are trained and qualified to recognise the potential factors and impacts to aircraft caused by terrain, trees and atmospheric conditions in accordance with Bureau of Meteorology (BoM) publications.

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

Assessment

A 172 m rotor diameter has been used for the wake turbulence analysis. Based on this scenario, NASF Guideline D suggests the effects of wake turbulence could be noticeable from the WTGs within 2752 m of the runway and the nominal circuit area, depending on wind direction.

Based on the results of published scientific studies which indicate that any medium level of turbulence would in most circumstances be confined to within 7 rotor diameters of a WTG, Aviation Projects considers that a conservative area of 10 rotor diameters 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. The minimum distance between turbines typical wind farms is approximately 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 constant rotor speed. 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 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 11 Wake Turbulence Distances

1 RD (m)	*16 RD (m)*	*10 RD (m)*	*7 RD (m)*
172	2752	1720	1204

In conditions of high wind speed the WTGs are "parked" with the blades in a "feathered" condition to reduce the wind impact 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 recent circumstances with an airliner experiencing severe turbulence which injured passengers, the aircraft was controllable (except for the first part of the event where it descended rapidly) and has not suffered any significant damage (although it will undergo a major inspection). It was an encounter with severe turbulence far greater than normally experienced and is avoided wherever areas of severe turbulence is forecast or known to exist.

The downwind turbulence from WTGs beyond 7RD 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 (BoM) shown in Figure 9.

Within the 7 RD boundary the turbulence is considered to only create a medium hazard which is likely to equate to pilots experiencing "Moderate" turbulence in which the *"Pilot remains in control at all times."*

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 9 BoM Turbulence Intensities

Light and moderate turbulence is also by generated by lines of trees, gullies and sloping terrain 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.* [1]

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.

No uncertified aerodromes were identified in this assessment.

10.6. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139 Division 139.E.1 Notifying potential hazards 139.165, the proposed WTGs must be reported to CASA. WTGs should be marked in accordance with CASR Part 139 MOS Chapter 8 Division 10 section 8.110.
- CASA will review the proposed WTG development and may make a recommendation for obstacle lighting; however, this would not be mandatory.

10.6.1. Summary of risks

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

Table 12 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 local and regional operators.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project WTGs to local and regional operators.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP) Communicate details of the Project WTGs to local and regional operators.
Effect of obstacle lighting on neighbours	Moderate	Likely	7	Acceptable without obstacle lighting (ALARP)

[1] Bureau of Meteorology – Hazardous Weather Phenomena – Turbulence

11. 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. Details of the Project should be provided to the managers of the identified certified aerodromes.
3. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, 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
4. Any obstacles higher than 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.
5. 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.
6. 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

Lighting of WTGs

7. Aviation Projects has assessed that installing obstacle lights on WTGs is not required to maintain an acceptable level of safety to aircraft.

Micrositing

8. The potential micrositing of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the WTG positions. Providing the micrositing is within 100 m of the WTGs, it is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Triggers for review

9. Triggers for review of this risk assessment are provided for consideration:
    a. Prior to construction to ensure the regulatory framework has not changed
    b. Following any significant changes to the context in which the assessment was prepared, including the regulatory framework
    c. Following any near miss, incident or accident associated with operations considered in this risk assessment.

ANNEXURES

1. References
2. Definitions
3. CASA regulatory requirements – Lighting and Marking
4. Risk Framework
5. Project turbine coordinates and heights

ANNEXURE 1 – REFERENCES

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

- Airservices Australia:
  - Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 20 March 2025
  - Designated Airspace Handbook, effective 28 November 2024
- Civil Aviation Safety Authority:
  - Civil Aviation Safety Regulations 1998 (CASR)
  - Advisory Circular (AC) 91-10: *Operations in the vicinity of non-controlled aerodromes*,
  - Advisory Circular 139.E-01: *Reporting of Tall Structures*
  - Advisory Circular (AC) 139.E-05:*Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome*
  - CASR Part 139 *(Aerodromes) Manual of Standards*
  - Manual of Standards Part 173 – *Standards Applicable to Instrument Flight Procedure Design*
- 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*
- Government of South Australia, PlanSA, Planning and Design Code, Version 2024.17, 12 September 2024
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, aeronautical navigation charts extracts, dated March 2025
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*

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.

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 CASR Part 139 MOS.

CASR Part 139 MOS 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.*

CASR Part 139 MOS 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

ICAO Annex 14 Section 6.2.4 and CASR Part 139 MOS Chapter 9.31 (8)(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.

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 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

WTG ID	*Latitude*	*Longitude*	*Terrain Elevation (m AHD)*	*WTG height (m AGL)*	*WTG Elevation (m AMSL)*	*WTG Elevation (ft AMSL)*
1	33°34'23.29"S	136°17'32.80"E	209.018	236	445.02	1460.03
2	33°34'15.80"S	136°17'50.80"E	219.531	236	455.53	1494.52
3	33°34'8.66"S	136°18'8.41"E	237.605	236	473.61	1553.82
4	33°34'0.81"S	136°18'26.41"E	251.874	236	487.87	1600.64
5	33°33'53.29"S	136°18'43.67"E	226.321	236	462.32	1516.80
6	33°33'46.18"S	136°19'2.02"E	218.268	236	454.27	1490.38
7	33°33'37.55"S	136°19'19.65"E	220.591	236	456.59	1498.00
8	33°33'30.42"S	136°19'36.88"E	221.898	236	457.90	1502.29
9	33°33'22.56"S	136°19'54.87"E	231.115	236	467.12	1532.53
10	33°33'13.55"S	136°20'11.56"E	248.931	236	484.93	1590.98
11	33°33'4.79"S	136°20'28.83"E	280.818	236	516.82	1695.60
12	33°32'35.89"S	136°20'26.18"E	237.826	236	473.83	1554.55
13	33°32'20.78"S	136°20'42.50"E	236.173	236	472.17	1549.12
14	33°32'9.16"S	136°21'0.50"E	247.019	236	483.02	1584.71
15	33°31'55.66"S	136°21'14.36"E	266.175	236	502.18	1647.56
16	33°33'29.89"S	136°21'8.00"E	299.565	236	535.57	1757.10
17	33°33'24.90"S	136°21'27.51"E	296.769	236	532.77	1747.93
18	33°32'29.41"S	136°23'13.22"E	304.908	236	540.91	1774.63
19	33°34'21.76"S	136°21'2.72"E	266.762	236	502.76	1649.48
20	33°34'36.13"S	136°21'27.88"E	294.93	236	530.93	1741.90
21	33°34'30.91"S	136°21'53.71"E	304.672	236	540.67	1773.86
22	33°34'18.85"S	136°22'27.42"E	312.143	236	548.14	1798.37
23	33°34'9.57"S	136°22'49.92"E	313.341	236	549.34	1802.30
24	33°33'27.97"S	136°23'57.82"E	360.289	236	596.29	1956.33
25	33°33'15.68"S	136°24'13.29"E	356.843	236	592.84	1945.02
26	33°33'1.63"S	136°24'26.71"E	370.881	236	606.88	1991.08
27	33°32'53.31"S	136°24'44.49"E	374.73	236	610.73	2003.71

WTG ID	Latitude	Longitude	Terrain Elevation (m AHD)	WTG height (m AGL)	WTG Elevation (m AMSL)	WTG Elevation (ft AMSL)
28	33°38'33.43"S	136°19'27.90"E	210.759	236	446.76	1465.74
29	33°38'25.57"S	136°19'42.91"E	217.316	236	453.32	1487.26
30	33°38'7.63"S	136°20'3.06"E	239.604	236	475.60	1560.38
31	33°37'56.91"S	136°20'15.23"E	238.851	236	474.85	1557.91
32	33°37'42.53"S	136°20'21.53"E	268.656	236	504.66	1655.70
33	33°37'17.32"S	136°20'29.13"E	246.574	236	482.57	1583.25
34	33°37'13.81"S	136°20'55.74"E	292.765	236	528.77	1734.79
35	33°36'51.34"S	136°20'56.13"E	308.441	236	544.44	1786.22
36	33°36'40.65"S	136°21'12.03"E	318.616	236	554.62	1819.61
37	33°36'10.90"S	136°21'24.83"E	305.563	236	541.56	1776.78
38	33°35'58.91"S	136°21'40.59"E	293.958	236	529.96	1738.71
39	33°35'4.17"S	136°25'11.91"E	310.679	236	546.68	1793.57
40	33°34'53.39"S	136°25'28.96"E	340.078	236	576.08	1890.02
41	33°34'42.05"S	136°25'45.99"E	342.152	236	578.15	1896.82
42	33°34'30.12"S	136°26'1.93"E	344.658	236	580.66	1905.05
43	33°34'17.39"S	136°26'18.44"E	354.766	236	590.77	1938.21
44	33°34'6.88"S	136°26'34.17"E	366.165	236	602.17	1975.61
45	33°36'2.95"S	136°23'3.87"E	330.266	236	566.27	1857.83
46	33°36'2.48"S	136°23'31.80"E	324.758	236	560.76	1839.76
47	33°35'59.79"S	136°23'53.76"E	346.472	236	582.47	1911.00
48	33°35'57.95"S	136°24'10.56"E	340.093	236	576.09	1890.07
49	33°35'51.59"S	136°24'30.44"E	336.497	236	572.50	1878.27
50	33°35'49.90"S	136°24'47.14"E	345.527	236	581.53	1907.90
51	33°35'50.82"S	136°25'6.04"E	331.034	236	567.03	1860.35
52	33°35'49.79"S	136°25'25.39"E	328.287	236	564.29	1851.34
53	33°35'45.97"S	136°25'44.29"E	343.39	236	579.39	1900.89
54	33°35'42.31"S	136°26'2.86"E	352.507	236	588.51	1930.80
55	33°35'35.09"S	136°26'21.05"E	359.888	236	595.89	1955.01
56	33°35'26.33"S	136°26'36.96"E	365.674	236	601.67	1974.00
57	33°35'12.49"S	136°26'51.55"E	377.531	236	613.53	2012.90

WTG ID	Latitude	Longitude	Terrain Elevation (m AHD)	WTG height (m AGL)	WTG Elevation (m AMSL)	WTG Elevation (ft AMSL)
58	33°35'10.53"S	136°27'12.39"E	384.85	236	620.85	2036.91
59	33°37'28.13"S	136°23'5.35"E	283.14	236	519.14	1703.22
60	33°37'14.02"S	136°23'15.49"E	288.402	236	524.40	1720.48
61	33°37'2.40"S	136°23'29.35"E	290.849	236	526.85	1728.51
62	33°37'5.95"S	136°24'0.30"E	268.685	236	504.69	1655.79
63	33°36'53.90"S	136°24'18.18"E	271.777	236	507.78	1665.94
64	33°36'54.67"S	136°24'44.35"E	261.656	236	497.66	1632.73
65	33°37'13.13"S	136°25'19.54"E	279.834	236	515.83	1692.37
66	33°37'2.24"S	136°25'34.92"E	290.788	236	526.79	1728.31
67	33°36'49.94"S	136°25'48.76"E	314.677	236	550.68	1806.68
68	33°36'28.84"S	136°27'39.50"E	362.682	236	598.68	1964.18
69	33°36'20.28"S	136°27'55.31"E	366.823	236	602.82	1977.77
70	33°36'11.36"S	136°28'10.52"E	356.085	236	592.09	1942.54
71	33°39'16.96"S	136°23'42.50"E	212.528	236	448.53	1471.55
72	33°37'50.33"S	136°27'44.80"E	309.496	236	545.50	1789.69
73	33°37'37.40"S	136°27'59.33"E	338.269	236	574.27	1884.08
74	33°40'20.29"S	136°24'26.31"E	222.199	236	458.20	1503.28
75	33°40'14.97"S	136°24'46.19"E	212.107	236	448.11	1470.17
76	33°40'8.95"S	136°25'4.18"E	227.487	236	463.49	1520.63
77	33°39'57.90"S	136°25'19.53"E	253.95	236	489.95	1607.45
82	33°38'38.36"S	136°28'19.54"E	326.102	236	562.10	1844.17
83	33°38'31.81"S	136°28'37.90"E	339.407	236	575.41	1887.82
84	33°38'21.20"S	136°28'53.87"E	348.689	236	584.69	1918.27

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