APPENDIX C

Aviation Impact Assessment

March 2023

AVIATION IMPACT ASSESSMENT

MOUNT HOPEFUL WIND FARM

Prepared for Neoen Australia Pty Ltd

AVIATION PROJECTS

DOCUMENT CONTROL

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ACRONYMS

AAAA	Aerial Application Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
BSC	Banana Shire Council
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
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 beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
RFDS	Royal Flying Doctor Service
RNAV	Area Navigation
RNP	Required Navigation Performance
RPT	regular public transport
RRC	Rockhampton Regional Council
RSR	route surveillance radar
SARA	State Assessment and Referral Agency
SDAP	State Development Assessment Provisions
VFR	visual flight rules
VFRG	visual flight rules guide
VMC	visual meteorological conditions
VOR	very high frequency omni-directional range
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.

EXECUTIVE SUMMARY

Introduction

Neoen seeks planning approval for the proposed Mount Hopeful Wind Farm (the Project).

The Project consists of up to 63 wind turbines and associated infrastructure to be developed over the project area. The project area is located approximately 60 km (32 nm) west from Gladstone Airport, 40 km (22 nm) south from Rockhampton Airport and 61 km (33 nm) north of Thangool Aerodrome.

The maximum tip height of the WTGs will be up to 260 m above ground level (AGL).

Aviation Projects has been engaged by UMWELT to prepare an Aviation Impact Assessment (AIA) for the proposed Project and formally consult with aviation agencies before submitting the DA for consideration by the State Assessment and Referral Agency (SARA) of the Queensland Department of State Development, Infrastructure, Local Government and Planning (DSDILGP).

The AIA will review potential impacts and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

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

Project description

The proposed Project will comprise the following:

- up to 63 wind turbines
- maximum overall height (tip height) of the wind turbines is up to 260 m above ground level (AGL)
- highest wind turbine is T52 with ground elevation of 568 m Australian Height Datum (AHD) and maximum height of a WTG vertical blade tip of 828 m (2716.5 ft above mean sea level (AMSL))
- highest wind turbine within 30 nm of Rockhampton Airport is T18 with ground elevation of 545 m AHD and maximum height of a WTG vertical blade tip of 805 m (2641 ft AMSL)
- 10 temporary or permanent wind monitoring towers (WMTs) with a maximum height of up to 170 m (558ft) AGL, which will be reported to Airservices Australia once the final locations are confirmed prior to construction.

Conclusions

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

Planning considerations

The Project as proposed satisfies the following Acceptable Outcomes of State Code 23:

Performance outcomes	*Acceptable outcomes - Compliance*
Aviation safety, integrity and efficiency	
PO1 Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: 1. location 2. siting 3. design 4. operation.	No acceptable outcome is prescribed
PO2 Development includes lighting and marking measures to ensure the safety, operational integrity and efficiency of air services and aircraft operations.	No acceptable outcome is prescribed

Based on performance outcomes PO1 and PO2, the following actions will support an application in demonstrating compliance with State Code 23 addressing aviation safety, integrity and efficiency:

- Demonstrate that all potential risks to air services have been identified
- Provide evidence from a suitably qualified aerodrome consultant / specialist that the development will not adversely affect the safety, operational integrity and efficiency of air services: and
- The methodology for preparing the risk assessment is contained in the NASF Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*.

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

The AIS of this report identifies high level risks, risk mitigation measures and development constraints that are likely to be applicable to the aviation risk assessment.

Certified airports

1. Rockhampton Airport (YBRK) is the only certified airport located within 30 nm of the Project.

2. The Project is located outside the 10 nm MSA of Rockhampton Airport but within the 25 nm MSA of Rockhampton Airport with limiting height (PANS-OPS) of 2500 ft AMSL, based on the published MSA of 3500 ft.
3. The maximum overall height of a WTG located within 30 nm of the airport is T18, with a reported height of 805 m AHD (2641.1 ft AMSL), which means that WTG T18 will infringe the PANS-OPS surface by 141.1 ft, requiring the 25 nm MSA PANS-OPS surface of 2500 to be increased by 200 ft to 2700, bringing the published 25 nm MSA minimum altitude up to 3700 ft AMSL.
4. An alternative and potentially less impactful solution would be to sectorise the 25 nm MSA so that the relevant sector over the wind farm would have an MSA of 3700 ft AMSL (based on the highest overall wind turbine T18 at 805 m AHD (2641.1 ft AMSL), while the remaining majority of the 25 nm MSA area would retain the lower 3500 ft AMSL.
5. The YBRK area navigation global navigation satellite system (RNP) approach procedures to both runways 15 and 33 have an initial approach altitude and missed approach altitude of 3500 ft AMSL, based on the 25 nm MSA. The minimum holding altitude for the holding patterns for all approaches is also at 3500 ft.
6. Similarly, the ground-based non-directional beacon (NDB)-A or very high frequency omni-directional range (VOR)-A, VOR RWY 15 and VOR RWY 33 procedures have a missed approach altitude of 3500 ft AMSL, based on the 25 nm MSA.
7. If the 25 nm MSA is increased as a result of the wind turbines, whether through sectorising or increasing the overall MSA, then there will be a consequential increase in the initial approach and/or missed approach altitudes and holding altitudes of these procedures.
8. There will be no impact on other altitudes, including descent minima, of either of these procedures.
9. There will be no impact on circling areas or obstacle limitation surfaces of any certified airport.

Obstacle Limitation Surfaces (OLS)

10. The Project is located outside the horizontal extent of and will not affect Rockhampton Airport OLS.

Aircraft Landing Areas (ALAs)

11. As a guide, an area of interest within a 3 nm radius of an aircraft landing area (ALA) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.
12. There are no ALAs within 3 nm of the project.

Air Routes and Lowest Safe Altitude

13. The Project will not impact on any nearby air routes or grid lowest safe altitudes (LSALT).

Airspace

14. The project area is located outside of controlled airspace (wholly within Class G airspace), within the horizontal extent but below Rockhampton Airport's controlled airspace (lower limit for Class D airspace of 3500 ft AMSL during operational hours for Rockhampton Air Traffic Control Tower). Outside of operational hours of Rockhampton Tower, the Lower Limit of Class C above the project site is 4500 ft AMSL.

Aviation Facilities

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

Radar

16. The Mt Alma Route Surveillance Radar (RSR) is located approximately 16.6 km south of the project. It is unlikely that the Project will impact Mt Alma RSR.

Aviation Impact Statement

17. Based on the proposed Project layout and overall turbine overall blade tip height limit of 260 m AGL, the blade tip elevation of the highest wind turbine, which is WTG52, will not exceed 828 m AHD (2716.5 ft AMSL).

18. This AIS concludes that the proposed Project:

    - will not infringe any OLS surfaces
    - will infringe PANS-OPS associated with the 25 nm MSA and consequential impacts to approach commencement altitudes, missed approach final altitude and minimum holding altitudes
    - may infringe Radar Terrain Clearance Chart surfaces
    - will not have an impact on nearby designated air routes
    - will not have an impact on the grid LSALT
    - is wholly contained within Class G airspace
    - is outside the clearance zones associated with aviation navigation aids and communication facilities.

Obstacle lighting risk assessment

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

Consultation

20. An appropriate and justified level of consultation was undertaken with relevant parties. Refer to Section 5 for details of the stakeholders and a summary of the consultation.

Summary of key recommendations

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

Notification and reporting

1. 'As constructed' details of WMT and 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.
   Although Airservices Australia has reviewed the previous wind farm, details of the revised wind farm must be provided to Airservices Australia, at this email address: airport.developments@airservicesaustralia.com prior to the construction of the wind farm. This will occur when approval to provide this AIA to Airservices Australia is provided.

2. 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 or not the structure will be hazardous to aircraft operations.
   The proponent is required to report the WMT to CASA in accordance with CASR 139.165, as soon as practicable after forming the intention to construct or erect the proposed object or structure.
   The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au.

3. Department of Defence should be consulted again as there has been a subsequent modification in the wind turbine height or scale of development, using the following email address: land.planning@defence.gov.au

4. Any obstacles above 110 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

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

   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 have 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 location and height information of wind turbines, wind monitoring towers and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information.

Operation

7. Whilst not a statutory requirement, Neoen should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of turbines

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

Lighting of turbines

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

Marking of wind monitoring towers

10. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Chapter 8, Division 10, (as modified by the guidance in NASF Guideline D). Specifically:

    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires; and

    b. guy wire ground attachment points should be in contrasting colours to the surrounding ground/vegetation; and

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

Micrositing

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

Triggers for review

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

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

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

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

1. INTRODUCTION

1.1. Overview

Neoen seeks planning approval for the proposed Mt Hopeful Wind Farm (the Project).

The Project consists of up to 63 wind turbines and associated infrastructure to be developed over the project area. The project area is located approximately 60 km (32 nm) west from Gladstone Airport, 40 km (22 nm) south from Rockhampton Airport and 61 km (33nm) north of Thangool Aerodrome.

The maximum tip height of the WTG will be up to 260 m above ground level (AGL).

Umwelt has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the proposed Project and formally consult with aviation agencies before submitting the development application (DA) for consideration by the State Assessment and Referral Agency (SARA) of the Queensland Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP).

The AIA will review potential impacts and provide aviation safety advice in respect of relevant requirements of air safety regulations and procedures and undertake consultation with relevant aviation agencies.

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

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and progress any ongoing dialogue through the planning process.

The assessment will specifically respond to the:

- Queensland State Code 23: *Wind farm development (State Code 23)* of the State Development Assessment Provisions, specifically Performance Outcomes PO1 and PO2 and their associated acceptable outcomes
- National Airport Safeguarding Framework (NASF), Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms) /Wind Monitoring Towers*.

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. confirmed the scope and deliverables with Neoen via Umwelt
2. reviewed client material, including the initial constraints analysis and identified mitigation measures
3. conducted a site visit to properly investigate aviation safety aspects and identifying existing tall structures within or adjacent to the proposed project area

4. reviewed relevant regulatory requirements and information sources
5. prepared a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified. The draft AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine need for obstacle lighting and of applicable aspects for client review and acceptance before submission to external aviation regulators
6. identified risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management –Guidelines*
7. consulted with relevant councils, Part 173 procedure designers (Airservices Australia) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
8. consulted/engaged with stakeholders to negotiate acceptable outcomes (if required)
9. finalised the AIA report for client acceptance when response received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement

The AIS includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.56 km) of the project area
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s)

Air Routes:

- Nominate air routes published in ERC-L & ERC-H which are located near/over the project area and review potential impacts of Project operations on aircraft using those air routes
- Define the relevant route segment by specifying the two waypoint names located on the routes which are located before and after the obstacles

Airspace:

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

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by Neoen for preparation of this assessment included:

- Neoen, Mt Hopeful Wind Farm – Project Layout:

  Mount Hopeful 116 WTG_with_labels.kmz
  Mt-Hopeful_20210114_electrical_ifra_McCamley.kmz
  Mt-Hopeful-20210112_project_boundaries.kmz
  Met mast locations.kmz

- 230125_Umwelt_TWilliamson_DesignData_Transfer (1).zip
  - DESIGN_Umwelt_Turbines_221102_GDA94z56.shp
  - DESIGN_Umwelt_PermanentMetMasts_221128_GDA9456.shp
- 20221027_Mount Hopeful WTG Coordinates.xlsx

2. BACKGROUND

2.1. Site overview

An overview of the Project layout and area relative to nearby towns, is provided in Figure 1 (source: Neoen, Google Earth).

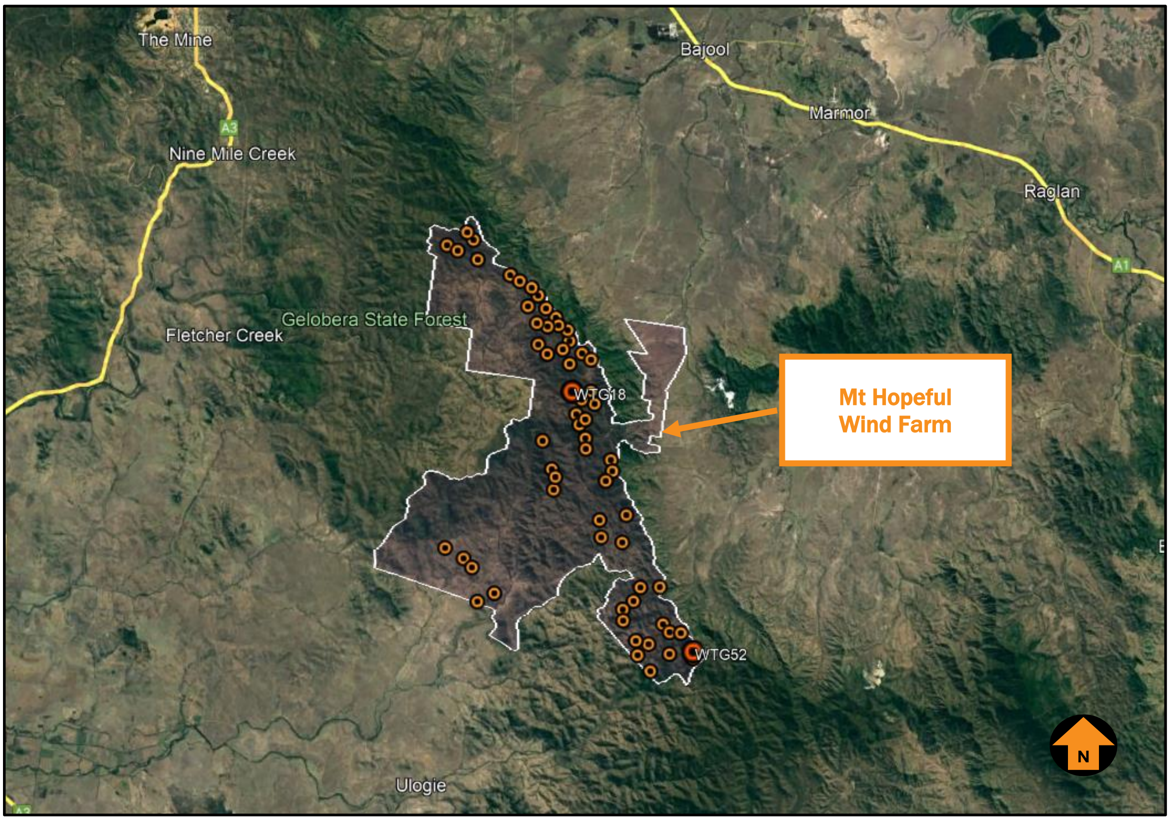

Figure 1 Project area overview and indicative layout

2.2. Project description

The Project may consist of up to 63 WTGs and associated infrastructure to be developed over the project area. The project area is located east of the Burnett Highway within the boundaries of Banana Shire Council (BSC) and Rockhampton Regional Council (RRC) local government areas (LGAs) in Queensland and approximately 60 km (32 nm) west from Gladstone Airport, 40 km (22 nm) south from Rockhampton Airport and 61 km (33nm) north of Thangool Aerodrome.

Refer to Figure 2 for the Project boundary within the boundaries of BSC and RRC (source: Neoen, QLD Globe).

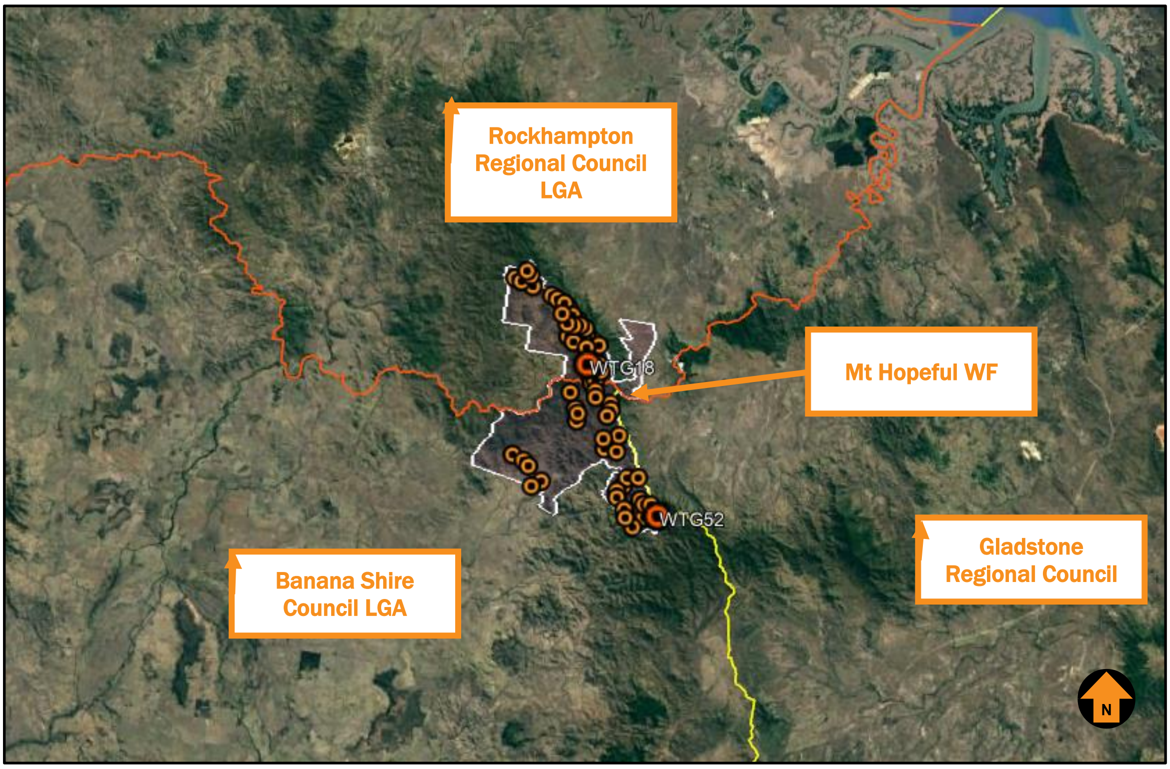

Figure 2 Project boundary relative to LGA

3. EXTERNAL CONTEXT

3.1. Department of State Development, Manufacturing, Infrastructure and Planning

The Department of State Development, Manufacturing, Infrastructure and Planning released the State Development Assessment Provisions (SDAP), version 3, commencing in February 2022.

SDAP sets out the matters of interest to the state for development assessment, where the Director-General of the department is responsible for assessing or deciding development applications. State Code 23 addresses wind farm development.

The code applies to a material change of use for a new or expanding wind farm. The purpose of State Code 23 is:

> *to protect individuals, communities and the environment from adverse impacts as a result of the construction, operation and decommissioning of wind farm development.*
>
> *Wind farms should be appropriately located, sited, designed and operated to ensure:*
>
> *(1) the safety, operational integrity and efficiency of air services and aircraft operations.*

State Code 23 contains Performance Outcomes (PO) and Acceptable Outcomes (AO). PO1 and PO2 and associated Acceptable Outcomes address aviation safety, integrity and efficiency and are provided in Table 1.

Table 1 State Code 23 - Aviation safety, integrity and efficiency for Material Change of Use

Performance outcomes	*Acceptable outcomes*
Aviation safety, integrity and efficiency	
PO1 Development does not adversely affect the safety, operational integrity and efficiency of air services and aircraft operations as a result of its: 1. location 2. siting 3. design 4. operation.	No acceptable outcome is prescribed
PO2 Development includes lighting and marking measures to ensure the safety, operational integrity and efficiency of air services and aircraft operations.	No acceptable outcome is prescribed

Based on performance outcomes PO1 and PO2, the following actions will support an application in demonstrating compliance with State Code 23 addressing aviation safety, integrity and efficiency:

- Demonstrate all potential risks to air services have been identified
- Provide evidence from a suitably qualified aerodrome consultant / specialist that the development will not adversely affect the safety, operational integrity and efficiency of air services.

The methodology for preparing the risk assessment is contained in the NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms) /Wind Monitoring Towers*.

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

The AIS of this report identifies high level risks, risk mitigation measures and development constraints that are likely to be applicable to the aviation risk assessment.

3.2. Banana Shire Council

The 2021 Banana Planning Scheme is the in-force planning scheme for the Banana Shire.

The analysis provided in Section 6 demonstrates that the Project is sufficiently distant from Thangool that it will not be affected by the project.

The Planning Scheme does not incorporate an Airport environs overlay code for the three certified airports in the shire (Taroom (YTAM), Thangool (YTNG) and Theodore (YTDR)). However, it does highlight protecting the airports in section 2.4 Rural Areas:

> *Taroom, Thangool and Theodore Airports are important regional resources, creating opportunities for transporting residents to places of interest, business or employment, produce to market and for establishing aviation-based activities. New development does not compromise aircraft safety or airport operations.*

Another mention of the airports in the shire is in section 2.8 Infrastructure and Servicing more specifically in section 2.8.1.1 Specific outcomes:

> *(13) The operation of the Shire's aerodromes and regionally strategic aviation facilities integrates with land uses and transport infrastructure and is protected from incompatible development and is expanded to support greater accessibility in the region.*

Given that there is not a specific aviation section in the Planning Scheme document, an area of 30 nm (55.56 km) from Thangool's aerodrome reference point (ARP) is used to identify possible constraints from the Project. Thangool is the closest of the three airports in the shire; however, since the airport is located beyond 30 nm from the Project, there will be no impact on the airport's operational airspace.

3.3. Rockhampton Regional Council

RRC published its regional planning scheme on 24 August 2015, the document has since been updated, the latest version of the planning scheme version 2.2 was released on 14 June 2021. The planning scheme incorporates an Airport environs overlay code for Rockhampton Airport. As stated in section 8.2.2.2 Purpose:

> *(1) The purpose of the airport environs overlay code is to ensure that:*
>
> > *(a) the current and future operations of the Rockhampton Airport and associated aviation facilities are not adversely impacted by development and land uses;*
>
> *(2) The purposes of the code will be achieved through the following overall outcomes:*
>
> > *(c) development and associated activities do not adversely impact on airport operations and aviation facilities by creating incompatible intrusions into operational airspace;*
> > *(e) development ensures that the operational airspace of the airport is not put at risk from artificial light sources or wildlife interference generated by development.*

Table 2 shows the performance and acceptable outcomes regarding the operational airspace (obstacle limitation surface) as found in section 8.2.2.3 Specific benchmarks for assessment.

Table 2 Development outcomes for assessable development and requirements for accepted development

Performance outcomes	*Acceptable outcomes*
Operational airspace (obstacle limitation surface)	
PO1 Development does not involve permanent, temporary or transient physical obstruction (natural or man-made) of operational airspace.	AO1.1 Development does not allow the following to infringe the airport's operational airspace as identified on overlay map OM-2A: (b) wind farms or wind monitoring equipment

Figure 3 shows map OM-2A, on this map the operational airspace of Rockhampton Airport is shown as well as height limits of proposed developments. The project area is highlighted in orange. As can be seen the project area is clear of the operational airspace and the Project meets the performance and acceptable outcomes of Rockhampton Region Planning Scheme.

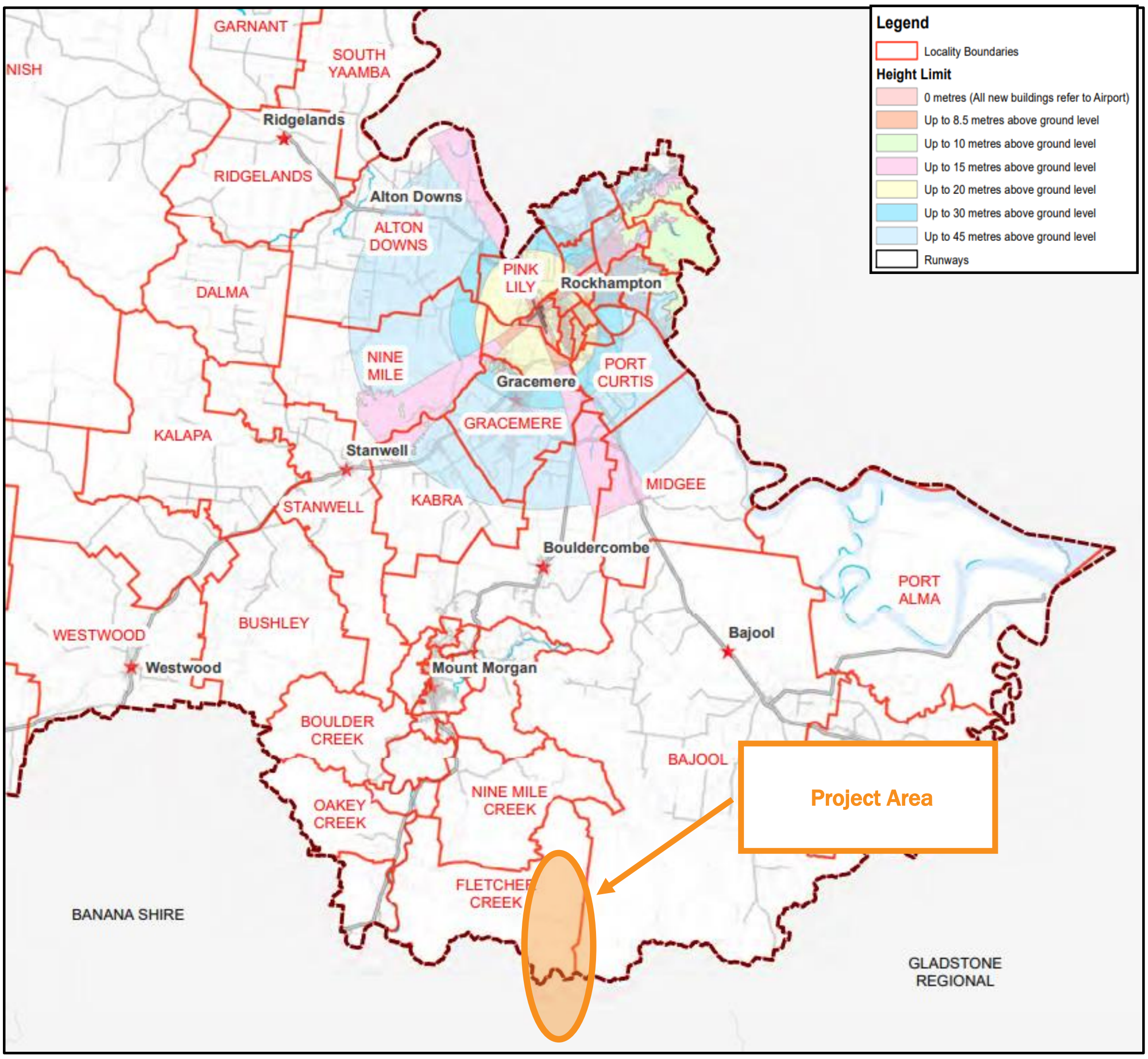

Figure 3 Map OM-2A-0 (source: Rockhampton Regional Council)

3.4. Rockhampton Airport Master Plan

Rockhampton Airport published its latest airport master plan in 2017. This document does not indicate any new developments that would restrict the construction of a new wind farm. The current obstacle limitations associated with the airport still apply.

3.5. Gladstone Airport Master plan

A search conducted on the Gladstone Regional Council website and Google revealed that Gladstone Airport has not published a Master Plan.

3.6. Thangool Aerodrome

A search conducted on the Banana Shire Council website and Google revealed that Thangool Aerodrome does not have a Master Plan.

3.7. Aircraft operations at non-controlled aerodromes

CASA Advisory Circulars (AC) are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of compliance with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

AC 91-10 v1.1 – *Operations in the vicinity of non-controlled aerodromes* – provides guidance on procedures that, when followed, will improve situational awareness and safety for all pilots when flying at, or in the vicinity of, non-controlled aerodromes. Section 7 describes the standard aerodrome traffic circuit procedures.

The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures are provided in Figure 4 and Figure 5.

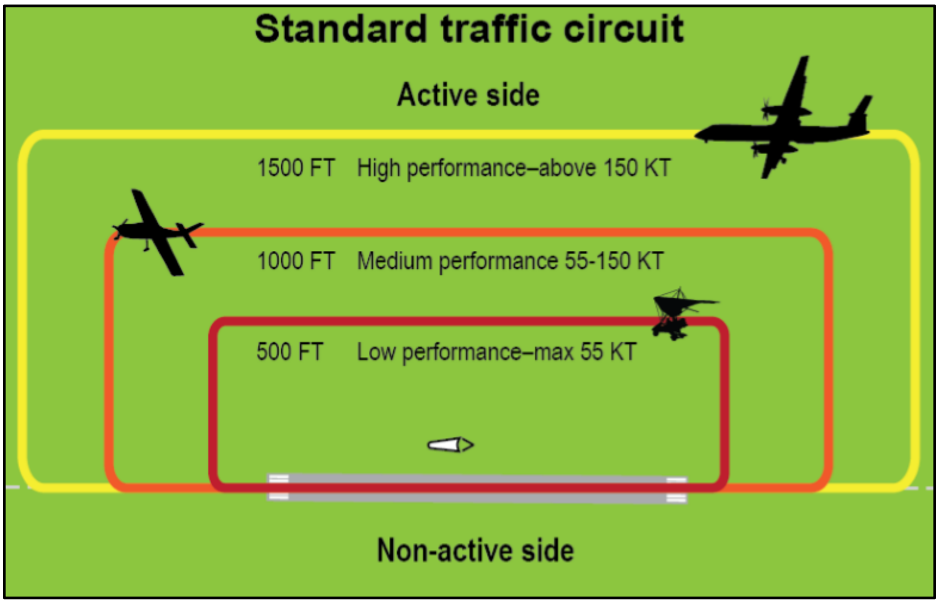

Figure 4 Lateral and vertical separation in the standard aerodrome traffic circuit

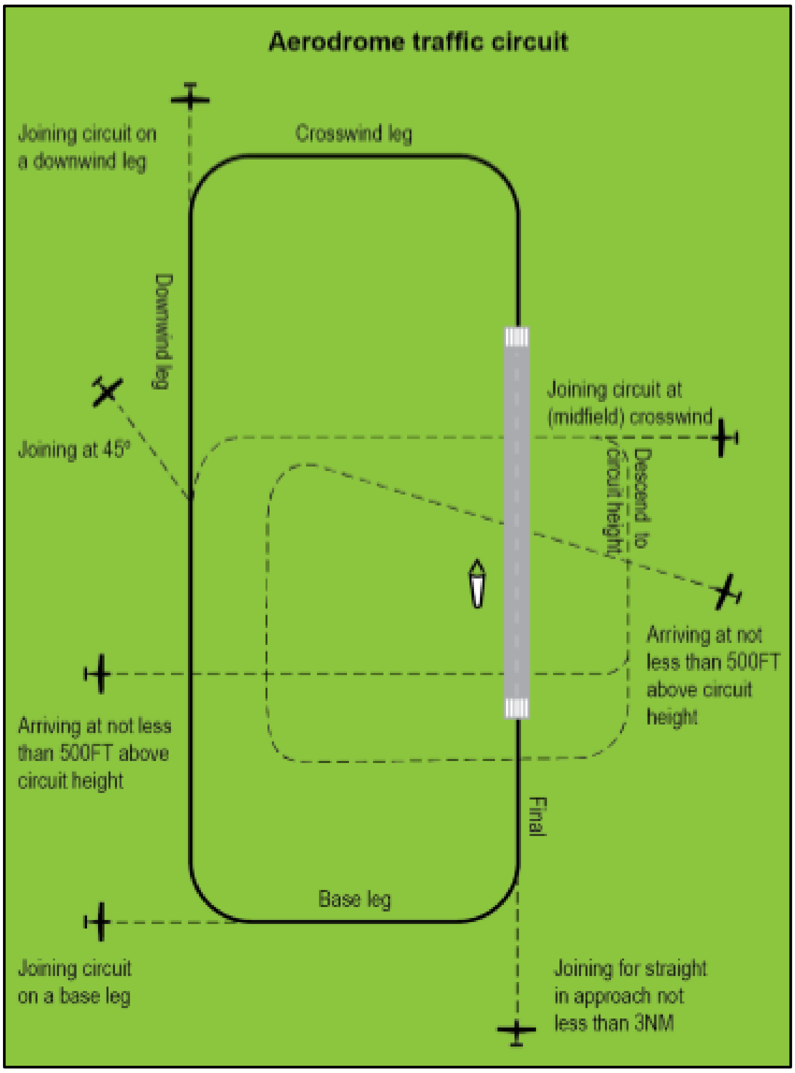

Figure 5 Aerodrome standard traffic circuit, showing arrival and joining procedures

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.*

3.8. Rules of flight

3.8.1. Flight under Day Visual Flight Rules (VFR)

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

Civil Aviation Safety Regulation (1998) 91.267 (Minimum height rules—other areas) prescribes the minimum height for flight. Generally speaking, and unless otherwise approved, aircraft are restricted to a minimum height of 500 ft AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas, and 1000 ft AGL over built up areas (within a horizontal radius of 600 m of the point on the ground or water immediately below the aeroplane).

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

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

3.8.2. 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):

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

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

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

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

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

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

According to CASR 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method. Obstacle lights on structures not within the vicinity of an aerodrome are effectively redundant to an aircraft being operated under the IFR.

3.9. Aircraft operator characteristics

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

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 600 m horizontal distance. In VMC, the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the project area once wind turbines are erected.

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

It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations within the vicinity of the Project to enable appropriate obstacle avoidance manoeuvring.

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

3.10. Passenger transport operations

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

Air Route Lowest Safe Altitudes (LSALT), Grid LSALT and PANS-OPS surfaces associated with instrument approach and departure procedures protect IFR flight operations from the terrain and obstacle environment.

3.11. Private operations

Private operations are generally conducted under day or night VFR, with some IFR.

3.12. Military operations

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

3.13. 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.

There is likely to be a low rate of aerial application operations in the area due to the mountainous nature of the terrain.

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

The Aerial Application Association of Australia (AAAA) has a formal risk management program which is recommended for use by its members.

The impact of the proposed turbines on the safe and efficient aerial application of agricultural fertilisers and pesticides in the vicinity of the Project was assessed.

3.14. Aerial Application Association of Australia

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

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

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

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

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

3.15. Local aerial application operators

Aerial application operators consulted in previous studies undertaken by Aviation Projects have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, but that properties adjacent to the wind farm would have to be assessed on an individual basis.

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

Based on previous studies undertaken by Aviation Projects, it is reasonable to conclude that safe aerial application operations would be possible on properties within the project area and neighbouring the project area, subject to final turbine locations and by implementing recommendations provided in this report.

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

The use of helicopters enables aerial application operations to be conducted in closer proximity to obstacles than would be possible with fixed wing aircraft due to their greater manoeuvrability.

3.16. Aerial firefighting

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

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

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

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

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

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

3.17. Emergency services - Royal Flying Doctor Service

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

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

For example, pilots and crew require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

4. INTERNAL CONTEXT

4.1. Wind farm description

The wind farm is situated in an area comprised mainly of farming properties with an undulating rural landscape. The site is located east of the intersection of the Queensland State highways A3 (Burnett Hwy) and A5 (Leichhardt Hwy).

Figure 6 shows the proposed project area from the north.

Figure 6 Landscape of the proposed project area as seen from the A1 (Bruce Hwy)

Figure 7 shows a view standing on Nine Mile Creek Road looking south-east towards the project area where the proposed WTGs are located.

Figure 7 Nine Mile Creek Road looking south-east at the project area

Figure 8 shows a view from state highway 60 (Dawson Highway) looking to the north towards the proposed project area where an existing overhead power line is located.

Figure 8 Dawson Highway looking to the north at the proposed project area

Figure 9 shows a view from Playfields Road looking to the east towards the proposed project area, where existing overhead powerlines are located.

Figure 9 Playfields Road looking to the east towards the project area

Figure 10 shows a 2478 ft AHD unlit telecommunication tower which is located on top of Mt Hopeful approximately 2 km north of the project area. The photo was taking looking west, standing at South Ulam Road near the intersection with Beak Road,

Figure 10 Existing telecommunication tower, view from South Ulam Road

4.2. Wind turbine description

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

The maximum ground elevation for the proposed WTG52 wind turbine is 568 m AHD, which results in a maximum overall height of 828 m AHD (2716.5 ft AMSL).

Figure 11 demonstrates the Project layout identifying the highest WTG52 and WTG 18, the highest WTG within 30 nm of Rockhampton Airport (source: Neoen, Google Earth).

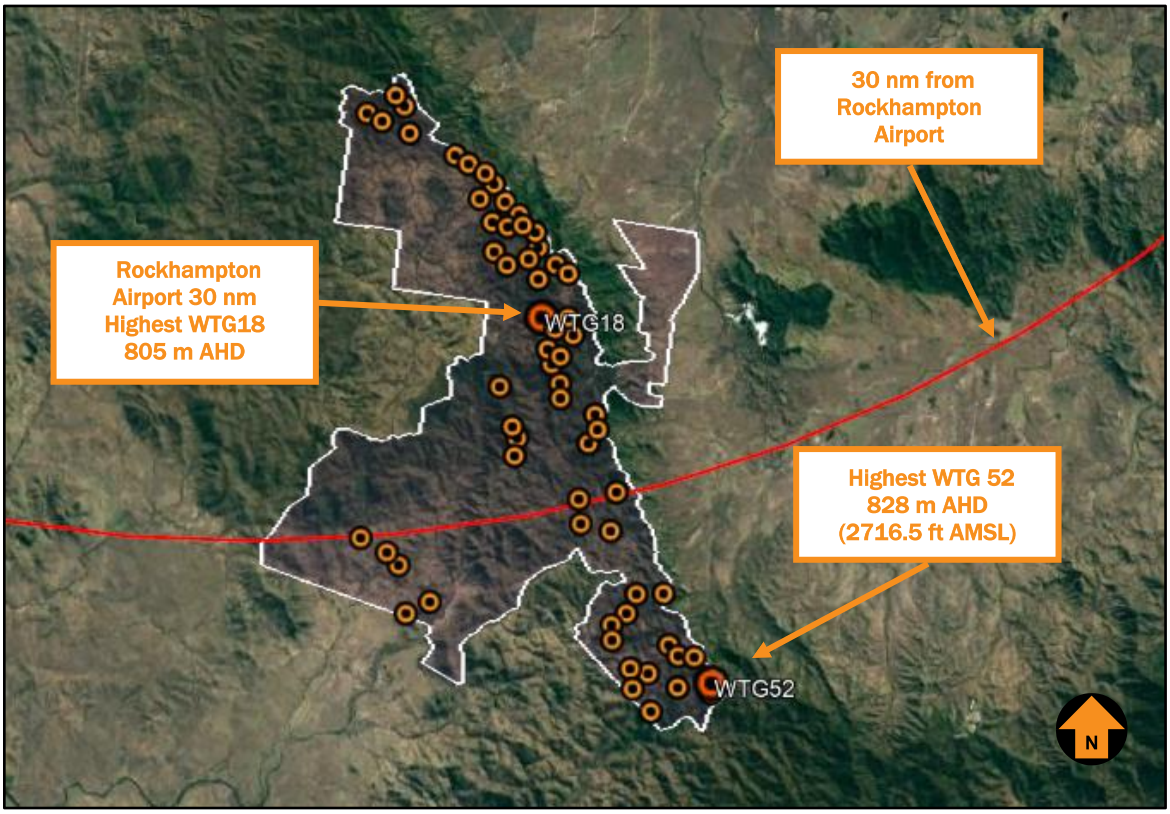

Figure 11 Project layout and highest wind turbines

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

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

4.3. Wind monitoring tower description

The single existing WMT on site is of steel lattice construction and 120 m AGL high.

There are 10 permanent WMTs proposed as part of the Project.

The WMTs will be of steel lattice construction with a maximum of 170 m (558 ft) AGL in height.

The WMTs will be guyed at several levels in three directions. The guy wires will have aviation markers located near the top of the proposed WMT.

Indicative locations are provided in Figure 12 (source: Neoen).

Once the details of the WMTs are finalised, they will be reported to Airservices Australia for entry into Vertical Obstruction Database when the construction is completed.

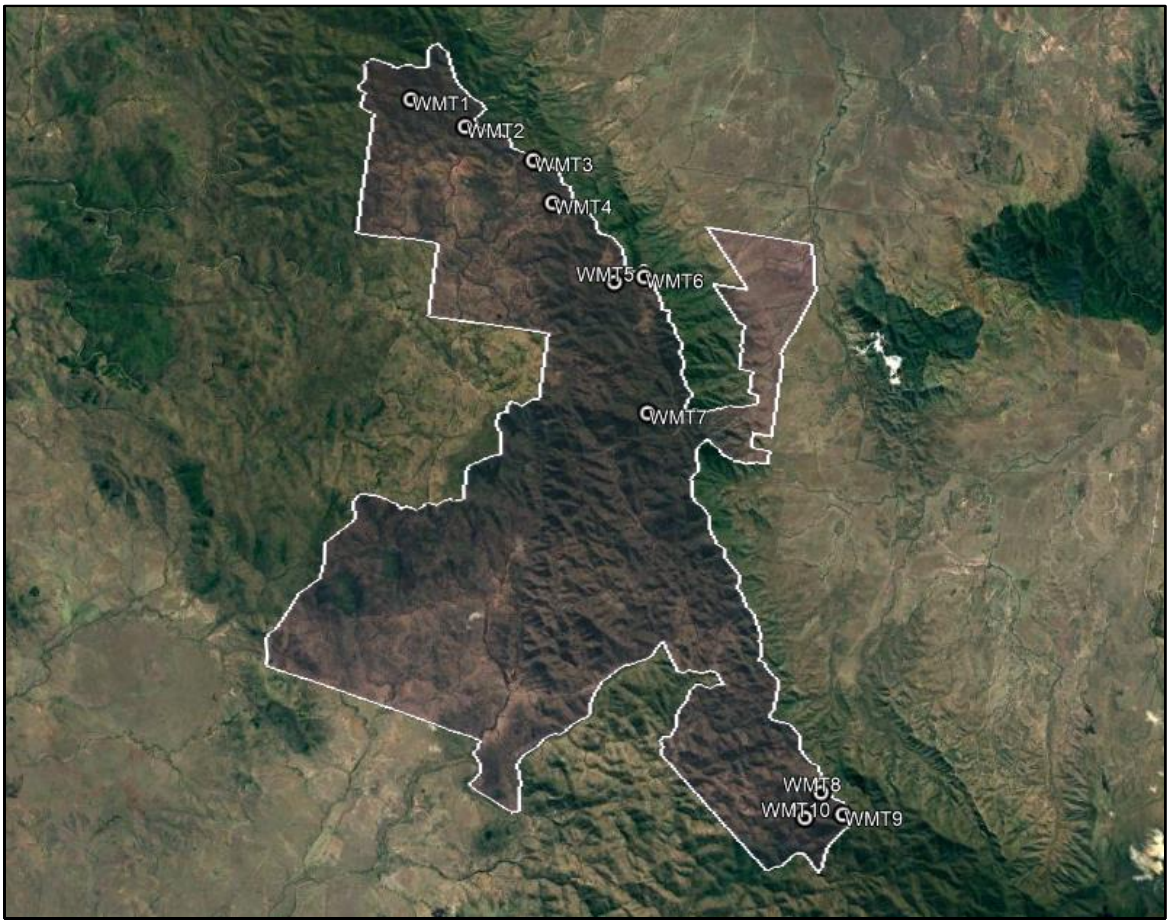

Figure 12 Indicative WMT locations

4.4. Overhead transmission line

There are existing 275 kV transmission lines available to the east and west of the proposed Project location.

Neoen is considering options for overhead and/or underground connections to the existing transmission lines through a proposed large substation/battery energy storage system (BESS) according to detailed design requirements.

Refer to Figure 13 (source: Neoen, Google Earth).

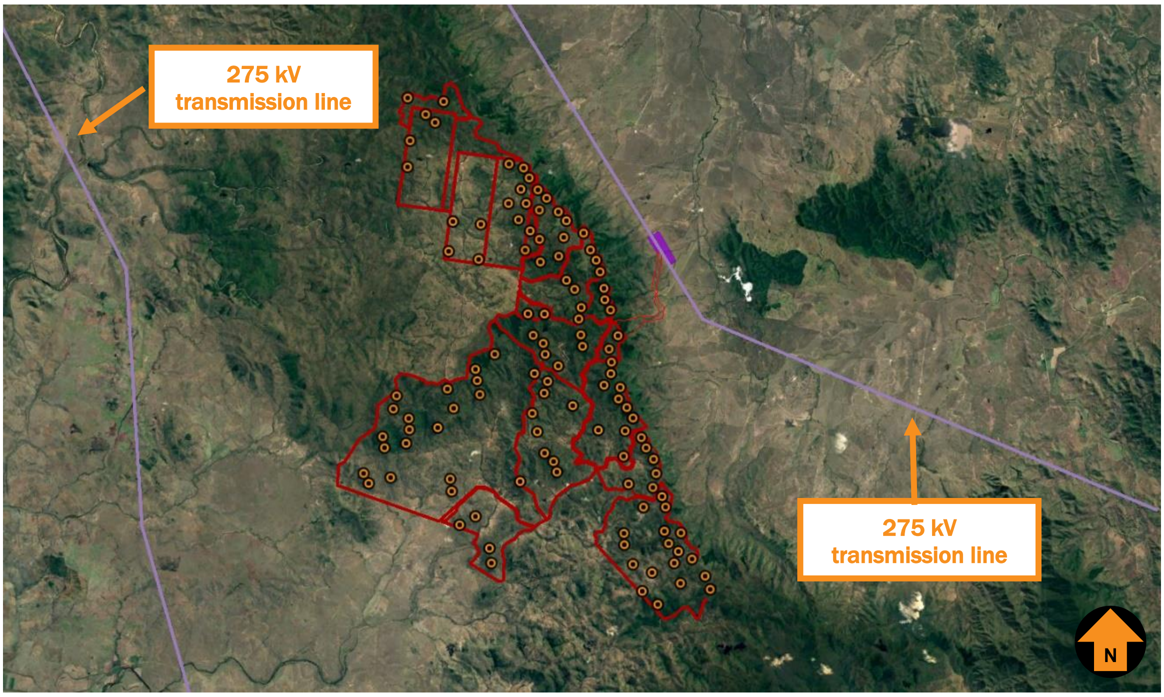

Figure 13 Existing distribution and transmission network

5. CONSULTATION

The stakeholders consulted include:

- Airservices Australia
- Aerodrome operators (Rockhampton Regional Council)
- CASA
- Department of Defence
- Queensland Fire and Emergency Services (QFES)
- Royal Flying Doctor Service.

Details and results of the consultation activities are provided in Table 3.

Due to the changes to the project, Airservices Australia will be consulted again.

Table 3 Stakeholder consultation details conducted in 2021

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	28 January 2021 Email to Airservices Australia Airport Developments	30 March 2021 Response from John Graham, Airport Development Applications Coordinator	*Airservices Australia was informed of the Project.* *In the email response, Mr Graham advised the Project would have an impact on the 25 nm MSA and the RNAV-Z (GNSS) RWY 33 for Rockhampton Airport. Other changes to procedures would also be required.* *The wind farm will also affect the Rockhampton Radar Terrain Clearance Chart (RTCC). (The extent of the impacts was not disclosed).* *Furthermore, he advised that the proposed wind farm will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.*	Any Airservices work associated with amending the Rockhampton RTCC boundary, the 25NM MSA (including other changes to procedures that will be required), and the RNAV-Z (GNSS) RWY 33 instrument procedure at Rockhampton aerodrome will be undertaken on a commercial basis and require further consultation. Responses from aviation operators and Rockhampton Airport regarding the nominated impacts are summarised herein.
Aerodrome operators	28 January 2021 Email to Rockhampton Regional Council 17 May 2021	2 June 2021 Email response from Deb McKee-Hegarty – Compliance Officer Rockhampton Airport	*RRC was informed of the Project and subsequently requested a stakeholder workshop to further discuss the project.* *RRC requested additional consultation with Alliance Airlines and Republic of Singapore Air Force.* *Formal advice was provided via letter as follows:*	Request to sectorise the YBRK 25nm MSA to account for the obstacles in the wind farm area

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
	Stakeholder Workshop with Rockhampton Regional Council		*RRC has reviewed the Aviation Impact Assessment and the response from a number of potentially affected parties. RRC notes that CASA is yet to make an assessment of the project and provide any recommendations.* *RRC note that the ASA response advises that the Radar Terrain Clearance Chart will be affected, as are procedural approach and departures which will require ASA redesign. Any cost in such procedural design changes should be met by the proponent.* *RRC supports the option of putting in place a sectored area within the MSA that encompasses the proposed Wind Farm Project.*	
Alliance Airlines	19 May 2021 Email to Alliance Airlines Fleet Manager Fokker 70/100	19 May 2021 Response from Brendan McMahon Fleet Manager Fokker 70/100	*Alliance Airlines was informed of the Project* *The response of Alliance Airlines offered a brief summary regarding the impact to the 25 nm MSA at YBRK as this will potentially impact:* • *The descent path angle or descent point on the RNAV-Z (GNSS) RWY 33 YBRK from IAF's 'LALIS' and 'SARUS'.* • *Descent path on the VOR RWY 33 YBRK and the GLADSTONE VOR TO ROK VOR DME/GNSS ARRIVAL & Sector B & C DME/GNSS ARRIVAL.*	Request to sectorise the YBRK 25nm MSA to account for the obstacles in the wind farm area

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			A response was provided to the effect that the identified issues were not necessarily correct, but no further correspondence was received at the time of finalising this report. Alliance Airlines indicated support for sectorising the 25 nm MSA.	
Banana Shire Council	1 February 2021 Email to Banana Shire Regional Council	12 February 2021 Response from Jaz Dodd, Coordinator Aerodrome Operations	*Banana Shire Regional Council was informed of the Project as operator of Thangool Aerodrome.* *Subsequently Council advised to have no objections on the condition that the project will have no impact on any Banana Shire Council aerodromes*	N/A
CASA	*CASA has advised that it will only review assessments referred to it by a planning authority or agency.*			No further action required; Project will be referred to CASA by planning authority
Department of Defence	28 January 2021 Email to Department of Defence	19 February 2021 Response from mr Charles Mangion, Director Land Planning & Regulation	*Department of Defence was informed of the Project.* *In an email and formal letter response, Mr Mangion advised Defence has conducted an assessment of proposed wind farm for potential impacts on the safety of Defence flying operations as well as possible interference to Defence communications and radar.* *Defence advised that the proposed 260 metre AGL turbines and 170 metre WMTs meet the requirements for reporting of tall structures.*	The proposed structures will meet the above definition of a tall structure. Defence therefore requests that the applicant provide ASA with "as constructed" details. The details can be emailed to ASA at vod@airservicesaustralia.com. Send the risk assessment of this proposal to CASA for consideration.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			Defence also recommends that the risk assessment be submitted to the Civil Aviation Safety Authority (CASA) to determine whether the proposal is a hazard to aircraft safety and requires approved lighting or marking. Defence supports this requirement and believes that, in this instance, it would be prudent for the risk assessment of this proposal to be sent to CASA for consideration. *If CASA determines that obstacle lighting is to be provided, it should be compatible with persons using night vision devices. If LED lighting is proposed, the frequency range of the LED light emitted should be within the range of wavelengths 665 to 930 nanometres.* *Defence has no objection to the proposed wind farm provided that the project complies with the above conditions.*	
Qantas Link	28 January 2021 Email to Qantas Link	3 February 2021 Response from Adrian Young - AOC Accountable Manager	*QantasLink was informed of the Project.* *QantasLink has advised the proposed wind farm will not impact on their operations.*	N/A
QFES	28 January 2021 Email to Queensland Fire	9 March 2021 Response from Karen Warwick – Executive Officer	*QFES was informed of the Project. QFES is very supportive of the project and is aware of many similar wind farms across Queensland.*	Inform QFES of Project location through aeronautical charting – once construction commences Project is reported to Airservices Australia.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
	and Emergency Service		*QFES has offered the following information for consideration when developing the project:* *- The accessibility to the wind farm for a QFES response to any type of incident.* *- What are the risks to QFES air operations capability (water bombing) in responding to a bushfire while the turbines are operating, given the water bombing aircraft operate at very low levels, sometimes at 100 metres depending on fire conditions?* *- What risk considerations are required from QFES for flight plans considering wind patterns, smoke plum, access to site and flight standards?* *- Due to the history of bushfires within the general areas of the wind farm, the consideration of vegetation management as part of your bushfire preparation will be important to QFES and the community.*	
RFDS	29 January 2021 Email to Royal Flying Doctor Service	29 January 2021 Response from Anthony Hooper – Manager Line Operations	*RFDS was informed of the Project.* *The response from RFDS advised that the Project will not have any significant impact on RFDS operations into and out of Rockhampton Airport*	*N/A*
Republic of Singapore Air Force	25 May 2021	N/A	*No response was received at the time of finalising this report*	*N/A*

Agency/Contact	Activity/Date	Response/ Date	Issues Raised During Consultation	Action Proposed
Virgin Australia	28 January 2021 Email to Virgin Australia	22 February 2021 Response from Duncan Poon – Flight Operations Engineer	*Virgin Australia was informed of the Project.* *No objection pursuant to Air Services Australia indicating the proposed development will not require additional changes to existing airspace procedures, the performance of any navigational aids, sector or circling altitudes or any Communication/ Navigation/ Surveillance (CNS) facilities over and above what has been proposed*	Request to sectorise the YBRK 25nm MSA to account for the obstacles in the wind farm area

6. AVIATION IMPACT STATEMENT

6.1. Nearby certified aerodromes

The closest certified airport to the project area is Rockhampton Airport (YBRK), which is located approximately 40 km (22 nm) to the north. Other certified airports in the area are Gladstone Airport (YGLA) and Thangool Aerodrome (YTNG)

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

The location of the Project relative to the nearest certified airports with 30 nm buffers is shown in Figure 14 (source: Neoen, OzRunways, Australian 250K Topographical Chart).

As shown in Figure 14, the Project boundary extends into the 30 nm area around Rockhampton Airport (YBRK), hence this airport may be impacted by the Project. Gladstone Airport (YGLA), and Thangool Aerodrome (YTNG) are located beyond 30 nm from the Project and will not be impacted.

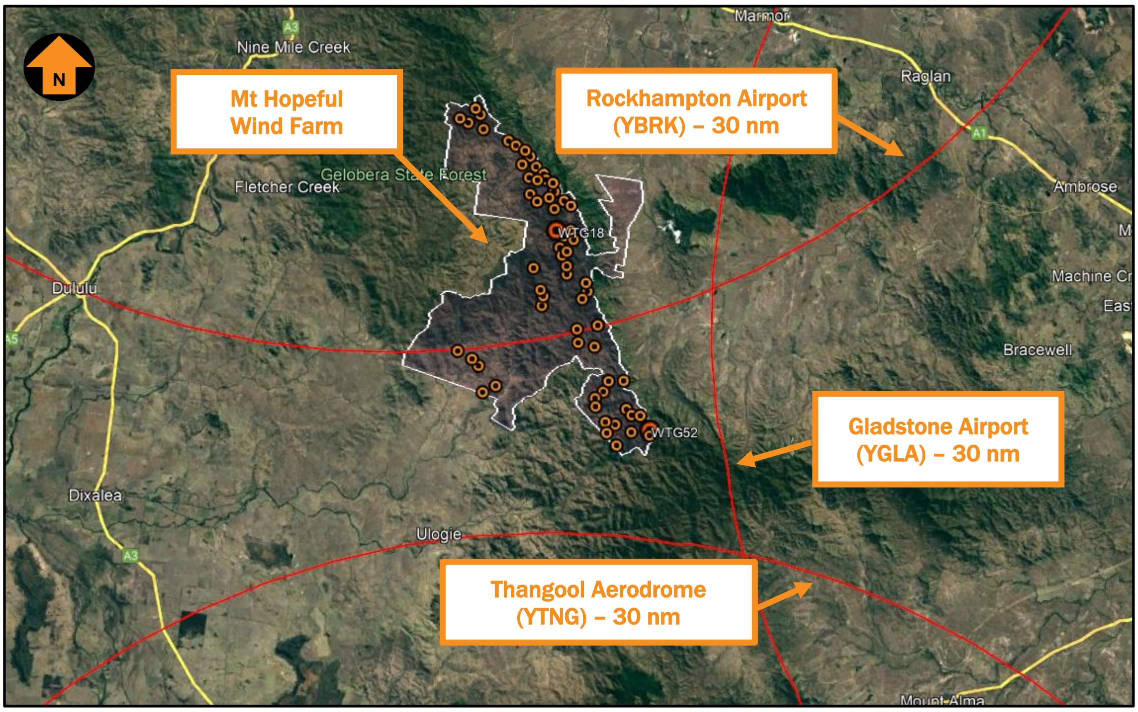

Figure 14 General location of the Project boundary and surrounding aerodromes

6.2. Rockhampton Airport

Rockhampton (YBRK) is a certified, non-precision approach aerodrome, operated by RRC), with a published aerodrome elevation of 11 m AHD (36 ft AMSL) (source: Airservices Australia, FAC chart, 5 November 2020).

Rockhampton Airport has two runways:

- Runway 04/22, length of 1645 m, width 23 m and runway strip 80 m.
- Runway 15/33, length of 2570 m, width 45 m and runway strip 300 m.

Figure 15 shows the Rockhampton Airport Runway layout (source: Google Earth).

Figure 15 Rockhampton Airport (YBRK) runway layout

Rockhampton Airport's ARP coordinates published in Airservices Australia's Designated Airspace Handbook are Latitude 23°22'55"S and Longitude 150°28'31"E.

6.3. Obstacle limitation surfaces

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

The Project is located outside the horizontal extent of and will not affect Rockhampton Airport OLS.

6.4. Rockhampton Airport - circling areas

The Project is located beyond the horizontal extent of circling areas at Rockhampton Airport.

6.5. PANS-OPS surfaces

Figure 16 shows the location of the Project layout with buffer areas for Rockhampton Airport 10 nm and 25 nm MSAs (including associated 5 nm buffer areas) (source: Neoen, Google Earth).

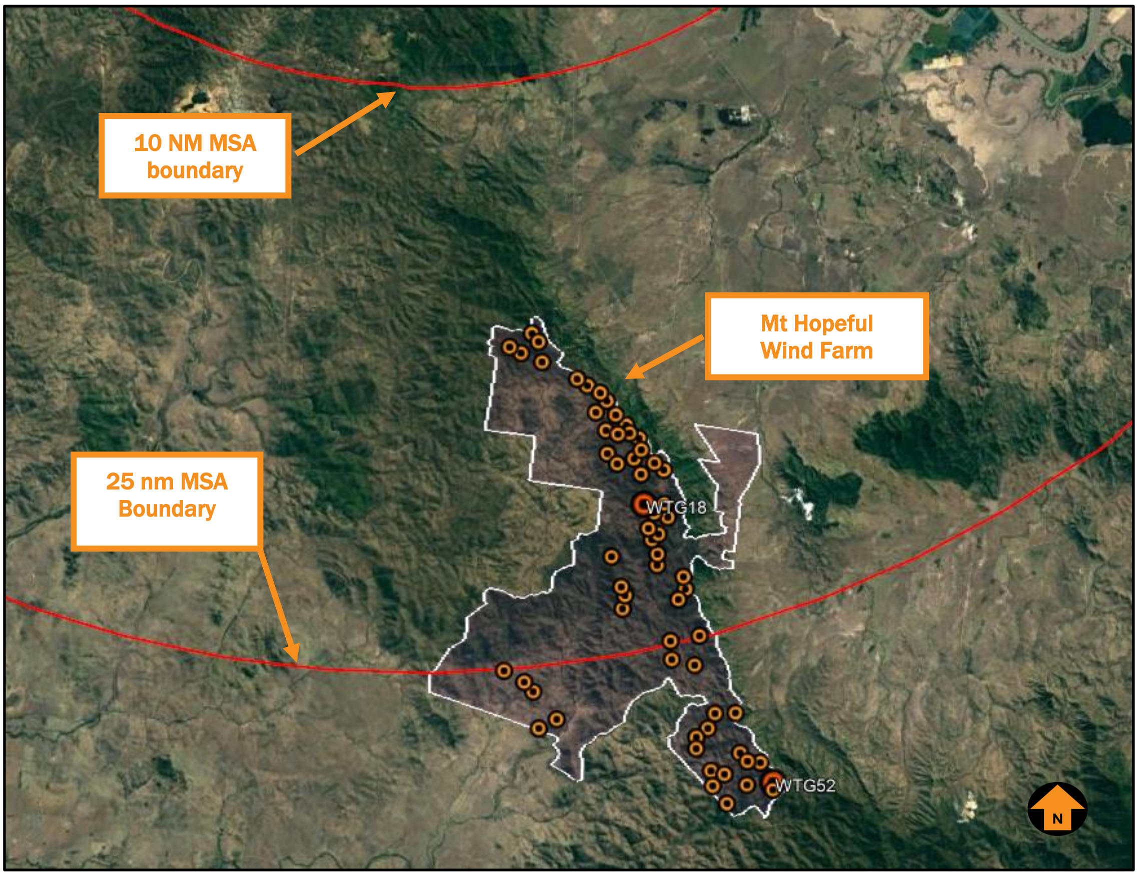

Figure 16 Rockhampton Airport - 15 nm and 30 nm buffer areas

The minimum safe altitude (MSA) is applicable for each instrument approach procedure at Rockhampton Airport. An image of the MSA published for the aerodrome is shown in Figure 17 (source: Airservices Australia).

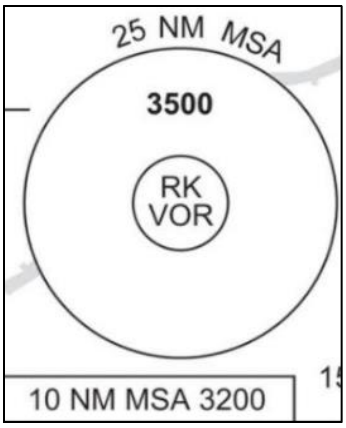

Figure 17 MSA at Rockhampton

The Manual of Standards 173 *Standards Applicable to Instrument Flight Procedure Design* (MOS 173), requires that a minimum obstacle clearance (MOC) of 1000 ft above the highest obstacle within the boundary of the relevant MSA.

Obstacles within the 10 nm MSA (10 nm radius + 5 nm buffer) and within the 25 nm MSA (25 nm radius + 5 nm buffer) of Rockhampton Airport's ARP define the minimum height at which an IFR aircraft can fly when within 10 nm and 25 nm without visual reference to the ground or water, prior to commencing an instrument approach or climbing following a missed approach.

The Project is located outside the 10 nm MSA of Rockhampton Airport but within the 25 nm MSA of Rockhampton Airport with a minimum altitude of 3500 ft AMSL and an associated PANS-OPS surface of 2500 ft AMSL.

The maximum overall height of a WTG located within 30 nm of the airport is WTG18, with a reported height of 805 m AHD (2641.1 ft AMSL), which means that WTG18 will infringe on the 2500 ft AMSL PANS-OPS surface. The PANS-OPS surface will need to be raised by 200 ft to 2700 ft, with the 25 nm MSA minimum altitude would need to be raised by 200 ft to an altitude of 3700 ft AMSL.

An alternative and potentially less impactful solution would be to sectorise the 25 nm MSA so that the relevant sector over the wind farm would have an MSA of 3700 ft AMSL (based on the highest overall wind turbineWTG18 while the remaining majority of the 25 nm MSA area would retain the lower 3500 ft AMSL.

An image showing the highest turbine within the 30 nm buffer area is provided at Figure 18.

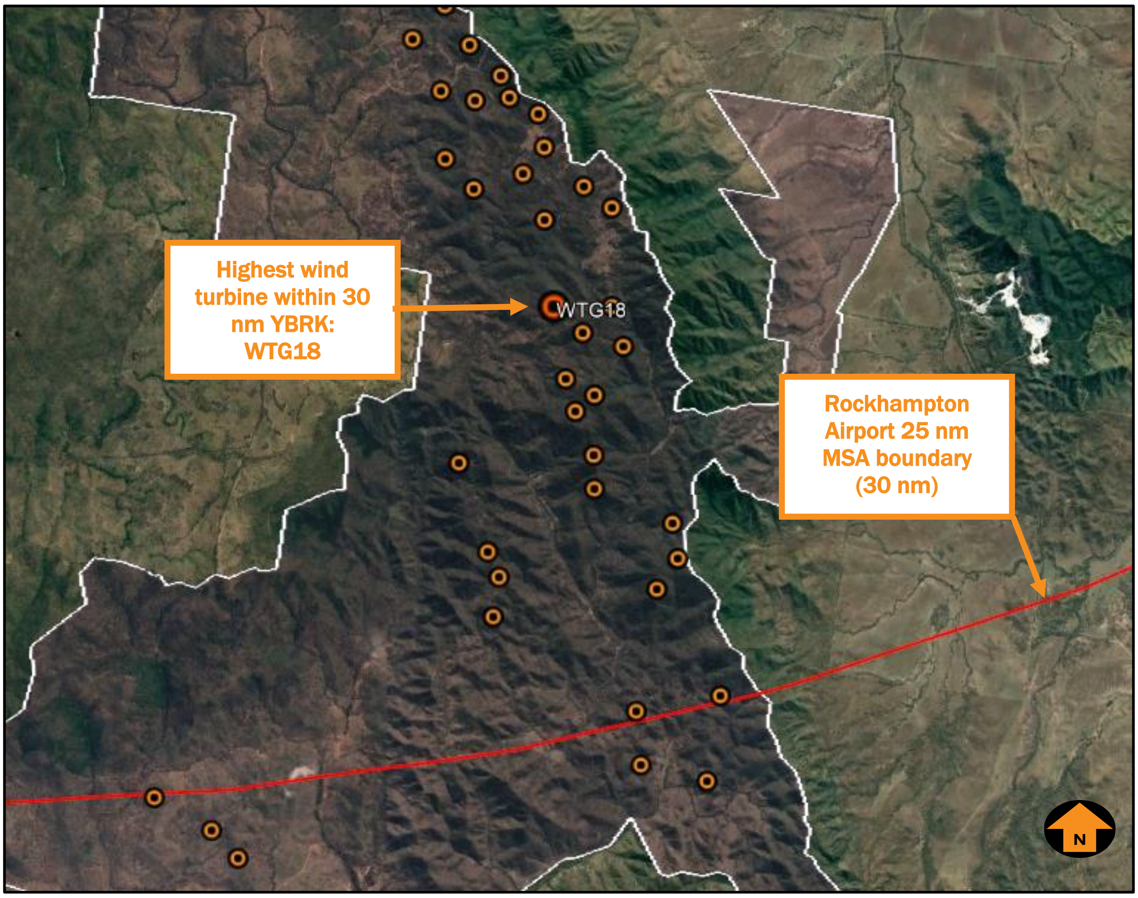

Figure 18 Highest WTG within 30 nm buffer area from Rockhampton Airport

6.6. Instrument flight procedures at Rockhampton Airport – impact analysis

A check of the AIP via OZ Runways shows that Rockhampton Airport is served by various ground and satellite-based non-precision instrument flight procedures for aircraft. These procedures, all designed by Airservices Australia, as published in AIP effective 05 November 2020, are listed in Table 4 (source: Airservices Australia).

Table 4 Instrument flight procedures at Rockhampton Airport

Procedure name	*Effective date*
AERODROME CHART PAGE 1	23-Mar-2023 (Am 174)
AERODROME CHART PAGE 2	1-Dec-2022 (Am 173)
APRON CHART	17-Jun-2021 (Am 167)
NOISE ABATEMENT PROCEDURE	30-May-2013 (Am 135)
SID ROCKHAMPTON THREE DEPARTURE(RADAR) RWY 15 & 33	1-Dec-2022 (Am 173)
SID BUDGI TWO DEP (RNAV)	1-Dec-2022 (Am 173)
SID TARES FOUR DEP (RNAV)	8-Sep-2022 (Am 172)
STAR ABVAS ONE ARR (RNAV)	1-Dec-2022 (Am 173)
STAR DADBO ONE ARR (RNAV)	1-Dec-2022 (Am 173)
DME OR GNSS ARRIVAL PAGE 1	1-Dec-2022 (Am 173)
DME OR GNSS ARRIVAL PAGE 2	1-Dec-2022 (Am 173)
VOR RWY 15	1-Dec-2022 (Am 173)
VOR RWY 33	1-Dec-2022 (Am 173)
NDB-A OR VOR-A	1-Dec-2022 (Am 173)
RNP RWY 15	1-Dec-2022 (Am 173)
RNP (GNSS) RWY 33	1-Dec-2022 (Am 173)

The RNP approach procedures have an initial approach altitude, minimum holding altitude and missed approach altitude of 3500 ft AMSL, based on the 25 nm MSA.

Similarly, the NDB-A or VOR-A, VOR RWY 15 and VOR RWY 33 procedures have a missed approach altitude of 3500 ft AMSL, based on the 25 nm MSA.

If the 25 nm MSA is increased as a result of the wind turbines, whether through sectorising or increasing the overall MSA, then there will be a consequential increase in the initial approach and/or missed approach altitudes of these procedures.

There will be no impact on other altitudes, including descent minima, of either of these procedures.

6.7. Air routes and LSALT

MOS 173 requires that a minimum obstacle clearance of 1000 ft above the highest terrain or obstacle is maintained along each air route.

The Project is solely located in the area with a grid lowest safe altitude of 1189 m AHD (3900 ft AMSL) with a protection surface of 884 m AHD (2900 ft AMSL).

The highest WTG has a maximum overall height of 828 m AHD (2716.5 ft AMSL) and is below the LSALT MOC of 2900 ft AMSL. Therefore, the Project will not affect the grid LSALT of 3900 ft AMSL.

Figure 19 shows the grid LSALT and air routes in the vicinity of the Project boundary (source: Neoen, OzRunways, ERC Low National, 13 August 2020).

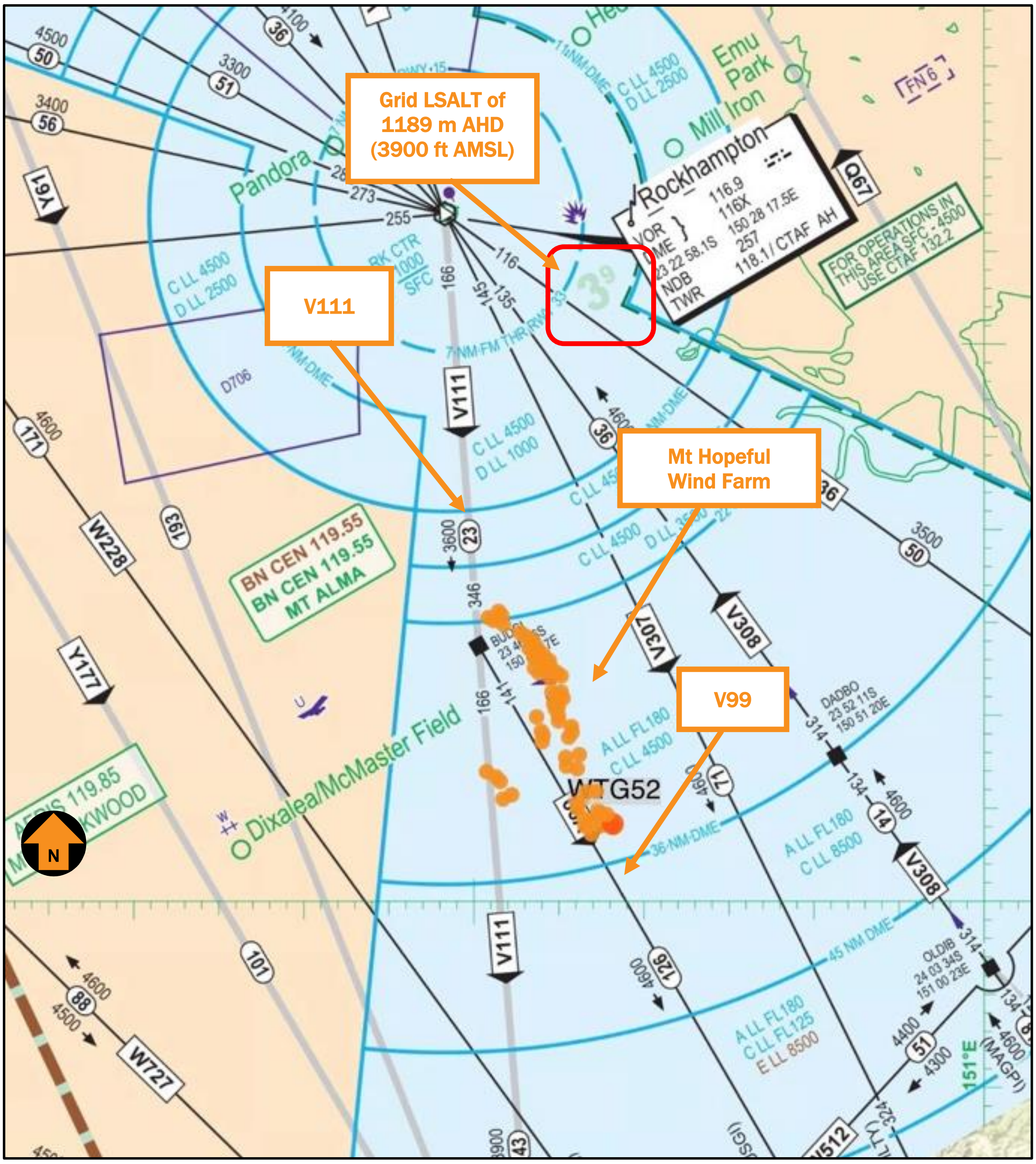

Figure 19 Air routes in the vicinity of the Project boundary

An impact analysis of the surrounding air routes is provided at Table 5.

Table 5 Air route impact analysis

Air route	Waypoint pair	Route LSALT	Protection Surface	Impact on airspace design	Potential solution	Impact on aircraft ops
V111	One way route - southbound Rockhampton to BUDGI	1189 m AHD 3900 ft AMSL	884 m AHD 2900 ft AMSL	Nil (below the controlling surface)	N/A	N/A
V111	BUDGI to Thangool	1097 m AHD 3900 ft AMSL	793 m AHD 2900 ft AMSL	Nil (below the controlling surface)	N/A	N/A
V99	One way route BUDGI to Gayndah	1402 m AHD 4600 ft AMSL	1097 m AHD 3600 ft AMSL	Nil (below the controlling surface)	N/A	N/A

The Project will not impact on air route or grid LSALT.

6.8. Nearby aircraft landing areas

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

A search on OzRunways, which sources its data from Airservices Australia (AIP), and website www.nationalmap.gov.au discovered a number of nearby non-regulated aerodromes within proximity of the project area. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

Figure 20 shows the location of nearby ALAs relative to the Project and a nominal 3 nm buffer from the ALAs (source: Neoen, Google Earth).

The closest ALA to the project area is an unknown aerodrome at a distance of 9.5 km (5.1 nm).

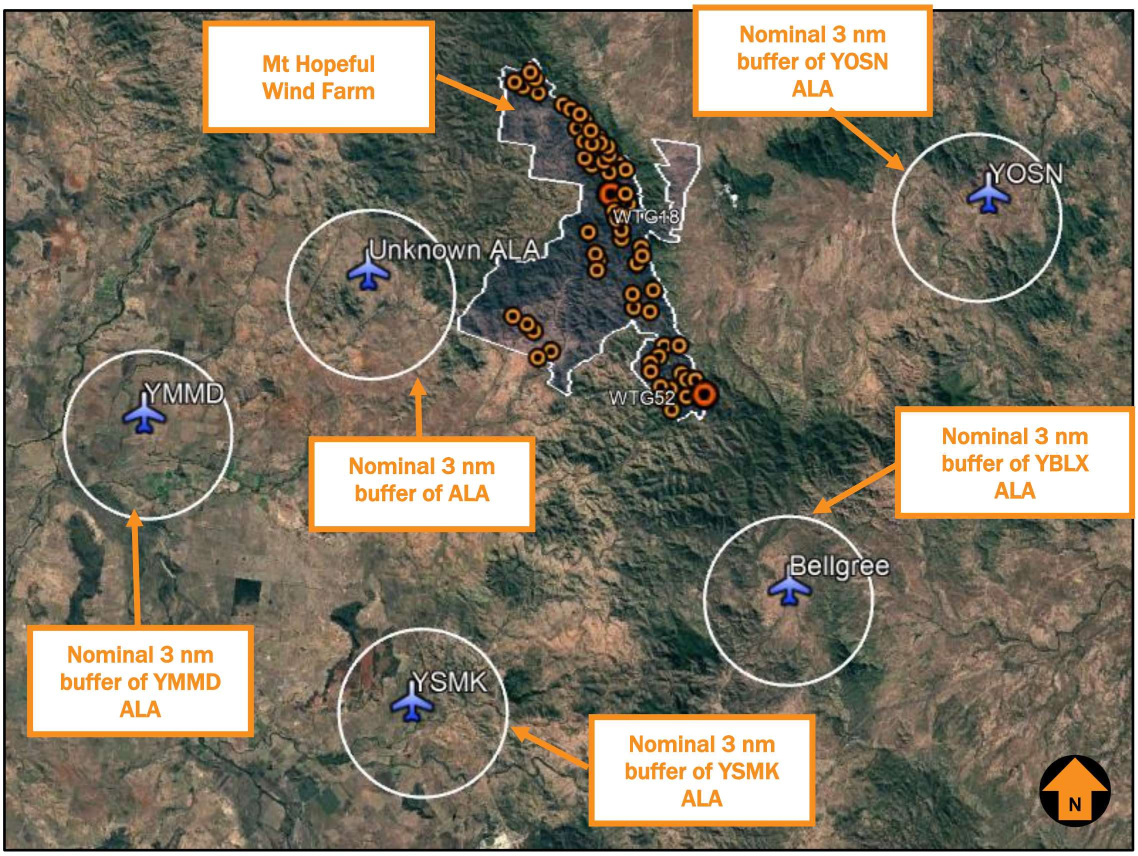

Figure 20 Project layout and the closest ALAs

Given that the closest ALA to the project area is the unknown aerodrome at a distance of 9.5km (5.1 nm), take-off and landing operations there will not be impacted.

6.9. Airspace

The project area is located outside controlled airspace (wholly within Class G airspace), within the horizontal extent but below Rockhampton Airport's controlled airspace (Class D airspace lower limit of 3500 ft AMSL).

6.10. Aviation facilities and Radar

A search was conducted of State Planning Policy (SPP) interactive mapping and SPP – state interest guideline Strategic airports and aviation facilities Appendix 5, to identify any aviation facilities that may be affected by the Project. With help of these online resources, the Mt Alma Route Surveillance Radar (RSR) has been identified. This facility has a 15 km Building restricted area surrounding it. The project area is located just outside this 15 km area as can be seen in Figure 21.

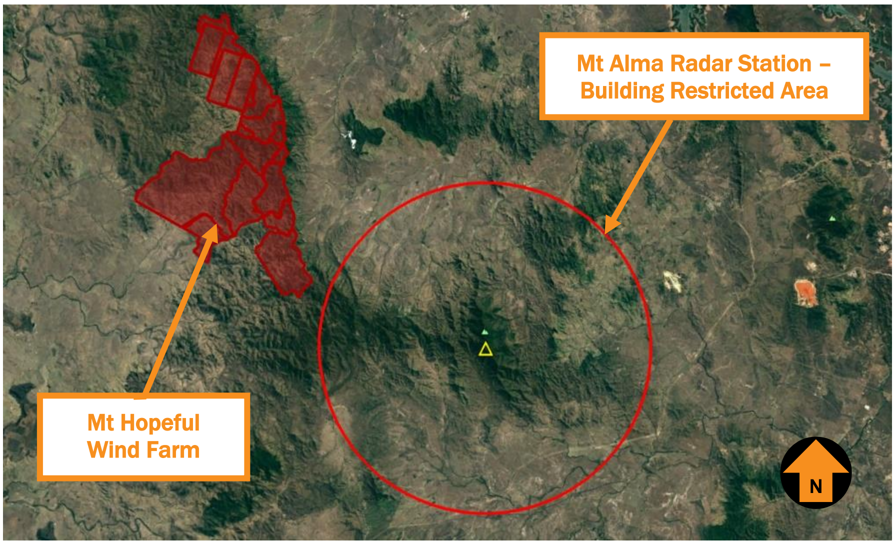

Figure 21 Mt Alma Radar Station – Building Restricted Area

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

Mt Alma (RSR) is located approximately 16.6 km (9 nm) south east of the closest WTG.

The EUROCONTROL guidelines state:

> *When further than 16 km from an SSR the impact of a wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.*

Therefore, it is unlikely that the Project will impact Mt Alma RSR.

6.11. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties in 2021. The extent of the Project does not change the responses in a significant way.

Airservices Australia will need to review this report to update their response due to the lower height of the WTGs, the infringements to the 25 nm MSA and the consequential changes required to holding pattern, missed approach and commencement altitude adjustments required.

Refer to Section 5 for details of the stakeholders and a summary of the consultation.

6.12. Summary

Based on the Project layout and overall turbine blade tip height limit of 260 m AGL, the blade tip elevation of the highest wind turbine, which is WTG 56, will not exceed 828 m AHD (2716.1 ft AMSL) and:

- will not infringe any OLS surfaces
- will infringe PANS-OPS associated with the 25 nm MSA and consequential impacts to approach commencement altitudes, missed approach final altitude and minimum holding altitudes
- may infringe Radar Terrain Clearance Chart surfaces
- will not have an impact on nearby designated air routes
- will not have an impact on the grid LSALT
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

Airservices Australia has previously advised that the wind farm will affect the Rockhampton RTCC. The extent of the impacts was not disclosed.

The list of wind turbines (obstacles), showing coordinates and elevation data that are applicable to this AIS, is provided in Annexure 3.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it has been concluded that aviation lighting is not required for WTGs and WMTs, but relevant lighting standards and guidelines are summarized in Annexure 5.

7.1. Wind monitoring towers

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

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

> *8.110 (5) As illustrated in Figure 8.110 (5), long, narrow structures like masts, poles and towers which are hazardous obstacles must be marked in contrasting colour bands so that:*
>
> *a) the darker colour is at the top; and the bands are, as far as physically possible, marked at right angles along the length of the long, narrow structure; and*
>
> *b) have a length ("z" in Figure 8.110 (5)) that is, approximately, the lesser of:*
>
> *A. 1/7 of the height of the structure; or*
>
> *B. 30 m.*

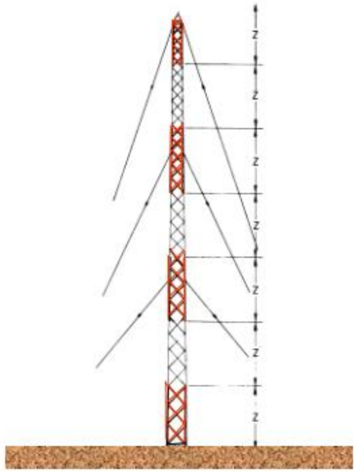

Figure 8.110 (5) Marking of mast, pole and tower (illustrates matters)

> *8.110 (7) Hazardous obstacles in the form of wires or cables must be marked using 3-dimensional coloured objects attached to the wire or cables.*
>
> *Note: Spheres and pyramids are examples of 3-dimensional objects. (8) The objects mentioned in subsection (7) must: be approximately equivalent*

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

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

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

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), including scheduled (RPT) and non-scheduled (charter) passenger and freight type. It may involve Australian civil (VH–) registered aircraft, or aircraft registered outside of Australia. General aviation/recreational encompasses:

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

8.2. ATSB occurrence taxonomy

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

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

8.3. National aviation occurrence statistics 2010-2019

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

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

Of the 326 fatalities recorded in the 10-year period, 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 6 (source: ATSB).

Table 6 Number of fatalities by GA sub-category – 2010 to 2019

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

Figure 22 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.

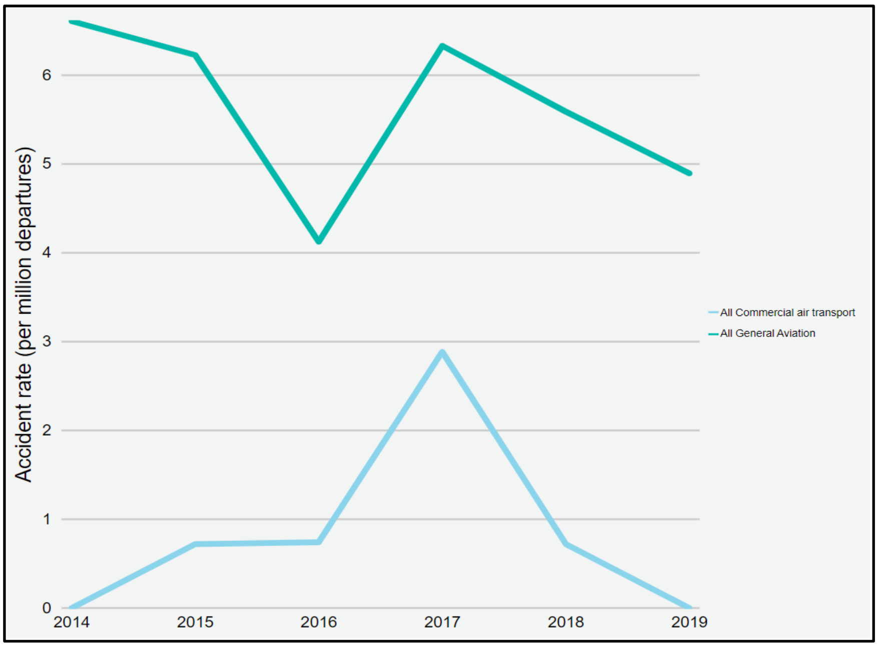

Figure 22 Fatal Accident Rate (per million departures) by Operation Type

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 7 (source: ATSB).

Table 7 Fatal accidents by GA sub-category – 2010 -2019

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

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

Over the 10-year period, no aircraft collided with a wind turbine or a wind monitoring tower.

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

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

8.4. Worldwide accidents involving wind farms

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

Based on the statistic of the Global Wind Energy Council (GWEC) report 2016, there were 341,320 wind turbines 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.

Of the four known accidents, one was caused by inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred overhead a wind farm, and the aircraft struck a wind turbine on its descent. This accident is not applicable to the circumstances under consideration.

There have been two accidents involving collision with a wind turbine during the day.

Only one of these (Melle, Germany 2017) resulted in a single fatality, as the result of a collision with a wind turbine steel lattice mast at a very low altitude during the day with good visibility and no cloud. If the mast was solid and painted white, then it more than likely would have been more visible than if it was equipped with an obstacle light.

In the other case (Plouguin, France, 2008), the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was in conditions of significantly reduced horizontal visibility in fog where the top of the turbine was obscured by cloud. The turbines became visible too late for avoidance manoeuvring and the aircraft made contact with two turbines. The aircraft was damaged but landed safely.

In both cases, is difficult to conclude that obstacle lighting would have prevented the accident.

The other fatal accident occurred at night in IMC and is not applicable to the circumstances under consideration.

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group, which suggests a Cessna 182 collided with a wind turbine near Baraboo, Wisconsin, on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area but suggests that the accident was caused by IFR flight into IMC encountered by the pilot and exceeding the design limits of the aircraft. A factor was flight to a destination alternate not performed by the pilot. No mention is made of wind turbines or a wind farm.

A summary of the four accidents is provided in Table 8.

Table 8 Summary of accidents involving collision with a wind turbine

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

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
2	The Piper PA-32R-300, N8700E, was destroyed during an impact with the blades of a wind turbine tower, at night in IMC. The wind turbine farm was not marked on either sectional chart covering the accident location; however, the pilot was reportedly aware of the presence of the wind farm.	27 Apr 2014	10 miles south of Highmore, South Dakota	4	Night IMC Low cloud and rain	420 ft AGL overall	Fitted but reportedly not operational on the wind turbine that was struck	The NTSB determined the probable cause(s) of this accident to be the pilot's decision to continue the flight into known deteriorating weather conditions at a low altitude and his subsequent failure to remain clear of an unlit wind turbine. Contributing to the accident was the inoperative obstruction light on the wind turbine, which prevented the pilot from visually identifying the wind turbine.	An operational obstacle light may have prevented the accident

3	Beechcraft B55 The pilot was attempting to remain in VMC by descending the aircraft through a break in the clouds. The pilot, distracted by trying to visually locate the aerodrome, flew into an area of known wind turbines. After sighting the turbines, he was unable to avoid them. The tip of the left wing struck the first turbine blade, followed by the tip of the right wing striking the second turbine. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plougin, France	0	Day VFR The weather in the area of the wind turbines had deteriorated to an overcast of stratus cloud, with a base between 100 ft to 350 ft and tops of 500 ft.	328 ft AGL hub height, 393 ft AGL overall	Not specified	This pilot reported having been distracted by a troubling personal matter which he had learned of before departing for the flight. The wind farm was annotated on aeronautical charts.	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	Turbine height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	VariEze N25063 The aircraft collided with a wind turbine following in-flight separation of the majority of the right canard and all of the right elevator	20 July 2001	Palm Springs, USA	2	Day VFR	N/A	N/A	The failure of the builder to balance the elevators per the kit manufacturer's instructions	Not applicable

9. RISK ASSESSMENT

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

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

9.1. Risk Identification

The primary risk being assessed is that of aviation safety associated with the proposed wind farm and WMTs.

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

1. potential for an aircraft to collide with a wind turbine, controlled flight into terrain (CFIT)
2. potential for an aircraft to collide with a wind monitoring tower (CFIT)
3. potential for a pilot to initiate manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in collision with terrain
4. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew
5. effect of obstacle lighting on neighbours.

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure and Regional Development, and in line with generally accepted practice, the risk to be assessed should primarily be associated with passenger transport services. The risk being assessed herein is primarily associated with smaller aircraft likely to be flying under the VFR, and so the maximum number of passengers exposed to the nominated consequences is likely to be limited.

A fifth identified risk event associated with WTGs and WMTs is the potential visual impact associated with obstacle lighting (if fitted) on surrounding residents.

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

9.2. Risk Analysis, Evaluation and Treatment

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

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

Table 9 Aircraft collision with wind turbine

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

Discussion

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

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

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

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

Refer to the discussion of worldwide accidents at Section 8.

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

The Project is clear of the OLS of any aerodrome.

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

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

Untreated Likelihood	Possible

Current Treatments (without lighting) • The Project is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 260 m (853 ft) AGL at the top of the blade tip. The rotor blade at its maximum height will be approximately 107.6 m (353 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines. • If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective. • Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The wind turbines are typically coloured white so they should be visible during the day. • The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Because the turbines are above 110 m AGL, there is a statutory requirement to report the towers to CASA.
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 - Unacceptable

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

Risk Decision	Unacceptable

Recommended Treatments The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Details of the Project should be communicated to local and regional aircraft operators prior to, during and following construction to heighten their awareness of its location and so that they can plan their operations accordingly. Specifically:

○ Provide the details to the Queensland Regional Airspace and Procedures Advisory Committee for consideration by its members in relation to VFR transit routes in the vicinity of the wind farm. ○ Engage with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, determining the best times for commencement of the local aerial agricultural operations or shutting down wind turbines altogether in bushfire emergencies requiring aerial firefighting operations within the project area. ○ Arrangements should be made to publish details of the wind farm in ERSA for surrounding aerodromes.	
Residual Risk With the additional recommended treatments, the likelihood of an aircraft collision with a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **as low as reasonably practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.**	
Residual Risk	7 - Tolerable

Table 10 Aircraft collision with wind monitoring tower

Risk ID:	2. Aircraft collision with a wind monitoring tower (CFIT)

Discussion

An aircraft collision with a WMT would result in harm to people and damage to property.

There is one existing WMT and 10 permanent WMTs are proposed as part of the Project.

The proposed WMTs will be of steel lattice construction with a maximum of 170 m (558 ft) AGL in height.

The towers will be installed at different locations around the project area.

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

The location of the proposed WMT locations and other applicable details will be advised to Airservices Australia.

There are only a few instances of aircraft colliding with a WMT, but they were all during the day with good visibility, and no instance was in Australia.

There is a relatively low rate of aircraft activity in the vicinity of the wind farm.

There are no known aerial agriculture operations conducted at night in the vicinity of the wind farm.

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

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

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There are a few occurrences of an aircraft colliding with a WMT, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none were in Australia. It is assessed that collision with a wind monitoring tower without obstacle lighting that would be effective in alerting the pilot to its presence is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments

- The WMT locations will be advised to CASA and Airservices Australia.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. The WMTs will be at a maximum height of 170 m (558 ft) AGL, which will be 17.8 m (58 ft) above the minimum height of 500 ft AGL for an aircraft flying at this height.

- In the event that descending cloud forces an aircraft lower than 152.4 m AGL (500 ft), the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of the tower.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).
- Aircraft authorised to intentionally fly below 152.4 m (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The towers will be constructed from grey steel.
- Since the towers will be higher than 110 m AGL, there is a statutory requirement to report them to CASA.

Level of Risk

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

Current Level of Risk	8 - Unacceptable

Risk Decision

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

Risk Decision	Unacceptable

Recommended Treatments

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

- Details of any WMTs when they are constructed should be advised to Airservices Australia.
- Consideration could be given to marking any wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings (as modified by the guidance in NASF Guideline D); specifically:
  8.10.2.6 Masts, poles and towers must be marked in contrasting bands with the darker colour at the top, as shown in Figure 8.10-3. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.
  8.10.2.8 Wires or cable obstacles must be marked using three-dimensional coloured objects such as spheres and pyramids, etc; of a size equivalent to a cube with 600 mm sides, spaced 30 m apart.
- Ensure details of any additional WMTs on the project area have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction.

Residual Risk With the additional recommended treatments, the likelihood of an aircraft colliding with a WMT resulting in multiple fatalities and damage beyond repair will be **Unlikely**. The consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision, given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. Only if a WMT exceeds 150 m AGL in height and is not in relatively close proximity to a wind turbine. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with the WMTs, without obstacle lighting on the WMT of the Project.**

Residual Risk	7 - Tolerable

Table 11 Harsh manoeuvring leading to controlled flight into terrain

<table>
<tr><td>*Risk ID:*</td><td colspan="2">3. Harsh manoeuvring leads to controlled flight into terrain (CFIT)</td></tr>
<tr><td colspan="3">

Discussion

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

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

The Project is clear of the OLS of any aerodrome.

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

The proposed turbines will be a maximum of 260 m (853 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 107.6 m (353 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).

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

If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.

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

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

Assumed risk treatments

- The wind turbines are typically coloured white so they should be visible during the day
- The ‘as constructed’ details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the turbines will be higher than 110 m AGL, there is a statutory requirement to report the turbines to CASA.

</td></tr>
<tr><td colspan="3">

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.

</td></tr>
<tr><td colspan="2" align="right">*Consequence*</td><td>Catastrophic</td></tr>
<tr><td colspan="3">

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day. It is assessed that a ground collision accident following manoeuvring to avoid a wind turbine is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

</td></tr>
<tr><td colspan="2" align="right">*Untreated Likelihood*</td><td>Possible</td></tr>
</table>

Current Treatments (without lighting) • The Project is clear of the OLS of any aerodrome. • Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. • The proposed turbines will be a maximum of 260 m (853 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 107.6 m (353 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines. • If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective. • Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night). • Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The wind turbines are typically coloured white, typical of most wind turbines operational in Australia, so they should be visible during the day. • The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the turbines will be higher than 110 m AGL, there is a statutory requirement to report the turbines to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.	
Current Level of Risk	8 – Unacceptable
Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments	

The following treatments which can be implemented at little cost will provide an acceptable level of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, Neoen may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for their safe operation within the project area.	
Residual Risk With the additional recommended treatments, the likelihood of ground collision resulting from manoeuvring to avoid a wind turbine resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 – Tolerable**. It is considered that the significant cost of obstacle lighting (which is not a preventative control), may only slightly reduce the likelihood of a collision given that the pilot is already in a highly undesirable situation (and not in all situations – such as where the obstacle light may be obscured by cloud) and hence is not justified. In the circumstances, the level of risk under the proposed treatment plan is considered **ALARP**. **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for ground collision resulting from manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project.**	
Residual Risk	7 - Tolerable

Table 12 Effect of Project on operating crew

Risk ID:	**4. Effect of the Project on operating crew**

Discussion

Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew.

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

Consequence

The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.

Consequence	Minor

Untreated Likelihood

The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project is clear of the OLS of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas.
- The proposed turbines will be a maximum of 260 m (853 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 107.6 m (353 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of wind turbines.
- If cloud descends below the turbine hub, obstacle lighting would be obscured and therefore ineffective.
- Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).

• Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities. • The wind turbines are typically coloured white so they should be visible during the day. • The 'as constructed' details of wind turbines are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts. • Since the turbines will be higher than 110 m AGL, there is a statutory requirement to report the turbines to CASA.	
Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Tolerable
Risk Decision A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.	
Risk Decision	Accept, conduct cost benefit analysis
Proposed Treatments Given the current treatments and the limited scale and scope of flying operations conducted within the vicinity of the Project, there is likely to be little additional safety benefit to be gained by installing obstacle lighting, other than if a WMT is not in relatively close proximity to a wind turbine. However, the following treatments, which can be implemented at little cost, will provide an additional margin of safety: • Ensure details of the Project have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators before, during and following construction. • Although there is no requirement to do so, Neoen may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures for such aircraft operations in the vicinity of the Project.	
Residual Risk Notwithstanding the current level of risk is considered **Tolerable**, the additional recommended treatments will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.** **It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the WTGs and WMTs of the Project.**	
Residual Risk	**5 - Tolerable**

Table 13 Effect of obstacle lighting on neighbours

Risk ID:	5. **Effect of obstacle lighting on neighbours**
Discussion This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm. Installation and operation of obstacle lighting on wind turbines or WMT can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions. If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: a) whether the object or structure will be a hazard to aircraft operations b) whether it requires an obstacle light that is essential for the safety of aircraft operations	
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 a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing: a) whether the object or structure will be a hazard to aircraft operations b) whether it requires an obstacle light that is essential for the safety of aircraft operations	
Level of Risk The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.	
Current Level of Risk	8 - Unacceptable

Risk Decision A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.	
Risk Decision	Unacceptable
Recommended Treatments Not installing obstacle lighting would completely remove the source of the impact. If lighting is required, there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including: • reducing the number of wind turbines equipped 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. There are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours. These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to those on the ground. Consideration may be given to activating the obstacle lighting via a pilot activated lighting system. An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.	
Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact. If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours. The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**. **It is our assessment that visual impact from obstacle lights can be negated if they are not installed.** If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.	
Residual Risk	7 - Tolerable

10. CONCLUSIONS

The results of this study are summarised as follows:

10.1. Project description

The Project will comprise the following:

- up to 63 wind turbines
- maximum overall height (tip height) of the wind turbines is up to 260 m AGL
- highest wind turbine is WTG52 with ground elevation of 568 m AHD and overall height of 828 m (2716.1 ft AMSL)
- 10 permanent WMTs with a maximum height of up to 170 m (558 ft) AGL, which will be reported to Airservices Australia once the final locations are confirmed prior to construction.

10.2. Regulatory requirements

The following regulatory requirements apply:

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

10.3. Planning considerations

The project satisfies performance and acceptable outcomes in Banana Planning Scheme regarding aircraft affected land as found in Table 5.2.2 Economic Resources Overlays.

The project satisfies performance and acceptable outcomes in Rockhampton Region Planning Scheme regarding operational airspace (obstacle limitation surface) as found in section 8.2.2.3 Specific benchmarks for assessment.

The Project as proposed satisfies the following Acceptable Outcomes of State Code 23:

Performance outcomes	*Acceptable outcomes - Compliance*
Aviation safety, integrity and efficiency	
PO1 The safety, operational integrity and efficiency of air services and aircraft operations are not adversely affected by the location, siting, design and operation of the development.	No acceptable outcome is prescribed
PO2 Development includes lighting and marking measures to ensure the safety, operational integrity and efficiency of air services and aircraft operations.	No acceptable outcome is prescribed

10.4. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties in 2021, refer to Section 5 for details of the stakeholders and a summary of the consultation.

Airservices Australia must be provided with this report to update their assessment and response, and to adjust the PANS-OPS surfaces to accommodate the Project.

10.5. Aviation Impact Statement

Based on the Project layout and overall turbine overall blade tip height limit of 260 m AGL, the blade tip elevation of the highest wind turbine, which is T086, will not exceed 1029 m AHD (3375 ft AMSL) and:

- will not infringe any OLS surfaces
- **will infringe PANS-OPS associated with the 25 nm MSA and consequential impacts to approach commencement altitudes, missed approach final altitude and minimum holding altitudes**
- **may infringe Radar Terrain Clearance Chart surfaces**
- will not have an impact on nearby designated air routes
- will not have an impact on the grid LSALT
- is wholly contained within Class G airspace
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

Airservices Australia advised that the wind farm will affect the Rockhampton RTCC. The extent of the impacts was not disclosed. An amendment to the RTCC sector to accommodate the Project is unlikely to have cause an adverse impact to aviation safety in the area.

10.6. Aircraft operator characteristics

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

Neoen may consider engaging with local aerial agricultural and aerial firefighting operators to develop procedures, which may include, for example, determining the best times for commencement of the local aerial agricultural operations or shutting down wind turbines altogether in bushfire emergencies requiring aerial firefighting operations within the project area.

Wind turbines are generally not a safety concern to aerial agricultural operators. WMTs remain the primary safety concern to aerial agricultural operators, who have expressed a general desire for these towers to be more visible.

The Project is located outside a nominal 3 nm buffer from all identified aircraft landing areas.

10.7. Hazard lighting and marking

The following conclusions apply to hazard marking and lighting:

- With respect to MOS 139 Chapter 8, Division 10, para 8.109, the proposed wind turbines and wind monitoring towers must be reported to CASA if they are considered a hazardous obstacle.
- Wind turbines and wind monitoring towers must be marked in accordance with respect to MOS 139 Chapter 8, Division 10, para 8.110.
- Wind turbines must be lit in accordance with MOS 139 Chapter 9, Division 4 9.3 and 9.31, unless an aeronautical study assesses they are of no operational significance.
- **Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.**
- CASA has advised that it will only review assessments referred to it by a planning authority or agency.
- With respect to marking of turbines, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- There will be 10 WMTs at a height of up to 170 m (538 ft) AGL. The proposed WMTs will be reported to Airservices Australia.
- Consideration should be given to marking any WMT according to the requirements set out in MOS 139 Section 8 Division 10 Obstacle Markings (as modified by the guidance in NASF Guideline D).

10.8. Summary of risks

A summary of the level of residual risk associated with the proposed Project with the Recommended Treatments implemented, is provided in Table 14.

Table 14 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Aircraft collision with wind monitoring tower	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Chapter 8 Division 10 Obstacle Markings, specifically 8.110 (5), (7) and (8). Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Effect on crew	Minor	Possible	5	Acceptable without obstacle lighting (ALARP). Communicate details of the Project to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes before, during and following construction.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

11. RECOMMENDATIONS

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

Notification and reporting

1. 'As constructed' details of WMT and 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.
   Although Airservices Australia has reviewed the previous wind farm, details of the revised wind farm must be provided to Airservices Australia, at this email address: airport.developments@airservicesaustralia.com prior to the construction of the wind farm. This will occur when approval to provide this AIA to Airservices Australia is provided.

2. 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 or not the structure will be hazardous to aircraft operations.
   The proponent is required to report the WMT to CASA in accordance with CASR 139.165, as soon as practicable after forming the intention to construct or erect the proposed object or structure.
   The notification should be provided to CASA via email to Airspace.Protection@casa.gov.au.

3. Department of Defence should be consulted again as there has been a subsequent modification in the wind turbine height or scale of development, using the following email address: land.planning@defence.gov.au

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

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

Operation

6. Whilst not a statutory requirement, Neoen should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project.

Marking of turbines

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

Lighting of turbines

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

Marking of wind monitoring towers

9. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Chapter 8, Division 10, (as modified by the guidance in NASF Guideline D). Specifically:

    a. marker balls or high visibility flags or high visibility sleeves should be placed on the outside guy wires; and

    b. guy wire ground attachment points should be in contrasting colours to the surrounding ground/vegetation; and

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

Micrositing

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

Triggers for review

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

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

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

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

ANNEXURES

1. References
2. Definitions
3. Turbine coordinates and heights
4. Risk Assessment Framework
5. CASA Regulatory Requirements – Lighting and Marking

ANNEXURE 1 – REFERENCES

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

- Airservices Australia
  - Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 23 March 2023
  - AIP Designated Airspace Handbook, effective 1 December 2022
- Civil Aviation Safety Authority
  - Civil Aviation Regulations 1998 (CAR)
  - Civil Aviation Safety Regulations 1998 (CASR)
  - *Civil Aviation Advisory Circular (AC) 91-10 v1.1, Operations in the vicinity of non-controlled aerodromes*
  - *Advisory Circular (AC) 139-08 v2.0: Reporting of Tall Structures*, dated March 2018
  - *Manual of Standards CASR Part 173 – Standards Applicable to Instrument Flight Procedure Design*, version 1.7, dated August 2020
  - *Manual of Standards CASR Part 139 (Aerodromes) Manual of Standards 2019*, dated 5 September 2019
- Commonwealth Department of Infrastructure Transport, Regional Development, Communication and the Arts: National Airport Safeguarding Framework, Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (WindFarms) /Wind Monitoring Towers,* dated July 2012
- Department of State Development, Infrastructure and Planning, QLD State Government, Development Assessment mapping system and State Planning Policy Planning interactive mapping system
- Department of State Development, Infrastructure and Planning, QLD State Government, State Development Assessment Provisions (SDAP), State Code 23: Wind Farm Development and State Code 23: Wind farm development Planning Guideline (June 2018), SDAP version 3, date of commencement 18 February 2022
- 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 5 November 2020
- 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)	Framework has the objective of developing a consistent and effective national framework to safeguard both airports and communities from inappropriate on and off airport developments.

Term	*Definition*
Obstacles	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Runway strip	A defined area including the runway and stopway, if provided, intended: a. to reduce the risk of damage to aircraft running off a runway b. to protect aircraft flying over it during take-off or landing operations.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.

ANNEXURE 3 – TURBINE COORDINATES AND HEIGHTS

Source: Neoen, Mt Hopeful Wind Farm – Project Layout:

- 230125_Umwelt_TWilliamson_DesignData_Transfer (1).zip
  - DESIGN_Umwelt_Turbines_221102_GDA94z56.shp
  - DESIGN_Umwelt_PermanentMetMasts_221128_GDA9456.shp

WTG Coordinates			Approx Elevation (m)	WTG Height (m AGL)	WTG Max Height (m AHD)	WTG Max Height (ft AMSL)	Notes
WTG Ref	Easting (m)	Northing (m)					
WTG 01	247250.0	7371525.0	525.0	260.0	785.0	2575.5	
WTG 02	248260.0	7371125.0	455.0	260.0	715.0	2345.8	
WTG 03	249930.0	7370355.0	460.0	260.0	720.0	2362.2	
WTG 04	250420.0	7370050.0	480.0	260.0	740.0	2427.8	
WTG 05	251030.0	7369720.0	495.0	260.0	755.0	2477.0	
WTG 06	251360.0	7369350.0	445.0	260.0	705.0	2313.0	
WTG 07	250850.0	7368800.0	468.0	260.0	728.0	2388.5	
WTG 08	251770.0	7368690.0	512.0	260.0	772.0	2532.8	
WTG 09	252280.0	7368220.0	502.0	260.0	762.0	2500.0	
WTG 10	251870.0	7367780.0	513.0	260.0	773.0	2536.1	
WTG 11	252890.0	7367610.0	483.0	260.0	743.0	2437.7	
WTG 12	251408.0	7366866.0	515.0	260.0	775.0	2542.7	
WTG 13	251875.0	7366390.0	540.0	260.0	800.0	2624.7	
WTG 14	252990.0	7367060.0	472.0	260.0	732.0	2401.6	
WTG 15	253640.0	7366460.0	505.0	260.0	765.0	2509.8	
WTG 16	253020.0	7365920.0	495.0	260.0	755.0	2477.0	
WTG 17	254100.0	7366140.0	492.0	260.0	752.0	2467.2	
WTG 18	253200.0	7364540.0	545.0	260.0	805.0	2641.1	YBRK 25 nm MSA
WTG 19	253660.0	7364120.0	533.0	260.0	793.0	2601.7	

WTG 20	254320.0	7363920.0	512.0	260.0	772.0	2532.8	
WTG 21	253400.0	7363380.0	532.0	260.0	792.0	2598.4	
WTG 22	253880.0	7362180.0	495.0	260.0	755.0	2477.0	
WTG 23	253910.0	7361650.0	495.0	260.0	755.0	2477.0	
WTG 24	251710.0	7362020.0	495.0	260.0	755.0	2477.0	
WTG 25	252200.0	7360600.0	430.0	260.0	690.0	2263.8	
WTG 26	252390.0	7360200.0	410.0	260.0	670.0	2198.2	
WTG 27	252310.0	7359560.0	412.0	260.0	672.0	2204.7	
WTG 28	255200.0	7361120.0	395.0	260.0	655.0	2149.0	
WTG 29	255280.0	7360550.0	487.0	260.0	747.0	2450.8	
WTG 30	254950.0	7360050.0	490.0	260.0	750.0	2460.6	
WTG 31	254680.0	7358060.0	360.0	260.0	620.0	2034.1	
WTG 32	256040.0	7358340.0	348.0	260.0	608.0	1994.8	
WTG 33	254780.0	7357180.0	310.0	260.0	570.0	1870.1	
WTG 34	255860.0	7356940.0	340.0	260.0	600.0	1968.5	
WTG 35	246800.0	7356500.0	305.0	260.0	565.0	1853.7	
WTG 36	247760.0	7355990.0	320.0	260.0	580.0	1902.9	
WTG 37	248200.0	7355540.0	310.0	260.0	570.0	1870.1	
WTG 38	249360.0	7354240.0	300.0	260.0	560.0	1837.3	
WTG 39	248500.0	7353800.0	335.0	260.0	595.0	1952.1	
WTG 40	256820.0	7354680.0	385.0	260.0	645.0	2116.1	
WTG 41	257810.0	7354720.0	362.0	260.0	622.0	2040.7	
WTG 42	256480.0	7353980.0	365.0	260.0	625.0	2050.5	
WTG 43	255940.0	7353550.0	388.0	260.0	648.0	2126.0	
WTG 44	255960.0	7353000.0	416.0	260.0	676.0	2217.8	
WTG 45	256620.0	7352000.0	451.0	260.0	711.0	2332.7	
WTG 46	257270.0	7351840.0	445.0	260.0	705.0	2313.0	
WTG 47	256720.0	7351280.0	460.0	260.0	720.0	2362.2	
WTG 48	257380.0	7350480.0	494.0	260.0	754.0	2473.8	
WTG 49	257980.0	7352870.0	485.0	260.0	745.0	2444.2	

WTG 50	258310.0	7352490.0	520.0	260.0	780.0	2559.1	
WTG 51	258880.0	7352460.0	560.0	260.0	820.0	2690.3	
WTG 52	259540.0	7351560.0	568.0	260.0	828.0	2716.5	Highest WTG
WTG 53	259520.0	7351180.0	542.0	260.0	802.0	2631.2	
WTG 54	258340.0	7351360.0	450.0	260.0	710.0	2329.4	
WTGA01	246700.0	7371800.0	490.0	260.0	750.0	2460.6	
WTGA02	247720.0	7372440.0	545.0	260.0	805.0	2641.1	
WTGA03	248050.0	7372060.0	557.0	260.0	817.0	2680.4	
WTGA04	251320.0	7367950.0	485.0	260.0	745.0	2444.2	
WTGA05	252420.0	7367840.0	535.0	260.0	795.0	2608.3	
WTGA07	252660.0	7366640.0	503.0	260.0	763.0	2503.3	
WTGA08	254120.0	7364540.0	520.0	260.0	780.0	2559.1	
WTGA09	253860.0	7363120.0	565.0	260.0	825.0	2706.7	
WTGA10	253560.0	7362860.0	510.0	260.0	770.0	2526.2	
MET1	247135.8	7371729	506.9	170.0	676.9	2220.7	
MET2	248711.1	7370983	445.4	170.0	615.4	2018.9	
MET3	250701	7369998	469.0	170.0	639.0	2096.4	
MET4	251274.6	7368796	460.4	170.0	630.4	2068.1	
MET5	253934.3	7366726	515.2	170.0	685.2	2248.0	
MET6	253084.5	7366549	488.9	170.0	658.9	2161.8	
MET7	254097.2	7362830	519.6	170.0	689.6	2262.4	
MET8	259231	7352130	535.2	170.0	705.2	2313.8	
MET9	259856	7351524	553.7	170.0	723.7	2374.3	
MET10	258804.5	7351379	457.5	170.0	627.5	2058.7	

ANNEXURE 4 – RISK ASSESSMENT FRAMEWORK

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

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

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

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

Likelihood

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

Table 1 Likelihood Descriptors

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

Consequence

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

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

Table 2 Consequence Descriptors

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

Risk matrix

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

Table 3 Risk Matrix

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

Actions required

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

Table 4 Actions Required

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

ANNEXURE 5 – CASA REGULATORY REQUIREMENTS - LIGHTING

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

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

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

In areas remote from an aerodrome, CASR 139.365 requires the owner of a structure (or proponents of a structure) that will be 110 m or more above ground level to inform CASA. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether or not the structure will be hazardous to aircraft operations.

Manual of Standards Part 139—Aerodromes

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

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

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

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

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

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

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

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

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

6. *High-intensity obstacle lights:*

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

   b. *must be flashing white lights.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    c. *provided at lower levels to indicate the full height of the structure; and* *d. spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.*

Advisory Circular 139-08 v2—Reporting of Tall Structures

In Advisory Circular (AC) 139-08 v2—*Reporting of Tall Structures*, CASA provides guidance to those authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

Airservices Australia has been assigned the task of maintaining a database of tall structures, the top measurement of which is:

a) 30 metres or more above ground level—within 30 kilometres of an aerodrome; or

b) 45 metres or more above ground level elsewhere.

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

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

International Civil Aviation Organisation

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

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

6.2.4 Wind turbines

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

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

Note 2. — See 4.3.1 and 4.3.2

Markings

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

Lighting

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

a) to identify the perimeter of the wind farm;

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

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

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and

e) at locations prescribed in a), b) and d), respecting the following criteria:

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

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

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

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

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

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

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

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

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

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and *a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and*

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

Section 4.3 Objects outside the OLS states the following:

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

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

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

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

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

Light characteristics

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

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

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

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

1. *Low-intensity obstacle lights must have the following:*
   - a. *fixed lights showing red;*
   - b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*
   - c. *a minimum intensity of 100 candela (cd);*
   - d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*
   - e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*

f. *not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.*

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

2. *To indicate the following:*

   a. *taxiway obstacles;*

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

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

1. *Medium-intensity obstacle lights must:*

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

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

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

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

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

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

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

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

Visual impact of night lighting

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

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

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness

- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
  - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal
  - 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
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall turbine.

Marking of turbines

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

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

Wind monitoring towers

The details of the WMTs were introduced in Section 0 of this report.

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

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

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

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

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

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

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M 0417 631 681 **P** 07 3371 0788 **F** 07 3371 0799 **E** enquiries@aviationprojects.com.au
19/200 Moggill Road, Taringa Qld 4068 **POST** PO Box 116, Toowong DC, Toowong Qld 4066

aviationprojects.com.au