DECEMBER 2015

AERONAUTICAL IMPACT ASSESSMENT

RYAN CORNER WIND FARM

Prepared for Ryan Corner Development Pty Ltd

AVIATION PROJECTS

AVIATION PROJECTS

DOCUMENT CONTROL

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Revision History

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1.0	Release	20 September 2011	Keith Tonkin	
1.1	Increased turbine height to 150 m AGL	16 October 2014		
1.2	Increased turbine height to 180 m AGL	8 September 2015	Union Fenosa	30 September 2015
1.3	Final Draft for Consultation	13 October 2015	Union Fenosa	
2.0	Release	23 December 2015		

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AGL	above ground level
AIP	Aeronautical Information Package
ALARP	as low as reasonably practicable
AMSL	above mean sea level
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
EES	Environment Effects Statement
ERSA	En Route Supplement Australia
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
MOS	Manual of Standards
MSA	minimum sector altitude
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
Project	Ryan Corner Wind Farm
Proponent	Ryan Corner Development Pty Ltd
RPT	regular public transport
VFR	visual flight rules
VMC	visual meteorological conditions

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)

EXECUTIVE SUMMARY

Introduction

The Ryan Corner Wind Farm (the Project) site is located approximately 10 km north west of Port Fairy in Victoria. This report has been prepared in relation to a proposed amendment for the Project. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines, and realigned access tracks. This report assesses the potential net impacts as a result of the proposed amendment.

The Project received planning approval in 2008. On 21 August 2008, Planning Permit No. 20060222 was issued for the Project for the 'Use and development of land for a Wind Energy Facility'. Condition 3 of the permit details the specifications of the Project, including the number and scale of the turbines. The permit originally specified the tower height of the wind turbines at 78 m, with an overall blade tip height of 121.5 m above natural ground level. On 12 August 2010, the Minister for Planning approved a minor amendment to the specifications of the wind turbines for the Project to allow a tower height of 80 m and overall blade tip height of 126.3 m above natural ground level.

Approval is now sought to further vary the turbine specifications as detailed on the permit. It is proposed to increase the tower height to 117 m, the rotor diameter to 130 m, and overall blade tip height to 180 m. This amendment would result in an overall increase in height of 53.7 m from natural ground level. In addition, it is proposed to microsite a number of turbines and realign access tracks and ultimately, reduce the number of turbines on the Project site from the approved 68 to 56 turbines.

Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and number of turbines on the Project.

Ryan Corner Development Pty Ltd (the Proponent) has engaged Aviation Projects to conduct an aeronautical impact assessment with respect to the proposed amendments.

Context

The following aspects were considered in the external context:

- Stakeholders;
- Department of Environment, Land, Water and Planning;
- Environment Protection and Heritage Council;
- Civil Aviation Safety Authority;
- International Civil Aviation Organization;
- Aviation Impact Statement;
- Nearby aerodromes;
- Aircraft operator characteristics;
- Light characteristics;

- Visual impact of night lighting;
- Marking of turbines;
- Marking of wind monitoring towers;
- Marking of power lines;
- Conclusions of EES Section 18 - Aviation Safety Assessment;
- Future regulatory requirements and guidance; and
- Comparative analysis.

The following aspects were considered in the internal context:

- Project description;
- Wind turbine description;
- Wind monitoring tower description; and
- Turbine lighting design.

Conclusions

As a result of the foregoing risk assessment, the following conclusions are drawn:

Consultation

- An appropriate and justified level of consultation was undertaken with the following parties:
  - Aerial Agricultural Association of Australia;
  - Air Ambulance Victoria;
  - Airservices Australia;
  - Civil Aviation Safety Authority;
  - Country Fire Authority Victoria;
  - Department of Defence;
  - Operators of non-regulated aerodromes within the vicinity of the Project;
  - Royal Flying Doctor Service;
  - Glenelg Shire Council;
  - Warrnambool City Council; and
  - Other stakeholders where noted.

Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft) that are not within the vicinity of an aerodrome.
- With respect to MOS 139 7.1.5.1, the proposed wind turbines and wind monitoring towers must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines must be regarded as obstacles if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.

Aviation Impact Statement

- The Aviation Impact Statement made the following conclusions:

  In summary, the Aviation Impact Statement has determined that:

  1) The blade tip elevation of the highest WTG will not exceed 224 m (735 ft) AHD and as such:

  - *Will not penetrate any OLS surfaces;*
  - *Will not penetrate any PAN-OPS surfaces;*
  - *Will not have an impact on nearby designated air routes;*
  - *Will not have an impact on prescribed airspace;*
  - *Is wholly contained within Class G airspace; and*
  - *Will not have an impact on existing local aviation activities.*

  2) The WTGs are located outside the clearance zones associated with aviation navigation aids and communication facilities.

  3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

  4) The wind farm is sufficiently distant from airfields to not have an impact on contingency procedures and engine inoperative flight paths.

  The development is considered approvable in accordance with the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

- Airservices has determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities.

- The RNAV-Z (GNSS) RWY 13 procedure at Warrnambool Airport was not designed by Airservices Australia and was not considered in its assessment. However, it was determined by IDS Australasia Pty Ltd, a CASR Part 173 certified instrument flight procedure designer, that the RNAV-Z (GNSS) RWY 13 procedure will not be impacted by Ryan Corner Wind Farm. An extract of the analysis by IDS is copied below:

  > *RNAV-Z (GNSS) RWY 13 Procedure*
  >
  > *The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the east of the wind farm and protection surfaces are not impacted.*

- Based on the information provided by Airservices Australia and IDS Australasia, it can be concluded that the Project will not have an impact on airspace procedures or communication, navigation and surveillance (CNS) facilities.

Nearby aerodromes

- The impacts at nearby aerodromes are addressed in the AIS.
- The Project will have no impact on the Warrnambool Regional Airport operations due to mechanical turbulence.
- The Project will have no impact on the Portland Airport.

Aircraft operator characteristics

- Based on input during consultation activities, the Project will result in a reduced net impact on aerial agricultural operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.
- No net impact will result from the Project on the operation of Country Fire Authority's (CFA) operation. It would be beneficial to develop procedures to stop turbines blades from rotating before CFA begins aerial firefighting operations within the Project area.
- No issues are anticipated with the Project on Air Ambulance Victoria's rotary wing operations.

Comparative analysis

- There are no operational wind farms in Victoria that have obstacle illuminated. Wind farms at Macarthur, Oaklands Hill and Waubra have obstacle lighting installed; however, the operators have been authorised to have them turned off.

Project description

- The proposed amendment will result in the following changes:
  - 56 wind turbines – decreased by 12 from the approved 68 wind turbines;
  - Maximum blade tip height of 180 m AGL (591 ft) – increased by 53.7 m from 126.3 ft AGL;
  - Maximum ground elevation of 44 m AHD (144 ft AMSL) – increased by 2 m from 42 due to micrositing; and

  - Maximum blade tip height of 224 AHD (735 ft AMSL) – increased by 55.7 m from 170.3 m AHD (559 ft AMSL).

- The existing wind monitoring towers at the Project site are 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- A hub height wind monitoring tower (up to a height of 117 m AGL) may be erected for turbine power curve verification within the project boundary.

Obstacle lighting and marking

- Aviation Projects has assessed 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.
- If lighting is required, the lighting design herein is subject to confirmation of the final turbine layout as any changes proposed could potentially affect which turbines should be lit in accordance with the 900 m interval consideration.
- CASA advised that it considers the Project to be a hazard to aviation safety, but the risks to aircraft safety would be mitigated by the provision of approved lighting. CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139 (characteristics for low intensity area stated in subsection 9.4.7). CASA agrees that the turbines that should be lit are identified in the drawing 'Ryan Corner Wind Farm Obstacle Lighting Design v1.1, (9 October 2015).
- A summary of design characteristics for obstacle lighting acceptable by CASA, if required, is provided below:
  - two steady red low intensity obstacle lights should be provided;
  - the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction; and
  - the characteristics of the obstacle lights should be in accordance with the applicable standards in MOS 139.
- To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program will need to be established in accordance with the guidance in MOS 139 Section 9.4.10.
- With respect to marking of turbines, it is generally accepted that, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- With respect to marking of wind monitoring towers, they will be lower than, and are likely to be within 400 m of, a turbine and are therefore not likely to require obstacle marking or lighting.
- Department of Defence advised it has no concerns with the Project subject to the following requests being met:

1) Clearance is sought from Airservices Australia and CASA and any conditions from these agencies are adhered to;

2) 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.

3) If LED obstruction lighting is to be provided to the wind turbines, the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres. This will enable the lighting to be visible to persons using night vision devices; and

4) Defence is consulted should there be any subsequent modification in the wind turbine height or scale of development.

Risk assessment

- A summary of the level of risk associated with the Project under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table E 1.

Table E 1 Risk assessment summary

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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 monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Communicate details of the wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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. 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	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permit Conditions.

Recommendations

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.
2. Department of Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development.
3. 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:
    - The planned operational timeframe and maximum height of the crane; and
    - Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. The Proponent should engage with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. Procedures may include stopping the rotation of the wind turbine rotor blades prior to the commencement of the aircraft operations within relevant areas.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, off-white or a light grey colour.

Lighting of turbines

6. With respect to Conditions 8 and 9 of Planning Permit 20060222, Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
7. If obstacle lighting is required (for example, as a requirement of CASA), obstacle lighting should be installed on the following 23 turbines (without the 'B' as the identification prefix): 6, 8, 10, 14, 18, 21, 28, 30, 31, 35, 37, 40, 43, 44, 45, 48, 54, 62, 64, 66, 69, 70 and 74.
8. If obstacle lighting is required (for example, as a requirement of CASA), the wind turbines should be lit with steady red low intensity lighting at night as per MOS 139 Section 9.4, while minimising visual impact. To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.
9. Department of Defence requested that if LED lighting is used for obstacle lighting, then emitted light should fall within the wavelength range of 655 to 930 nanometres for night vision devices compatibility.
10. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

11. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

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; and

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

1. INTRODUCTION

1.1. Situation

The Ryan Corner Wind Farm (the Project) site is located approximately 10 km north west of Port Fairy in Victoria. This report has been prepared in relation to a proposed amendment for the Project. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines, and realigned access tracks. This report assesses the potential net impacts as a result of the proposed amendment.

The Project received planning approval in 2008. On 21 August 2008, Planning Permit No. 20060222 was issued for the Project for the 'Use and development of land for a Wind Energy Facility'. Condition 3 of the permit details the specifications of the Project, including the number and scale of the turbines. The permit originally specified the tower height of the wind turbines at 78 m, with an overall blade tip height of 121.5 m above natural ground level. On 12 August 2010, the Minister for Planning approved a minor amendment to the specifications of the wind turbines for the Project to allow a tower height of 80 m and overall blade tip height of 126.3 m above natural ground level.

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Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and number of turbines on the Project.

Ryan Corner Development Pty Ltd (the Proponent) has engaged Aviation Projects to conduct an aeronautical impact assessment with respect to the proposed amendments.

1.2. Purpose of task

The purpose of this engagement is to consider the impacts to aviation safety arising from the proposed amendments to the existing approval, including the need for obstacle lighting for the Project so that the Proponent can make an informed decision about whether or not to install obstacle lighting, in due consideration of regulatory requirements, acceptable levels of aviation safety and community concerns about the visual impact of obstacle lighting.

1.3. Scope

The scope of the task is to consider the impacts to aviation safety arising from the proposed amendments to the existing approval, including whether obstacle lighting of the wind turbines of the approved Project will be required to maintain an acceptable level of aviation safety. The risk assessment is to be conducted using the methodology outlined in AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines*.

1.4. Report structure

This report is structured around the following areas of consideration:

- external context;
- internal context;
- risk assessment;
- conclusions; and
- recommendations.

1.5. Methodology

In undertaking this task, the following activities were undertaken:

- current approvals, permits and associated planning material were reviewed to identify obstacle lighting issues;
- the current regulatory context was reviewed;
- a site visit was conducted on 31 July 2011;
- a comparative analysis of the obstacle lighting situation for Victorian wind farms was conducted;
- online resources were investigated for aircraft accidents/incidents associated with wind farms;
- current aviation activities within the vicinity of the Project were investigated;
- applicable stakeholders, including CASA were consulted;
- an Aviation Impact Statement was prepared in accordance with guidance provided by Airservices Australia; and
- the levels of risk associated with aviation activities conducted within the vicinity of the Project site were assessed, including a review of current and planned treatments and consideration of the effect that turbines with or without obstacle lighting will have on the overall level of risk to aviation safety.

1.6. Stakeholders

Stakeholders considered and/or consulted in the preparation of this report include:

- Aerial Agricultural Association of Australia;
- Air Ambulance Victoria;
- Airservices Australia;
- Civil Aviation Safety Authority;
- Country Fire Authority Victoria;
- Department of Defence;
- Glenelg Shire Council;
- Operators of non-regulated aerodromes within the vicinity of the Project;
- Royal Flying Doctor Service;
- Warrnambool City Council; and
- Other stakeholders where noted.

1.7. Client material

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

- Email from Union Fenosa Wind Australia, dated 5 September 2014;
- Email from Union Fenosa Wind Australia, with revised wind turbine layout data attached, dated 9 July 2015;
- Email from Union Fenosa Wind Australia, with attached revised wind monitoring tower data, dated 27 August 2015;
- Letter from CASA, dated 4 December 2015;
- Letter from CASA, dated 17 August 2006;
- Letter from Defence, dated 16 December 2015;
- Letter from Department of Planning and Community Development, *Ryan Corner Wind Energy Facility Environment Effects Statement, Moyne Planning Permit Application 20060222, Moyne Native Vegetation Removal Application pl07/067, Inquiry Directions – Aviation Lighting*, dated 1 October 2007.
- Letter from Department of Planning and Community Development, *Hawkesdale and Ryan Corner Wind Farm Projects Amendment to Turbine Specifications*, dated 12 August 2010;
- Ryan Corner Environment Effects Statement Section 18 – *Aircraft Safety Assessment*, dated 13 October 2006;

- Ryan Corner Permit No 20060222 dated 21 August 2008;
- *Ryan Corner Wind Farm Development Plan*, drawing number RCWF-DP-01-v002, dated 9 December 2011; and
- The Ambidji Group Pty Ltd, *Ryan Corner Wind Farm Evaluation of Lighting Requirements*, Rev A dated 25 October 2007.

1.8. References

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

- Aeronautical Information Package; including AIP Book effective 12 November 2015, and En Route Supplement Australia dated 12 November 2015;
- Civil Aviation Safety Authority, *Civil Aviation Regulations 1988 (CAR)*, as amended;
- Civil Aviation Safety Authority, *Civil Aviation Safety Regulations 1998* (CASR), compilation number: 65, dated 1 September 2015;
- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.12, dated 13 November 2014;
- Civil Aviation Safety Authority, email from Mr Byron Sullivan re Obstacle marking and lighting of wind farms – status update, 15 July 2011;
- Department of Infrastructure and Regional Development, *The National Airports Safeguarding Framework: Guideline D,* dated 15 July 2012;
- Environment Protection and Heritage Council, *National Wind Farm Development Guidelines DRAFT*, dated July 2010;
- International Civil Aviation Organization (ICAO) Doc 8168 *Procedures for Air Navigation Services—Aircraft Operations* (PANS-OPS);
- ICAO Standards and Recommended Practices, *Annex 14—Aerodromes*;
- Victoria Department of Planning and Community Development, *Policy and planning guidelines for development of wind energy facilities in Victoria*, dated August 2011; and
- other references as noted.

2. EXTERNAL CONTEXT

2.1. Consultation

Details and results of the consultation activities are provided in Table 1. The following stakeholders were consulted.

- Aerial Agricultural Association of Australia;
- Air Ambulance Victoria;
- Airservices Australia;
- Civil Aviation Safety Authority;
- Country Fire Authority Victoria;
- Department of Defence;
- Operators of non-regulated aerodromes within the vicinity of the Project;
- Royal Flying Doctor Service;
- Shire of Glenelg;
- Warrnambool City Council; and
- Other stakeholders where noted.

Table 1 Stakeholder consultation details

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Aerial Agricultural Association of Australia **Chief Executive Officer** **Phil Hurst**	13 October 2015 Request for consideration sent via email phil@aerialag.com.au	Nil	Nil	Nil
AGA Services **Rob Boaschen** **Company owner**	Telecon 13 October 2015 Kristen advised to email the owner – Rob Boaschen rob@agaservices.com.au. Email sent on 20 October 2015.	Nil	Nil	Nil

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Air Ambulance Victoria **Anthony de Wit Manager Air Operations**	13 October 2015 Emailed request for feedback airops.manager@ambulance.vic.gov.au	14 October 2015 Email response received from Anthony de Wit	AHPL [Australian Helicopters Pty Ltd] provided the following comments: "AHPL do not have any specific operating protocols in regards to wind turbine farms. Wind farms are annotated as obstacles on our operational maps. As the new proposed turbines will be above 360 feet (110m) I think there will be a requirement for them to have an obstacle light placed on top. Any man made obstacle above 360 feet will also be registered with Air services Australia and will be annotated on aviation maps. This is an advantage to us over other wind farms that do not exceed the 360' limit and are therefore not shown on our documents. Due to the surrounding terrain, specifically Tower Hill, the increase in blade height will not affect the area LSALT or the Warrnambool instrument approach minimums. This will be assessed by CASA as well I would expect once the obstacles are registered. I do not anticipate any issue with the proposed development on our operation."	Nil

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Airservices Australia **Airport Developments** **Carly Fiumara**	13 October 2015 Emailed request for consideration Airport.Developments@Airservices Australia.com	25 November 2015 Email response received	**Airspace Procedures** With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 224 M / 735 FT AHD the Wind Farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Warrnambool or Portland aerodrome. Note: procedures not designed by Airservices at Warrnambool or Portland aerodrome were not considered in this assessment. **CNS Facilities** This proposal for a wind farm at the provided location and to a maximum height of 224m AHD 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.	Nil.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Border Air Services Pty Ltd **Brett Hiflop**	Telecon 13 October 2015 03 5593 1169 0428 528 640	NA	One of the biggest issues are the rotating blades of the wind turbines. If blades are not rotating, it would make the aerial application easier. Increasing height might have an impact on application of fertiliser. Mr Hiflop suggested the fertiliser would have to drop from above the towers if they were rotating. If it could be negotiated with the wind farm operators to stop the blades from rotating, aerial agricultural aircraft could operate below tower height; however, this also depends on relative tower density. Mr Hiflop agreed that, as a net impact, the decrease in tower density would be an improvement regarding the ability to operate within the wind farm site. With respect to herbicides, the application altitude is much lower and the turbines would need to be stopped from rotating in order to safely operate within the confines of the wind farm. Generally, there is an increase in cost to the farmer [the customer] due to the increase in time needed to finish the aerial application due to the extra hazards.	Nil.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Civil Aviation Safety Authority **Dilip Mathew** **Manager Aerodromes and Aviation Infrastructure**	13 October 2015 Letter sent to Dilip Mathew seeking CASA's position in relation to the Project with specific reference to potential aviation impacts.	4 November 2015 Responding letter addressed to Mr Michael Juttner (Senior Planner for Department of Environment, Land, Water and Planning.	CASA considers the proposal to be a hazard to aviation safety, but the risks to aircraft safety would be mitigated by the provision of approved lighting.	CASA recommends the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics for low intensity are stated in subsection [9.4.6]. CASA agrees that the turbines that should be lit are those identified in the drawing *Ryan Corner Wind Farm Obstacle Lighting Design v1.1*, (9 October 2015).
Country Fire Authority Victoria **Wayne Rigg** **CFA Aviation Officer**	Telecon 21 October 2015 Ph: 0439 577 151		Mr Rigg advised that wind farms are hazards, but they are not as bad as wires because wind turbines are much more visible. The positions of wind turbines are not an issue as long as the blades are not rotating. Mr Rigg stated that experience with operating around Waubra Wind Farm has shown that there are no issues. CFA aerial operation crews deal with the obstacles under visual flight rules. Individual wind turbines are treated as just another hazard regardless of overall height. Mr Rigg agreed that there is no net impact significant to CFA aerial operations and generally there is no issue on the condition that wind turbines are able to	Put in place procedures to turn off the rotation of the wind turbines before the beginning of aerial firefighting operations in the vicinity of the Project.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
		Email response 22 October 2015 W.Rigg@cfa.vic.gov.au	be stopped rotating. "As discussed from an aerial fire fighting perspective wind towers are treated like any other hazard that we encounter when flying and all of our fire fighting is undertaken under Visual Flight Rules. Procedures must be in place with the operators for the towers to be turned off before beginning aerial fire fighting operations."	
County Helicopters **Helicopter Agricultural Services** **Ashley**	Telecon 20 October 2015 03 5338 1999 0417 442 980	NA	Ashley advised that his organisation does quite a lot of work around wind farms and it has an effective working relationship with wind farm operators. County Helicopters only operates during day light hours. The company can achieve 100% coverage of aerial application tasks around wind farms. Regarding wind turbine height issues, there is generally a lot of clearance between the rotor and operating height, which is about 2 m above crop height. Ashley agreed that an increase in the clearance between the ground and the lower part of the rotor would result in a reduced overall impact to aerial application operations.	Nil.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Department of Defence **Estate Planning QVT**	Request for consideration sent on 13 October 2015 to lpsi.directorate@defence.gov.au	Letter response received on 17 December 2015	There is an ongoing requirement to obtain and maintain accurate information about tall structures, which relates to the erection, extension or dismantling of tall structures the top of which is: a) 30 m or more AGL within 30 km of an aerodrome; or b) 45 m or more AGL elsewhere. The Project will meet the above definition of a tall structure. As tall structures, wind farms can have the potential to pose a number of concerns for Defence, particularly with regard to aircraft safety, military low flying and radar interference. The risk posed by a tall structure to aircraft safety can be minimised if information on the tall structure is conveyed to pilots so that they can fly at a safe margin above the structure. Defence does not object to this Project subject to certain conditions, some of which relate to other agency requirements.	'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm. If LED obstruction lighting is to be provided to the wind turbines, ensure the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres, thus being visible to persons using night vision devices. Consult Defence should there be any subsequent modification in the wind turbine height or scale of development.

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Field Air Group of Companies **Steve Rossington** **Chief Pilot**	Telecon 13 October 2015 03 5330 9300	NA	The position in regards to wind farms is aligned with AAAA's position. Wind monitoring towers are the biggest danger. Mr Rossington stated "if you don't know where to look, you cannot see them." Wind monitoring towers are raised without notice and in some cases in close proximity to air strips that are used by aerial agricultural operators. Mr Rossington advised one time, when he could not get back to Ballarat Airport due to weather, he had turned final approach to land at an airstrip (that is used sometimes when weather closes in) and he noticed a wind monitoring tower a few hundred metres away, which he had no idea was there. If he had made a right hand circuit, he would have collided with it. He was not sure of the solution, whether there should be balls put on the supporting wires, a light to be installed or to make the towers different colours, but concluded that the wind monitoring towers just need to stand out more.	Refer to discussion on Aerial Application and Obstacle Marking and Lighting

Agency/Contact	Activity/Date	Response/Date	Issues Raised During Consultation	Action Proposed
Glenelg Shire Council **Samantha Kohlman** **Airport Manager**	Email sent 13 October 2015	Email response received 14 December 2015	Glenelg Shire Council operates Portland Airport which is located 15 km west of Portland, and also the Casterton airstrip approximately 100 km northwest of Portland. The Project is a considerable distance from Portland Airport. However, considering the significance of the amendment in height of the turbines for approval, Ms Kohlman has requested consideration of the proposal by the Council aviation consultant. No further advice had been received at the time of release of this report.	Nil.
Royal Flying Doctor Service	13 October 2015 03 8412 0400 Allison 0936 – requested callback	No response received.	Nil.	Nil.
Warrnambool City Council **Terry O'Sullivan**	Telecon 7 October 2014 1300 003 280 (local call) or (03) 5559 4800	NA.	Ideally the wind turbines and their wake turbulence would be situated at least 15 km from Warrnambool Regional Airport.	The Project is located more than 15 km from Warrnambool Regional Airport. Nil.

2.2. Department of Environment, Land, Water and Planning

The proposed development was the subject of Planning Permit Application 20060222, lodged in 2006 with the Victorian Department of Planning (now called Department of Environment, Land, Water and Planning).

The Civil Aviation Safety Authority (CASA) was consulted (in August 2006 and again in October 2007) and provided its view on the potential impact of the turbines on aviation safety. The responses are discussed in further detail in section 2.4 of this report.

On 1 October 2007 the Victorian Department of Planning and Community Development issued an Inquiry Direction – Aviation Lighting, in which it was directed that a lighting plan for the Project, if it was required to be lit, was to be exhibited.

The Ambidji Group Pty Ltd was then engaged to prepare a report entitled Ryan Corner Wind Farm Evaluation of Lighting Requirements (Rev A dated 25 October 2007), in which the original lighting design proposed in the Environmental Effects Statement (EES) was revised and two alternative lighting design options were proposed.

On 21 August 2008 the Minister for Planning issued Planning Permit No 20060222 for the proposed construction and operation of a wind farm consisting of up to 68 turbines and associated infrastructure, as described in the Ryan Corner Wind Farm Environment Effects Statement and Application for Planning Permit dated October 2006 and modified in accordance with the Planning Permit.

On 12 August 2010, a letter by the Department of Planning and Community Development, reference number BMIN007771, notified the Proponent of the approval to amend the Planning Permit as follows:

- The increase of the maximum blade tip height of the wind turbines to 126.3 m AGL;
- The increase of the maximum height of the tower to 80 m AGL; and
- The increase in the wind turbine blade length to 46.25 m.

Conditions 8 and 9 address lighting.

> *8. Except in the case of an emergency, no external lighting of infrastructure, other than low level security lighting may be installed or operated without the further written consent of the Minister for Planning.*
>
> *9. Obstacle lighting for aviation safety must meet the following requirements, to the satisfaction of the Minister for Planning:*
>
> *a) The number of lit turbines are kept to the minimum required, such that the wind farm is not declared a hazard to aviation.*
>
> *b) The individual lighting installations must be in accordance with the CASA Advisory Circular 139-18(0) and the CASA Manual of Standards, particularly Chapter 9.*
>
> *c) The impact minimisation features allowed under the documents in 9(b) must be installed including, but not limited to:*
>
> *(i) Treatment of the rear of the blade to avoid reflection of aviation lights;*
>
> *(ii) Shielding of the lights on the top and bottom such that the maximum intensity of light is limited to a beam of 3 degrees, with only 0.5 degrees of this beam width below the horizon; and*

(iii) All lights on the wind farm synchronised to flash in unison.

d) Within the guidance of 9 (b) above, advice must be sought from a suitably qualified wildlife ecologist to ensure the light flashing period minimises any impact on bats or night flying birds.

2.3. Environment Protection and Heritage Council

The Environment Protection and Heritage Council (EPHC) has produced Draft National Wind Farm Development Guidelines, dated July 2010, to complement existing planning and development processes. The Guidelines are intended to be best practice and not mandatory. The twelve month evaluation period has concluded, but no revision or final version of the Guidelines was available at the time of writing.

Guidance notes provided under section 3.7 Aircraft safety state as follows:

> *The physical intrusion of towers and blades into the airspace used by aircraft is addressed by the Civil Aviation Safety Authority (CASA) guidelines, which are currently under review. The CASA guidelines, once finalised, may indicate that night lighting should be installed on some or all turbines within the wind farm. This, in turn, may pose a visual impact that will need to be considered in the landscape assessment and in the birds and bats assessment.*

2.4. Civil Aviation Safety Authority

The Civil Aviation Safety Authority regulates aviation activities in Australia. Applicable requirements include the Civil Aviation Regulations 1988 (CAR), Civil Aviation Safety Regulations 1998 (CASR) and associated Manuals of Standards (MOS) and other guidance material.

2.4.1. 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 (AGL) to inform CASA. This requirement is to allow CASA, under CASR 139.370, to assess the effect of the structure on aircraft operations and determine whether or not the structure will be a hazardous object because of its location, height, or lack of marking or lighting.

After an initial enquiry by Gamesa Energy Australia in March 2006 and subsequently providing further explanatory information in July 2006, Mr Kim Jones, CASA's Manager, Airways and Aerodromes wrote on 17 August 2006:

Ref: Proposed Hawkesdale and Ryan Corner Windfarms, Victoria

Thank you for your letter dated 25 July, and data regarding relative heights of your proposed wind turbines and surrounding terrain. Having reviewed this data, CASA will not require that the turbines be lit.

Mr Jones wrote again on 3 April 2007:

Ref: Proposed Hawkesdale and Ryan Corner Windfarms, Victoria

I refer to my letter of 17 August 2006 in which I advised you that CASA will not require the proposed turbines at the above sites to be lit. On further representation from the industry and deliberation of the

eight aerodromes and airstrips located close to the proposed sites, CASA believes that there are and will be significant aircraft traffic traversing the area. The number of tall turbine structures does pose a significant hazard. Without the obstacle lights, the hazard posed by these tall structures to pilots operating at night or in marginal visibility conditions cannot be minimised. I need to withdraw my earlier advice, and regret any inconvenience caused.

Mr Jones did not explain why the number of tall turbine structures pose a significant hazard, and the conclusion about not being able to minimise the hazard to aircraft operating at night or in marginal visibility conditions is without justification.

On 13 October 2015, a letter was addressed to Dilip Mathew (Manager, Aerodromes and Aviation Infrastructure of CASA), seeking CASA's position in relation to the proposed development, with specific reference to potential aviation impacts. Mr Mathew responded in a letter to Mr Michael Juttner (Senior Planner of the Deparment of Environment, Land, Water and Planning). An extract of the correspodence is copied below:

> *CASA notes that the proposed Wind Turbines:*
>
> - *Will not penetrate any OLS surfaces*
> - *Will not penetrate any PAN-OPS surfaces*
> - *Will not have an impact on nearby designated air routes*
> - *Will not have an impact on prescribed airspace*
> - *Is wholly contained within Class G airspace*
> - *Will not have an impact on existing local aviation activities.*
>
> *CASA considers the proposal to be a hazard to aviaiton safety, but the risks to aircraft safety would be mitigated by the provision of approved lighting.*
>
> *CASA recommends that the wind farm is lit with steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139. Characteristics of low intensity are stated in sebsection 9.4.7.*
>
> *CASA agrees that the turbines that should be lit are those identified by the consultant in the drawing 'Ryan Corner Wind Farm Obstacle Lighting Design v1.1, (9 October 2015).*

It should be noted that characteristics of low intensity obstacle lights are outlined in MOS 139 subsection 9.4.6 and that characteristics of medium intensity obstacle lights are outlined in MOS 139 subsection 9.4.7.

Mr Mathew did not explain why the proposal is considered a hazard to aviation safety or how the risks would be mitigated by the provision of approved obstacle lighting.

2.4.2. Manual of Standards 139--Aerodromes

Chapter 7 of MOS 139 sets out the standards applicable to Obstacle Restriction and Limitation.

Section 7.1.1.2(b) defines an obstacle:

7.1.1.2(b) any object that penetrates the obstacle limitation surfaces (OLS), a series of surfaces that set the height limits of objects, around an aerodrome.

Note: For instrument runways, obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.

Section 7.1.5 deals with objects outside the obstacle limitation surfaces (OLS):

7.1.5 Objects Outside the OLS

7.1.5.1 Under CASR Part 139 any object which extends to a height of 110 m or more above local ground level must be notified to CASA.

Note: For instrument runways, obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome. See MOS 139 paragraph 7.1.1.

7.1.5.2 Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.

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

Section 9.4.1 provides some general guidance on obstacle lighting:

9.4.1.2 In general, an object in the following situations would require to be provided with obstacle lighting unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance:

(b) outside the obstacle limitation surfaces of an aerodrome, if the object is or will be more than 110 m above ground level.

Section 9.4.2 provides guidance on Types of Obstacle Lighting and Their Use:

9.4.2.2 Low intensity obstacle lights are steady red lights and are to be used on non-extensive objects whose height above the surrounding ground is less than 45 m.

Note: *A group of trees or buildings is regarded as an extensive object.*

9.4.2.3 Medium intensity obstacle lights are to be used either alone or in combination with low intensity lights, where:

(a) the object is an extensive one;

(b) the top of the object is 45 m or more above the surrounding ground; or

(c) CASA determines that early warning to pilots of the presence of the object is desirable.

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height.

In the previous risk assessment conducted by Aviation Projects in *Ryan Corner Wind Farm Obstacle Lighting Requirements v1.0* (2011) where the wind turbines were proposed to not exceed 126.3 m AGL (414 ft), it was reported that CASA indicated the turbines posed a hazard to aviation. In the current proposal, the turbines will be located outside the obstacle limitation surfaces of an aerodrome and will be more than 150 m AGL (up to 180 m AGL). The risk assessment prepared for this report concluded that

there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of MOS 139 Chapter 9.

2.4.3. Advisory Circular 139-18(0) *Marking and lighting of wind farms*

CASA previously provided guidance on the marking and lighting of wind farms in Advisory Circular (AC) 139-18(0) *Obstacle Marking and Lighting of Wind Farms*, dated July 2007. This document was withdrawn from publication in 2008.

No replacement guidance has been developed or published by CASA since the withdrawal of AC 139-18(0).

It can be concluded that there is no regulatory obligation to conform to the guidance provided in AC 139-18(0), since it has been withdrawn from publication.

2.4.4. Current CASA guidance

To ascertain the current status of CASA guidance regarding obstacle marking and lighting of wind farms, Mr Byron Sullivan, CASA's Aerodrome Engineer (Aerodrome Lighting) was consulted via email on 15 July 2011. The relevant section of his response is provided below:

For tall structures not in the vicinity of an aerodrome.

For objects not in the vicinity of an aerodrome, CASA has no specific authority to require action for the marking and lighting of tall structures. If the owner of the structure decides to mark and/or light it as part of their duty of care to not pose a hazard to aviation, then the marking and lighting should be in accordance with the standards published in MOS Part 139.

Our previous Advisory Circular AC 139-18(0) was withdrawn following a legal challenge that it gave the impression that CASA did have regulatory authority over tall structures not in the vicinity of an aerodrome.

The subject of expanding CASA's regulatory authority to cover tall structures not in the vicinity of an aerodrome, has not yet been decided, as far as I know.

On the basis of this guidance, it can be concluded that there is no regulatory obligation to install obstacle lighting on the wind turbines of the Project.

2.5. International Civil Aviation Organization

As a contracting state to the International Civil Aviation Organization (ICAO) and signatory to the Chicago Convention on International Civil Aviation, Australia has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention. Where these SARPs are not met, a difference must be filed.

Annex 14 to the Convention — Aerodromes, Volume 1 documents SARPs applicable to wind turbines. Section 6.4 of Annex 14 provides as follows:

6.4 Wind turbines

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

Note.— See 4.3.1 and 4.3.2.

Markings

6.4.2 **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

6.4.3 **Recommendation.—** *When lighting is deemed necessary, medium-intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it 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 6.3.14 [900 m], 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; and

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

6.4.4 **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.*

Sections 4.3.1 and 4.3.2 of Annex 14 state as follows:

4.3 Objects outside the obstacle limitation surfaces

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:

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

Where these SARPs are not met, a difference must be filed.

Under the provisions of ICAO Annex 14 4.3.2 recommendation (and MOS 139 7.1.5.2), the proposed turbines would be considered obstacles because the heights of the turbines are proposed to be greater than 150 m (492 ft) AGL.

Concerning ICAO Annex 14 4.3.1 recommendation, CASA (the appropriate authority) must be consulted because the turbines are proposed to reach a height of greater than 110 m AGL.

The risk assessment prepared for this report concludes that there will be an acceptable level of aviation safety without obstacle lighting and therefore there will be no requirement for obstacle lighting under the provisions of ICAO Annex 14 section 6.4.1.

2.6. Aviation Impact Statement

Conclusions of EES Section 18 – Aviation Safety Assessment as shown in section 2.13 of this report indicated that there was no impact on any operational airspace at Warrnambool Regional Airport, noting the approved maximum blade tip height was 121.5 m AGL. Subsequently, in August 2010, the amendment to increase the maximum blade tip height to 126.3 m AGL was approved; however, there was no conclusion with respect to impacts on operational airspace.

An Aviation Impact Statement for the Project was produced in support of this risk assessment by IDS Australasia. The AIS reported the following conclusions:

> *The assessments and reviews contained in this Aviation Impact Statement were conducted in accordance with the relevant aviation and aeronautical regulations and standards. In summary, the Aviation Impact Statement has determined that:*
>
> *1) The blade tip elevation of the highest WTG will not exceed 224 m (735 ft) AHD and as such:*
>
> - *Will not penetrate any OLS surfaces;*
> - *Will not penetrate any PAN-OPS surfaces;*
> - *Will not have an impact on nearby designated air routes;*
> - *Will not have an impact on prescribed airspace;*
> - *Is wholly contained within Class G airspace; and*
> - *Will not have an impact on existing local aviation activities.*
>
> *2) The WTG's are located outside the clearance zones associated with aviation navigation aids and communication facilities.*
>
> *3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).*
>
> *4) The wind farm is sufficiently distant from airfields to not have an impact on contingency procedures and engine inoperative flight paths.*
>
> *The development is considered approvable in accordance with the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.*

A copy of the AIS is provided at **Annexure 1**.

In an email from Airport Developments (Airservices Australia), dated 25 November 2015, it was determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities. An extract of the email is copied below:

I refer to your request for Airservices assessment of the Ryan Corner Wind Farm which is proposed for regional Victoria.

Airspace Procedures

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 224 M / 735 FT AHD the Wind Farm will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Warrnambool or Portland aerodrome.

Note: procedures not designed by Airservices at Warrnambool or Portland aerodrome were not considered in this assessment.

CNS Facilities

This proposal for a wind farm at the provided location and to a maximum height of 224m AHD 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.

The RNAV-Z (GNSS) RWY 13 procedure at Warrnambool Airport was not designed by Airservices Australia and was not considered in its assessment. However, it was determined by IDS Australasia Pty Ltd, a CASR Part 173 certified instrument flight procedure designer, that the RNAV-Z (GNSS) RWY 13 procedure will not be impacted by Ryan Corner Wind Farm. An extract of the analysis by IDS is copied below:

RNAV-Z (GNSS) RWY 13 Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the east of the wind farm and protection surfaces are not impacted.

Based on the information provided by Airservices Australia and IDS Australasia, it can be concluded that the Project will not have an impact on airspace procedures or communication, navigation and surveillance (CNS) facilities.

2.7. Nearby aerodromes

Warrnambool Regional Airport

Warrnambool Regional Airport is a registered aerodrome, with a main runway (13/31) that is 1372 m long, and a secondary runway (04/22) that is 1069 m long. The aerodrome is located at a bearing of 101 degrees magnetic at 15 nm (27.8 km) from the Project. Aircraft operations conducted at the aerodrome include regular public transport (RPT), general aviation, training, private, medical emergency (helicopter) and charter. On a daily basis, Sharp Airlines conduct RPT operations and Ambulance Victoria operates helicopters out of the aerodrome.

The AIS has addressed the matters associated with the operational airspace at Warrnambool Regional Airport.

Warrnambool City Council was consulted during preparation of the EES and advised that the development of the Project would have no impact on Warrnambool Regional Airport.

Warrnambool City Council was consulted again on 7 October 2014 with respect to potential impacts of the Project on the aerodrome and it was noted that the Project will be situated outside the OLS and such that the turbulence generated by the turbines be also outside the OLS (ideally at least 15 km from the aerodrome).

The Department of Infrastructure and Regional Development (C'th) has released guidance regarding provision of wind turbine wake turbulence in paragraph 43 of National Airports Safeguarding Framework (NASF) Guideline D, which states:

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

The maximum diameter of the proposed wind turbine is 130 m, which, according to NASF guidance, could result in mechanical turbulence up to 2080 m downwind of the turbine. Considering that the distance of the Project from Warrnambool Regional Airport is outside the 15 km radius from the aerodrome (and a greater distance from the horizontal extent of the OLS, it can be concluded that the Project will have no impact on the aerodrome operations due to turbulence.

Portland

Portland Airport is a certified aerodrome, with a main runway (08/26) that is 1616 m long, and a secondary runway (17/35) that is 1180 m long. The aerodrome is located at a bearing of approximately 265° at 29.5 nm (55 km) from the Project. Various aircraft operations are conducted at the aerodrome, including RPT by Sharp Airlines on a daily basis and general aviation operations, for example, flying training and emergency services and charter.

The AIS has addressed the matters associated with the operational airspace at Portland Airport.

In an email dated 13 October 2015, Glenelg Shire Council was requested to advise what, if any, issues that are of concern to the Council with respect to aviation in the vicinity of the Project. In a response email dated 14 December 2015, Samantha Kohlman (Airport Manager for Glenelg Shire Council) provided the following advice:

> *I have received your email concerning the Ryan Corner Wind Farm project located north west of Port fairy.*
>
> *Glenelg Shire Council operate the Portland Airport which is located 15 kms West of Portland and also the Casterton airstrip approx 100km NW of Portland.*
>
> *The Ryans Corner WindFarm Project is a considerable distance form Portland Airport but considering the significant amended height of the turbines for approval I am liasing with our aviation consultant for comment on the consideration of the impact to aviation within the Glenelg Shire Council.*
>
> *Awaiting consultant comments for further response.*

No further comments were received at the time of writing of this report. However, it is unlikely that the Project will have an impact on Portland or Casterton aerodromes.

2.8. Aircraft operator characteristics

2.8.1. Passenger transport operations

Regular public transport (RPT) and passenger carrying charter operations are generally operated under the Instrument Flight Rules (IFR). The AIS has determined that no IFR aircraft operations will be impacted by the Project.

2.8.2. Private operations

Private operations are generally conducted during day light hours or Visual Flight Rules (VFR) at night, and some under IFR. Flight under day VFR is conducted above 500 ft (152.4 m) above the highest point of the terrain within a 600 m radius (300 m for helicopters). It is expected that the wind turbines will be sufficiently visually conspicuous to pilots conducting VFR operations to enable appropriate obstacle avoidance manoeuvring if transiting the area of the Project.

Night VFR aircraft operations are required to conform to IFR applicable altitude requirements, which are not impacted by the Project

2.8.3. Aerial application

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

In previous consultation with the Aerial Agriculture Association of Australia (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 also the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included as Appendix 1, and AAAA Aerial Application Pilots Manual – excerpts on planning are provided as Appendix II.

Local aerial application operators consulted during the consultation activities have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, and that fixed wing aircraft are limited to a greater degree than rotary wing aircraft. However, one operator that was consulted advised that it frequently operates around wind farms and can achieve 100% coverage within the wind farm with rotary wing aircraft. Properties adjacent to the Project would have to be assessed on an individual basis.

Generally, it was found that the most significant issues with operating around wind farms are the following:

(1) **The rotating blades of the wind turbines** – stopping the blade rotation of the wind turbines may allow aerial agricultural operations below tower height, subject to the density of with turbines. Herbicides are required to be applied at lower altitudes and this application would be hindered more significantly by wind turbine blade rotation. If wind turbine rotations were stopped during agricultural operations in the Project's vicinity, the impact on aerial agricultural operations due to this issue is likely to be alleviated.

(2) **The height margin between the rotor blade at its lowest point and the ground** – the greater clearance between the aerial agricultural operation heights (determined by ground level) and the lowest part of the wind turbine rotor diameter, the lesser the impact on aerial agricultural operations. As the Project will result in an increased height margin between the wind turbine blades and ground level, the impact on aerial agricultural operations due to this issue will be reduced.

(3) **Wind turbines density –** reducing the number of wind turbines, thereby reducing the number of turbines per unit area, would result in a net improvement with respect to impacts on aerial agricultural operations. As the Project will result in a reduced number of turbines within the same project area, the wind turbine density is reduced and therefore the impact due to this issue on aerial agricultural operations is reduced.

(4) **Visibility of wind monitoring towers (WMT) –** WMTs are generally very difficult to see unless the pilot is aware of their location. The locations of the WMT in this Project area have been notified to RAAF AIS and are not proposed to be relocated.

Based on the information provided during the consultation activities, it is reasonable to conclude that there will be a reduced net impact of the changes of the existing wind farm approval on aerial agricultural

operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.

2.8.4. Aerial fire fighting

On 21 October 2015, a teleconference was conducted with Wayne Rigg (Country Fire Authority (CFA) Aviation Officer). Mr Rigg advised that wind farms are hazards, but they are not as bad as wires because wind turbines are much more visible. The wind turbines are not an issue as long as they are turned off (the rotors are not rotating).

Mr Rigg stated that experience with operating around Waubra Wind Farm has shown that there are no issues. CFA aerial operation crew deal with the obstacles under visual flight rules. The wind monitoring towers are treated as just another hazard, regardless of overall height.

Mr Rigg agreed that there is no net impact significant to CFA aerial operations and generally there is no issue on the condition that wind turbines are able to be stopped rotating.

Mr Rigg provided the following comments in an email dated 22 October 2015:

> *As discussed from an aerial fire fighting perspective wind towers are treated like any other hazard that we encounter when flying and all of our fire fighting is undertaken under Visual Flight Rules.*
>
> *Procedures must be in place with the operators for the towers to be turned off before beginning aerial fire fighting operations.*

Based on the information provided during this consultation activity, it is reasonable to conclude that there is no additional impact significant to aerial fire lighting and generally no issue subject to the ability to stop the wind turbine blades from rotating.

2.8.5. Emergency services

On 14 October 2015, Anthony de Wit (Air Manager Air Operations for Air Ambulance Victoria) provided a responding email to a request for consideration of impacts of the Project on Air Ambulance Victoria's operation. An extract of the response is copied below:

> *I have received the following feedback from Australian helicopters in relation to … Ryan Corner…:*
>
> > *AHPL* [Australian Helicopters Pty Ltd] *do not have any specific operating protocols in regards to wind turbine farms. Wind farms are annotated as obstacles on our operational maps. As the new proposed turbines will be above 360 feet (110m) I think there will be a requirement for them to have an obstacle light placed on top. Any man made obstacle above 360 feet will also be registered with Air services Australia and will be annotated on aviation maps. This is an advantage to us over other wind farms that do not exceed the 360' limit and are therefore not shown on our documents.*

Due to the surrounding terrain, specifically Tower Hill, the increase in blade height will not affect the area LSALT or the Warrnambool instrument approach minimums. This will be assessed by CASA as well I would expect once the obstacles are registered.

I do not anticipate any issue with the proposed development on our operation.

At the moment I have not received any feedback from our fixed wing operator, however once I do I will let you know.

At the time of writing of this report, no further comments were provided. However, based on the information presented during this consultation activity, it can be concluded that the Project will not have a significant net impact on rotary wing emergency services.

2.9. Light characteristics

If obstacle lighting is required, installed lights should be designed according to the criteria set out in the applicable regulatory material. Previously, the generally accepted lighting design characteristics includes two flashing red medium intensity obstacle lights which would have been recommended to be provided. However, for the Project, CASA has recommended steady red low intensity lighting.

A summary of design characteristics acceptable by CASA is provided below:

- two steady red low intensity obstacle lights should be provided;
- the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction; and
- 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 section 9.4.6 outlines Characteristics of Low Intensity Obstacle Lights.

  9.4.6.1 Low intensity obstacle lights, for general applications, are to have the following characteristics:

  (a) fixed lights showing red;

  (b) a horizontal beam spread that results in 360° coverage around obstacle;

  (c) a peak intensity of 100 cd minimum;

  (d) a vertical beam spread (to 50% of peak intensity) of 10°;

  (e) a vertical distribution with 100 cd minimum at +6° and +10° above the horizontal; and

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

  Notes:

  1. The intensity level is higher than ICAO standards because in Australia only obstacles assessed as significant to aircraft operations are required to be provided with obstacle lighting.

2. Currently the intensity requirement is normally met by a double-bodied light fitting which also provides a degree of redundancy.

3. Double-bodied light fittings should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

4. For objects that do not infringe the obstacle limitation surfaces, and where CASA has not determined that obstacle lights are required, if the object owner wishes, of their own volition, to provide obstacle lights, it is sufficient for these low intensity obstacle lights to have the following intensity distribution: peak intensity 32 cd minimum, vertical beam spread of 10°, and 32 cd minimum at +6° and +10° elevation.

9.4.6.2 Low intensity obstacle lights, used to indicate taxiway obstacles or unserviceable areas of the movement area, are to have a peak intensity of 10 cd minimum.

MOS 139 section 9.4.7 outlines Characteristics of Medium Intensity Obstacle Lights.

9.4.7.1 Medium intensity obstacle lights are to be flashing or steady red lights or flashing white lights, visible in all directions in azimuth.

9.4.7.2 The frequency of flashes is to be between 20 and 60 flashes per minute.

9.4.7.3 The peak effective intensity is to be 2,000 ± 25% cd with a vertical distribution as follows:

(a) vertical beam spread is to be 3° minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity);

(b) at -1° elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity; and

(c) at 0° elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

9.4.7.4 Where the flashing white light is used in lieu of obstacle marking during the day to indicate temporary obstacles in the vicinity of an aerodrome, in accordance with Paragraph 9.4.2.4(a), the peak effective intensity is to be increased to 20,000 ± 25% cd when the background luminance is 50 cd/m^2 or greater.

MOS 139 Section 9.4.10 sets out the requirements for ongoing availability of obstacle lights:

9.4.10.4 For obstacles located outside the obstacle limitation surface area of an aerodrome, the owners of the lights need to establish a program to monitor the lights and report light failures. The reporting point for obstacle light failure is normally the nearest CASA office. When an obstacle light is unserviceable, the matter needs to be reported immediately to the relevant CASA office so that a NOTAM warning pilots of the light outage can be initiated.

To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program will need to be established in accordance with this guidance.

2.10. Visual impact of night lighting

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

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

2.11. Marking of turbines

ICAO Annex 14 Vol 1 Section 6.4.2 recommends that the rotor blades, nacelle and upper 2/3 of the supporting mast of the wind turbines should be painted white, unless otherwise indicated by an aeronautical study.

It is generally accepted that, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.

2.12. Marking of wind monitoring towers

Consideration could be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings; 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.*

NASF Guideline D suggests consideration of the following measures specific to the marking and lighting of wind monitoring towers:

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

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

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

2.13. Conclusions of EES Section 18 - Aviation Safety Assessment

Section 18 - Aviation Safety Assessment of the Environmental Effects Statement (EES) noted the following key results from the initial assessment and consultation:

- *the Project does not impact any OLS or PANS-OPS surfaces at any of the airports in the vicinity;*
- *the Project does not impact any other flying (Commercial or recreational) activities in the area;*
- *the details of the project should be marked on the World Aeronautical Chart and other navigation documentation, as with any other potential hazard; and*
- *there are very limited night-time flying activities in the area, and where they occur, they should be maintaining a height much greater than the height of the turbines (except for helicopter activities, but these are subject to operational procedures to ensure safe landing at night, when descending below the height of the turbines).*

2.14. Future regulatory requirements and guidance

The National Airports Safeguarding Advisory Group (NASAG), comprising of Commonwealth, State and Territory Government planning and transport officials, the Australian Government Department of Defence, the Civil Aviation Safety Authority (CASA), Airservices Australia and the Australian Local Government Association (ALGA), has developed the National Airports Safeguarding Framework (the Framework).

The National Airports Safeguarding Framework is a national land use planning framework that aims to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports; and
- improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

Guideline D of the Framework deals with wind farm developments: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms) / Wind Monitoring Towers.*

The Framework and any future development or amendment of regulations or guidance could potentially affect the requirement for lighting and/or applicable design specifications.

Consideration of the need for obstacle lighting and the final layout and design specification is therefore subject to confirmation of applicable regulatory requirements and guidance. This consideration, in the form of an updated aeronautical study (a detailed and thorough risk assessment using internationally recognised standards) as previously described, should occur once the final layout is known and prior to installation of the lights during construction.

2.15. Comparative analysis

Publicly available information, advice from the Client and telephone conversations with applicable developers and/or operators revealed that none of the wind farms that were identified and noted in Table 2 operated obstacle lighting on the wind turbines.

Waubra previously operated obstacle lighting. In 2012 the Minister for Planning issued consent for the obstacle lighting to be switched off at the Waubra Wind Farm. This consent followed the advice of an aviation risk assessment prepared on behalf of the proponent, which determined that 'the wind farm did not require aviation obstacle lighting and switching the lights off would not pose an unacceptable risk to aircraft'.

Oaklands Hill and Macarthur also have obstacle lighting installed but not operated. A representative of the project owner advised that CASA requested that the lights be turned off.

The status of obstacle lighting on the wind farms in Victoria is detailed in Table 2.

Table 2 Obstacle lighting on Victorian wind farms

Wind Farm Name	Status	Maximum blade tip height	Obstacle Lighting
Ararat	Construction	135 m	Not yet determined.
Bald Hills	Operational	125 m	Status not determined.
Berrimal	Approved	185 m	Not yet determined.
Berrybank	Approved	131 m	No obstacle lighting (permit condition).
Bulgana	Approved	196 m	Not yet determined.
Cape Nelson North	Operational	126.3 m	No obstacle lighting.
Cape Sir William Grant	Operational	126.3 m	No obstacle lighting.
Chepstow	Construction	126.3 m	Not yet determined.
Cherry Tree	Approved	159 m	Not yet determined.
Coonooer Bridge	Construction	150 m	Not yet determined.
Crowlands	Approved	147 m	Not yet determined.
Hawkesdale	Approved	126.3 m	Not yet determined.
Lal Lal	Approved	130 m	Not yet determined.
Macarthur	Operational	140 m	Lighting installed but not used. CASA authorised that the lights be turned off.
Moorabool	Approved	150 m	Not yet determined.
Mortlake South	Approved	141 m	Not yet determined.
Mount Mercer	Construction	126 m	No obstacle lighting.
Mt Gellibrand	Approved	150 m	Not yet determined.
Oaklands Hill	Operational	124 m	Lighting installed but not used. CASA authorised that the lights be turned off.
Ryan Corner	Approved	126.3 m	Not yet determined.
Salt Creek	Approved	150 m	Not yet determined.
Waubra	Operational	119.8 m	Lights installed, non-operative. Minister for Planning issued consent in 2012 for obstacle lighting to be switched off.
Woolsthorpe	Approved	135 m	Proponent advises no obstacle lighting to be installed.

3. INTERNAL CONTEXT

3.1. Project description

The Project is planned to comprise a maximum of 56 wind turbines on a site located approximately 10 km north west of Port Fairy, and just north of operational wind farms at Codrington and Yambuk.

The Project site is situated in an area comprised mainly of farming properties on gently rolling terrain.

The Project location, extracted from the original letter to CASA dated 28 March 2006, is shown in Figure 1.

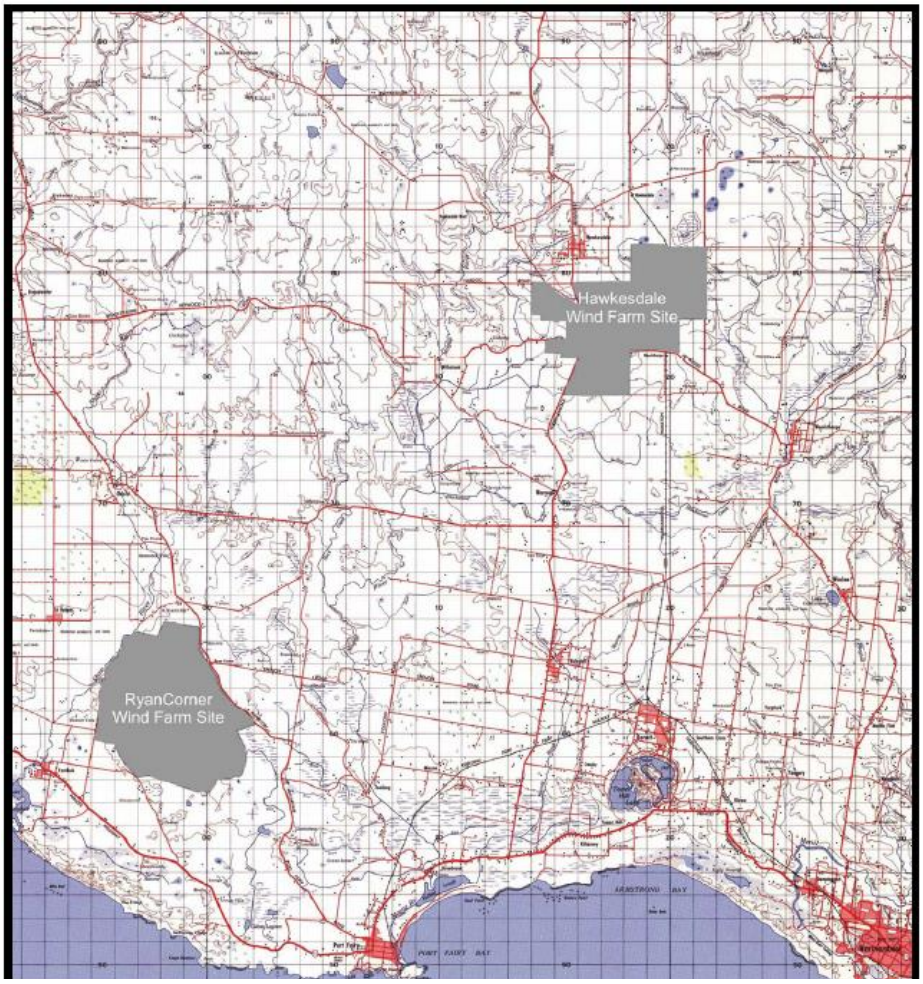

Figure 1 Site Map

A preliminary turbine layout, sourced from the Proponent dated 27 August 2015, is shown in Figure 2.

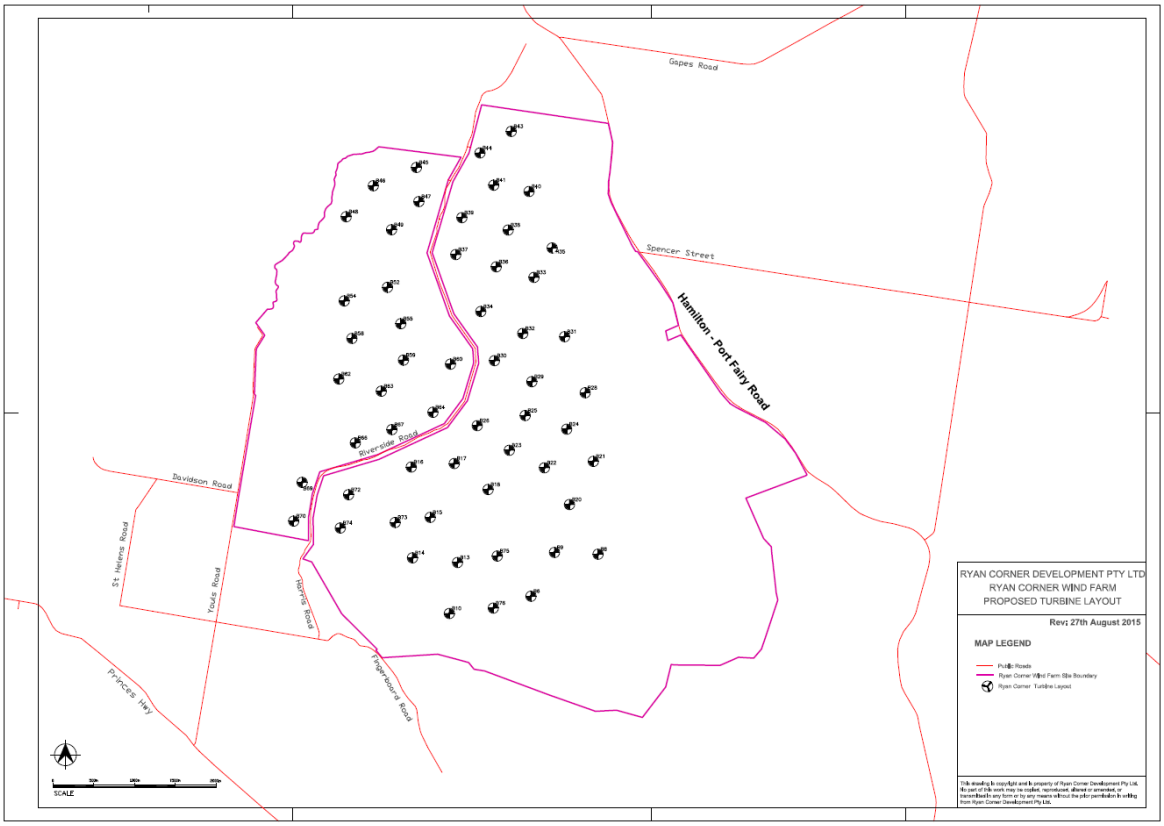

Figure 2 Preliminary turbine layout

3.2. Wind turbine description

The approved planning permit (Planning Permit 20060222) specifies that the wind turbines, nacelles and rotor blades must be pale grey, off white or other colour that blends with the landscape, and must be of a non-reflective finish. The approved Permit specifies that the wind turbines are to have a maximum blade tip height of 126.3 m AGL (414.4 ft) with a maximum hub height of 80 m AGL (262.5 ft).

The proposed wind turbine maximum heights at the Project have been revised and may now extend to a height of 180 m AGL (591 ft) to the top of the blade tip, with a maximum hub height of 117 m AGL (384 ft) and a rotor diameter of up to 130 m.

The maximum ground elevation, located at the proposed wind turbine identified as B40, is 44 m AHD (144 ft AMSL), resulting in a maximum blade tip height of 224 m AHD (735 ft AMSL).

The proposed amendment will result in the following changes:

- The number of wind turbines decreased by 12;
- The maximum blade tip height increased by 53.7 m;

- The maximum ground elevation increased by 2 m due to micrositing; and
- The maximum blade tip height increased by 55.7 m.

A list of the wind turbine coordinates, base heights and hub heights is provided at **Annexure 2.**

3.3. Wind monitoring tower description

The Proponent advises there are four wind monitoring towers in the Project – one 60 m (197 ft) and three 40 m (131 ft) high. They are not marked or lit, nor are they required to be. Their location and other applicable details have been advised to RAAF AIS. Removal or retention of these wind monitoring towers is subject to final micrositing of the wind turbines (in accordance with any Planning Permit Conditions).

Table 3 shows the wind monitoring tower data applicable to the Project.

Table 3 Wind monitoring tower data

Tower ID	Datum	Zone	UTM X	UTM Y	Elevation (m)	Type	Height (m)
RC_2	WGS84	54H	598831	5764128	47	Tubular	40
RC_3	WGS84	54H	600464	5759385	43	Tubular	60
RC_4	WGS84	54H	598671	5761282	46	Tubular	40
RC_5	WGS84	54H	596655	5762381	28	Tubular	40

The Proponent also advises that it is considering erection of one or more hub height wind monitoring towers for turbine power curve verification. The location of these towers is yet to be determined, although it is envisaged that they would be positioned within, rather than on the perimeter of, a cluster of turbines.

A photo taken from the north eastern corner of the Project site looking south west towards Yambuk Wind Farm is shown in Figure 3. A wind monitoring tower can be seen just to the right of centre in the middle distance.

Figure 3 View of site from north eastern corner looking south west

3.4. Turbine lighting design

In the event that obstacle lighting is required, a lighting design has been prepared on the basis of the requirements set out in ICAO Annex 14 Vol 1 Chapter 6, MOS 139 Chapter 9 and advice provided by CASA.

Turbines proposed to be lit are, wherever possible, located on the perimeter of the Project at appropriate spacing and/or are significantly higher than surrounding turbines.

In addition, the lighting proposal has been based on:

- the specific configuration of the Project and its location in relation to surrounding facilities and features (including terrain);
- the relative elevation and proximity of each turbine in relation to others; and
- the position of turbines in relation to falling and rising terrain.

Due to the proposed configuration of the Project, however, not all lit turbines are within 900 m of each other—although the apparent intermediate distance (approaching from any direction) is minimised (and retained under approximately 1 nm) due to the location of intermediate lights set further back from turbines on the perimeter.

Given the minimum requirement for 5000 m visibility for flight under the visual flight rules, the lighting design should provide sufficient warning to pilots that they will be able to manoeuvre their aircraft to avoid the turbines.

If obstacle lighting is required (for example, as a requirement of CASA), obstacle lighting would be installed on the following 23 turbines (without the 'B' as the identification prefix): 6, 8, 10, 14, 18, 21, 28, 30, 31, 35, 37, 40, 43, 44, 45, 48, 54, 62, 64, 66, 69, 70 and 74.

This lighting design is subject to confirmation of the final turbine layout as any changes proposed could potentially affect which turbines should be lit in accordance with the 900 m interval consideration.

A graphic representation of the lighting design which identifies those turbines proposed to be lit is provided in **Annexure 3**.

4. 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.

4.1. Likelihood

Likelihood is defined in AS/NZS ISO 3100:2009 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 4.

Table 4 Likelihood Descriptors

No	*Descriptor*	*Description*
1	Rare	The event may occur only in exceptional circumstances
2	Unlikely	The event could occur at some time (not known to have occurred)
3	Possible	The event might occur at some time in the future
4	Likely	The event will probably occur in most circumstances (has occurred infrequently)
5	Almost certain	The event is expected to occur in most circumstances (has occurred frequently)

4.2. 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 5.

Table 5 Consequence Descriptors

No	Descriptor	People Safety	Property	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	Fatal or 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 or fatal 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.

4.3. Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 6.

Table 6 Risk Matrix

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

4.4. Actions required

Actions required according to the derived level of risk are shown in Table 7.

Table 7 Actions Required

9-10	Unacceptable Risk -	Immediate action required by either treating or avoiding risk. Refer to executive management.
7-8	Manageable Risk -	Treatment action is required to manage risk to an acceptable level. Refer to operational management.
5-6	Manageable 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	Acceptable Risk -	Managed by routine procedures, and can be accepted with no action.

4.5. Risk Identification

The primary risk being assessed is that of aviation safety. In this case, risk is considered to be manifested by the Project in the following ways:

- there is potential for an aircraft to collide with a wind turbine;
- there is potential for an aircraft to collide with a wind monitoring tower;
- there is potential for a pilot to initiate harsh manoeuvring in order to avoid colliding with a wind turbine or monitoring tower resulting in controlled flight into terrain (CFIT); and
- there is potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew.

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 operations conducted by major RPT airlines. The risk is associated with smaller aircraft likely to be flying under the VFR, and so the maximum number of passengers is likely to be limited.

The secondary risk being assessed is the visual impact that obstacle lights (if fitted) will have on the surrounding residents.

4.6. 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.

Each of the five risk events are considered in separate tables in the following pages.

Risk ID:	1. Aircraft collision with wind turbine

Discussion

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

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.

There have been four reported occurrences worldwide of aircraft collisions with a component of a wind turbine structure since the year 2000. 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.

One example of a reported collision with a wind turbine occurred in France. The pilot decided to descend below the cloud base in the attempt to find the aerodrome. At the time of the collision, the pilot was attempting to find the runway as the ground was visible. In addition, 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.

Other examples of collisions occurred in VMC, where turbines would have been unobscured by weather, where it was reported that pilots were flying in the vicinity of wind farms for operations associated with testing wind farm impacts on the environment or where pilots were transiting near the wind farms en route to their destination.

If these recorded collisions were taken to be an exhaustive list of occurrences since 2000, it can be deduced that aircraft collisions with wind turbines occur very infrequently.

Based on research conducted during the preparation of this Aviation Impact Assessment, it was found that there is a relatively low rate of aircraft activity in the vicinity of the Project, with the exception of agricultural aviation operations.

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

Any object that extends to a height of 150 m or more above local ground level must be regarded as an obstacle unless it is assessed by CASA to be otherwise.

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, 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. It is assessed that collision with a wind turbine resulting in multiple fatalities and damage beyond repair would only occur in exceptional circumstances, which is classified as rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- The Project is clear of the obstacle limitation surfaces of any aerodrome.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m (230 ft) higher than the height below which there would be no statutory requirement to report the turbines to CASA in any case.

Level of Risk

The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.

Current Level of Risk	6 - Manageable

Risk Decision

A risk level of 6 is classified as Manageable: Treatment action possibly required to achieve a risk as low as reasonably practical (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 there being only four recorded occurrences of an aircraft colliding with a wind turbine since 2000 the likelihood of this outcome is so low that there is likely to be little additional safety benefit to be gained by installing obstacle lighting.

However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Warrnambool Regional Airport.
Residual Risk With or without further treatment, the likelihood of an aircraft collision with a wind turbine resulting in multiple fatalities and damage beyond repair remains Rare, and the consequence remains Catastrophic, resulting in an overall risk level of 6. In the circumstances, this level of risk is considered acceptable. 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. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.

Residual Risk	6 - Manageable

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

Discussion

An aircraft collision with a wind monitoring tower would result in harm to people and damage to property.

The Proponent advises there are four wind monitoring towers in the Project – one 60 m (197 ft) and three 40 m (131 ft) AGL. They are not marked or lit, nor are they required to be. Their location and other applicable details have been advised to RAAF AIS.

Removal or retention of these wind monitoring towers is subject to final micrositing of the wind turbines (in accordance with any Planning Permit Conditions).

The Proponent also advises that it is considering erection of a hub height wind monitoring tower for turbine power curve verification. The location of this tower is yet to be determined, but it will be positioned within rather than on the perimeter of a cluster of turbines.

There are a few instances of aircraft colliding with a wind monitoring tower, but they were all during the day with good visibility, and none was in Australia.

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

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

For objects at a height of 110 m AGL or more and outside the OLS of an aerodrome, CASA must be notified. Obstacle lighting may be required unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance.

Consequence

If an aircraft collided with a wind monitoring tower, 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 wind monitoring tower, but all were during the day with good visibility when obstacle lighting would arguably be of no effect, and none was 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 may only occur in exceptional circumstances, which is classified as Rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- The existing wind monitoring towers at the Project are 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- Removal or retention of these wind monitoring towers is subject to final micrositing of the wind turbines (in accordance with any Planning Permit Conditions).
- A hub height wind monitoring tower may be erected for turbine power curve verification. The location of this tower is yet to be determined, but it will be positioned within rather than on the perimeter of a

cluster of turbines.

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The highest wind monitoring tower is 80 m AGL (263 ft), so there is at least 237 ft (72.4 m) vertical separation from 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 are constructed from grey steel.

Level of Risk

The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.

Current Level of Risk	6 - Manageable

Risk Decision

A risk level of 6 is classified as Manageable: 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

Within the current regulatory regime, the level of risk to aviation safety associated with the wind monitoring towers is considered acceptable without further treatment. However, the following treatments which can be implemented at a relatively low additional cost will provide an additional margin of safety:

- Details of the existing wind monitoring tower, and future wind monitoring towers when they are constructed, should be advised to RAAF AIS.
- It is likely that the wind monitoring tower will be within 400 m of the taller turbines and, therefore, not likely to require obstacle marking.
- Although there is no obligation to do so, consideration could be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings; 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.
- Details of the wind monitoring towers should be communicated to local and regional aircraft operators and arrangements should be made to publish details in ERSA for surrounding aerodromes following

construction to heighten awareness of their location. • It should also be noted that when the Project is constructed, the wind monitoring towers will be surrounded by wind turbines which are significantly more visible, and pilots should therefore be deterred from flying near the wind monitoring tower which will further reduce the likelihood of a collision.	
Residual Risk Notwithstanding the current level of aviation safety risk is considered acceptable, the additional treatment, which will eventuate as a result of constructing the Project, will enhance aviation safety. In the circumstances, the risk level of 6 is considered acceptable. It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for collision with the wind monitoring towers, without obstacle lighting on the turbines of the Project.	
Residual Risk	6 - Manageable

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

Discussion

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

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

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

Consequence

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

Consequence	Catastrophic

Untreated Likelihood

There are a few CFIT accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day. It is assessed that a CFIT accident following harsh manoeuvring to avoid a wind turbine may only occur in exceptional circumstances, which is classified as Rare.

Untreated Likelihood	Rare

Current Treatments (without lighting)

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The ‘as constructed’ details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m (230 ft) higher than the height below which there would be no statutory requirement to report the turbines to

CASA in any case.	
Level of Risk The level of risk associated with a Rare likelihood of a Catastrophic consequence is 6.	
Current Level of Risk	6 - Manageable
Risk Decision A risk level of 6 is classified as Manageable: 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 there has been one recorded example of a CFIT accident arising from harsh manoeuvring to avoid a wind turbine since 2000 (none in Australia), the likelihood of this outcome is so low that there is likely to be little additional safety benefit to be gained by installing obstacle lighting. However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Warrnambool Regional Airport.	
Residual Risk Notwithstanding the current level of risk is considered acceptable, the additional recommended treatment will enhance aviation safety. In the circumstances, the risk level of 6 is considered acceptable. It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for CFIT resulting from harsh manoeuvring to avoid a wind turbine, without obstacle lighting on the turbines of the Project. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.	
Residual Risk	6 - Manageable

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.

There is a relatively low rate of aircraft activity 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. This would be a Minor consequence.

Consequence	Minor

Untreated Likelihood

The likelihood of the imposition of operational limitations is Possible – might occur at some time in the future.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 600 m (or 300 m for helicopters) in visual flight during the day when not in the vicinity of built up areas. The proposed turbines will be a maximum of 180 m AGL (591 ft) at the top of the blade tip, so the rotor blade at its maximum height will be 27.6 m (91 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 (in this case 117 m AGL (384 ft)), 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 pale grey or off white so they should be visible during the day.
- The 'as constructed' details of wind turbines are required to be notified to RAAF AIS so that the location and height of wind farms can be noted on aeronautical maps and charts.
- The turbines are proposed to be a maximum of 180 m AGL (591 ft) at the blade tip. This is 70 m (230

ft) higher than the height below which there would be no statutory requirement to report the turbines to CASA in any case.	
Level of Risk The level of risk associated with a Possible likelihood of a Minor consequence is 5.	
Current Level of Risk	5 - Manageable
Risk Decision A risk level of 5 is classified as Manageable: 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. However, the following treatment which can be implemented at little cost will provide an additional margin 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. • Arrangements should be made to publish details of the Project in ERSA for surrounding aerodromes, such as Warrnambool Regional Airport.	
Residual Risk Notwithstanding the current level of risk is considered acceptable, the additional recommended treatment will enhance aviation safety. In the circumstances, the risk level of 5 is considered acceptable. 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 turbines of the Project. However, the Proponent may consider other factors in its decision as to whether obstacle lighting should be installed.	
Residual Risk	5 - Manageable

Risk ID:	5. Effect of obstacle lighting on neighbours

Discussion

Installation and operation of obstacle lighting on wind turbines can have an effect on neighbours' visual amenity and enjoyment.

As the wind turbines are proposed to be higher than 150 m AGL (492 ft), the wind turbines must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 110 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Waubra previously operated obstacle lighting. In 2012 the Minister for Planning issued consent for the obstacle lighting to be switched off at the Waubra Wind Farm. This consent followed the advice of an aviation risk assessment prepared on behalf of the proponent, which determined that 'the wind farm did not require aviation obstacle lighting and switching the lights off would not pose an unacceptable risk to aircraft'.

Oaklands Hill and Macarthur also have obstacle lighting installed that are not operated. The wind farm owner advised that CASA determined the lighting as a visual obstacle and more being a benefit for the pilots. Subsequently, CASA requested that the lights be turned off.

Consequence

The worst credible effect of obstacle lighting 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 Likely - the event will probably occur in most circumstances (has occurred infrequently).

Untreated Likelihood	Likely

Current Treatments

As the Project wind turbines are proposed to be higher than 150 m AGL (492 ft), the turbines must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 110 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Not installing obstacle lighting would completely remove the source of the impact.

The Planning Permit specifies the following requirements:

> *8. Except in the case of an emergency, no external of infrastructure, other than low level security lighting may be installed or operated without the further written consent of the Minister for Planning.*

9. Obstacle lighting for aviation safety must meet the following requirements, to the satisfaction of the Minister for Planning:

a) The number of lit turbines are kept to the minimum required, such that the wind farm is not declared a hazard to aviation.

b) The individual lighting installations must be in accordance with the CASA Advisory Circular 139-19(0) and the CAA Manual of Standards, particularly Chapter 9.

c) The impact minimisation features allowed under the documents in 9(b) must be installed including, but not limited to:

(i) Treatment of the rear of the blade to avoid reflection of aviation lights;

(ii) Shielding of the lights on the top and bottom such that the maximum intensity of light is limited to a beam of 3 degrees, with only 0.5 degrees of this beam width below the horizon; and

(iii) All lights on the wind farm synchronised to flash in unison.

d) Within the guidance of 9 (b) above, advice must be sought from a suitably qualified wildlife ecologist to ensure the light flashing period minimises any impact on bats or night flying birds.

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 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; and
- mitigating light glare from obstacle lighting through measures such as baffling.

Level of Risk

The level of risk associated with a Likely likelihood of a Moderate consequence is 7.

Current Level of Risk	7 - Manageable

Risk Decision

A risk level of 7 is classified as Manageable: Treatment action is required to manage the risk to an acceptable level. Refer to operational management.

Risk Decision	Reject – Treatment action required

Proposed Treatments

Not installing obstacle lighting would completely remove the source of the impact.

If lighting is required, there are Planning Permit Conditions and 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.

Residual Risk Not installing obstacle lights would clearly be an acceptable outcome to those affected by visual impact. Consideration of visual impact in the lighting design should enable installation of lighting that produces an acceptable impact to neighbours, which reduces the likelihood of a Moderate consequence to Possible – the event might occur at some time in the future, resulting in a risk level of 6 – Manageable. It is our assessment that visual impact from obstacle lights can be negated if they are not installed, but 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	6 - Manageable

4.7. Summary of risks

A summary of the level of risk associated with the approved Project, under the proposed treatment regime, is provided in Table 8.

Table 8 Summary of Risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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 monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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. 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	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permit Conditions.

5. CONCLUSIONS

As a result of this study, the following conclusions were made:

5.1. Consultation

- An appropriate and justified level of consultation was undertaken with the following parties:
  - Aerial Agricultural Association of Australia;
  - Air Ambulance Victoria;
  - Airservices Australia;
  - Civil Aviation Safety Authority;
  - Country Fire Authority Victoria;
  - Department of Defence;
  - Glenelg Shire Council;
  - Operators of non-regulated aerodromes within the vicinity of the Project;
  - Royal Flying Doctor Service;
  - Warrnambool City Council; and
  - Other stakeholders where noted.

5.2. Regulatory requirements

- There is no regulatory requirement for lighting of obstacles lower than 150 m AGL (492 ft) that are not within the vicinity of an aerodrome.
- With respect to MOS 139 7.1.5.1, the proposed wind turbines and wind monitoring towers must be reported to CASA if they will be higher than 110 m AGL.
- With respect to MOS 139 7.1.5.2, the wind turbines must be regarded as an obstacle if they are higher than 150 m AGL, unless CASA assesses otherwise. Obstacle monitoring includes the PANS-OPS surface which extends beyond the OLS of the aerodrome.
- With respect to MOS 139 9.4.1.2 (b), the wind turbines will need to be lit if they will be outside the OLS and above 110 m AGL, unless an aeronautical study assesses they are of no operational significance.

5.3. Aviation Impact Statement

- The Aviation Impact Statement made the following conclusions:

  In summary, the Aviation Impact Statement has determined that:

  1) The blade tip elevation of the highest WTG will not exceed 224 m (735 ft) AHD and as such:

- *Will not penetrate any OLS surfaces;*
- *Will not penetrate any PAN-OPS surfaces;*
- *Will not have an impact on nearby designated air routes;*
- *Will not have an impact on prescribed airspace;*
- *Is wholly contained within Class G airspace; and*
- *Will not have an impact on existing local aviation activities.*

2) The WTGs are located outside the clearance zones associated with aviation navigation aids and communication facilities.

3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

4) The wind farm is sufficiently distant from airfields to not have an impact on contingency procedures and engine inoperative flight paths.

The development is considered approvable in accordance with the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

- Airservices Australia has determined that there will be no aviation impacts on airspace procedures that have been designed by Airservices or communication, navigation and surveillance (CNS) facilities.
- The RNAV-Z (GNSS) RWY 13 procedure at Warrnambool Airport was not designed by Airservices Australia and was not considered in its assessment. However, it was determined by IDS Australasia Pty Ltd, a CASR Part 173 certified instrument flight procedure designer, that the RNAV-Z (GNSS) RWY 13 procedure will not be impacted by Ryan Corner Wind Farm. An extract of the analysis by IDS is copied below:

  RNAV-Z (GNSS) RWY 13 Procedure

  The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the east of the wind farm and protection surfaces are not impacted.

- Based on the information provided by Airservices Australia and IDS Australasia, it can be concluded that the Project will not have an impact on airspace procedures or communication, navigation and surveillance (CNS) facilities.

5.4. Nearby aerodromes

- The impacts at nearby aerodromes are addressed in the AIS.
- The Project will have no impact on the Warrnambool Regional Airport operations due to mechanical turbulence.
- The Project will have no impact on the Portland Airport.

5.5. Aircraft operator characteristics

- Based on input during consultation activities, the Project will result in a reduced net impact on aerial agricultural operations. Moreover, the impacts may be further alleviated by an effective and functional working relationship between the Proponent and aerial agricultural operators that are likely to operate in the vicinity of the Project.
- No net impact will result from the Project on the operation of Country Fire Authority's (CFA) operations. It would be beneficial to develop procedures to stop turbines blades from rotating before CFA begins aerial firefighting operations within the Project area.
- No issues are anticipated with the Project on Air Ambulance Victoria's rotary wing operation.

5.6. Comparative analysis

- There are no operational wind farms in Victoria that have obstacle illuminated. Wind farms at Macarthur, Oaklands Hill and Waubra have obstacle lighting installed; however, the operators have been authorised to have them turned off.

5.7. Project description

- The proposed amendment will result in the following changes:
    - 56 wind turbines – decreased by 12 from the approved 68 wind turbines;
    - Maximum blade tip height of 180 m AGL (591 ft) – increased by 53.7 m from 126.3 ft AGL;
    - Maximum ground elevation of 44 m AHD (144 ft AMSL) – increased by 2 m from 42 due to micrositing; and
    - Maximum blade tip height of 224 AHD (735 ft AMSL) – increased by 55.7 m from 170.3 m AHD (559 ft AMSL).
- The existing wind monitoring towers at the Project site are 60 m (197 ft) and 40 m (131 ft) AGL, and do not require lighting. Their location and other applicable details have been advised to RAAF AIS.
- A hub height wind monitoring tower (up to a height of 117 m AGL) may be erected for turbine power curve verification within the project boundary.

5.8. Obstacle lighting and marking

- Aviation Projects has assessed 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.
- If lighting is required, the lighting design herein is subject to confirmation of the final turbine layout as any changes proposed could potentially affect which turbines should be lit in accordance with the 900 m interval consideration.
- CASA advised that it considers the Project to be a hazard to aviation safety, but the risks to aircraft safety would be mitigated by the provision of approved lighting. CASA recommends that the wind farm is lit with

steady red low intensity lighting at night as per Section 9.4 of the CASA Manual of Standards Part 139 (characteristics for low intensity area stated in subsection 9.4.7). CASA agrees that the turbines that should be lit are identified in the drawing 'Ryan Corner Wind Farm Obstacle Lighting Design v1.1, (9 October 2015).

- A summary of design characteristics for obstacle lighting acceptable by CASA, if required, is provided below:
  - two steady red low intensity obstacle lights should be provided;
  - the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction; and
  - the characteristics of the obstacle lights should be in accordance with the applicable standards in MOS 139.
- To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program will need to be established in accordance with the guidance in MOS 139 Section 9.4.10.
- With respect to marking of turbines, it is generally accepted that, as an alternative to white, an off-white or light grey colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.
- With respect to marking of wind monitoring towers, they will be lower than, and are likely to be within 400 m of, a turbine and are therefore not likely to require obstacle marking or lighting.
- Department of Defence advised it has no concerns with the Project subject to the following requests being met:

  5) Clearance is sought from Airservices Australia and CASA and any conditions from these agencies are adhered to;

  6) 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.

  7) If LED obstruction lighting is to be provided to the wind turbines, the frequency range of the LED light emitted fall within the range of wavelengths 655 to 930 nanometres. This will enable the lighting to be visible to persons using night vision devices; and

  8) Defence is consulted should there be any subsequent modification in the wind turbine height or scale of development.

5.9. Risk assessment

- A summary of the level of risk associated with the proposed the Project, under the proposed treatment regime, is provided in Table 9.

Table 9 Summary of risks

Risk Element	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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 monitoring tower	Catastrophic	Rare	6	Acceptable without obstacle lighting. Although there is no obligation to do so, consider marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 Obstacle Markings, specifically 8.10.2.6 and 8.10.2.8. Communicate details of wind monitoring towers to local and regional operators and make arrangements to publish details in ERSA for surrounding aerodromes following construction.
Harsh manoeuvring leads to CFIT	Catastrophic	Rare	6	Acceptable without obstacle lighting. 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. 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	Possible	6	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact and in accordance with Planning Permit Conditions.

6. RECOMMENDATIONS

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

Notification and reporting

1. 'As constructed' details of wind turbine and wind monitoring tower coordinates and elevations should be provided to RAAF AIS, which may be achieved using the RAAF AIS website with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm.
2. Defence should be consulted if there is any subsequent modification in the wind turbine height or scale of development.
3. 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:
    - The planned operational timeframe and maximum height of the crane; and
    - Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

Operation

4. The Proponent should engage with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project. Procedures may include stopping the rotation of the wind turbine rotor blades prior to the commencement of the aircraft operations within relevant areas.

Marking of turbines

5. The rotor blades, nacelle and the supporting mast of the wind turbines should be painted white, off-white or a light grey colour.

Lighting of turbines

6. With respect to Conditions 8 and 9 of Planning Permit 20060222, Aviation Projects has assessed that the Project will not require obstacle lighting to maintain an acceptable level of safety to aircraft.
7. If obstacle lighting is required (for example, as a requirement of CASA), obstacle lighting should be installed on the following 23 turbines (without the 'B' as the identification prefix): 6, 8, 10, 14, 18, 21, 28, 30, 31, 35, 37, 40, 43, 44, 45, 48, 54, 62, 64, 66, 69, 70 and 74.
8. If obstacle lighting is required (for example, as a requirement of CASA), the wind turbines should be lit with steady red low intensity lighting at night as per MOS 139 Section 9.4, while minimising visual impact. To ensure the ongoing availability of obstacle lights (if required), a monitoring, reporting and maintenance program should be established in accordance with the guidance in MOS 139 Section 9.4.10.
9. Department of Defence requested that if LED lighting is used for obstacle lighting, then emitted light should fall within the wavelength range of 655 to 930 nanometres for night vision devices compatibility.
10. The Proponent may consider other factors in its decision as to whether obstacle lights should be installed.

Marking of wind monitoring towers

11. Consideration should be given to marking the wind monitoring towers according to the requirements set out in MOS 139 Section 8.10 (as modified by the guidance in NASF Guideline D).

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; and

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

ANNEXURES

1. Aviation Impact Statement
2. Turbine coordinates and heights
3. Obstacle lighting design

ANNEXURE 1 – AVIATION IMPACT STATEMENT

IDS Australasia, Aviation Impact Statement, Ryan Corner Wind Farm, Victoria, Australia (Final) v2.0, 07 October 2015.

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AVIATION IMPACT STATEMENT
RYAN CORNER WIND FARM
VICTORIA, AUSTRALIA

KEYWORDS	RYAN CORNER, WIND FARM, AIS
SUMMARY	This document contains the Aviation Impact Statement (AIS) considerations as detailed by Airservices Australia in relation to the Ryan Corner Wind Farm, Victoria, Australia.
CLASSIFICATION	**COMMERCIAL IN CONFIDENCE**
PRODUCED BY	IDS Australasia (IDSAU) Flight Procedure Design Organisation (FPDO)
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DATE	7 October 2015

FINAL REPORT

Document Evolution		
Revision	Date	Reason of change
V1.0	18/08/2015	New Report
V1.1	03/09/2015	Updated Report
V1.2	03/09/2015	IDS Internal review
V1.3	04/09/2015	First draft release
V2.0	07/10/2015	Final Delivery

Contents

Index of Figures

Index of Tables

Notes

Vertical datum used is the Australian Height Datum unless specified otherwise.

Horizontal datum used is the World Geodetic System 1984 (WGS84) unless specified otherwise.

1 Acronyms & Abbreviations

Acronym / Abbreviation	Description
AGL	Above Ground Level
AHD	Australian Height Datum
AIP	Aeronautical Information Publication
AIS	Aviation Impact Statement
ATC	Air Traffic Control
CASA	Civil Aviation Safety Authority (Australia)
FIA	Flight Information Area
FIS	Flight Information Service
FPDAM	Flight Procedure Design & Airspace Management (software package)
GNSS	Global Navigation Satellite System
IAP	Instrument Approach Procedure
IFR	Instrument Flight Rules
LSALT	Lowest Safe Altitude
MOS	Manual of Standards
MSA	Minimum Sector Altitude
NDB	Non-directional beacon
NOTAM	Notice to Airmen
OLS	Obstacle Limitation Surface
PANSOPS	Procedures for Air Navigation Services – Aircraft Operations
PSR	Primary Surveillance Radar
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules
WGS84	World Geodetic System 1984
WTG	Wind Turbine Generator

2 Executive Summary

IDS Australasia Pty Ltd has been engaged by Aviation Projects Pty Ltd to undertake an Aviation Impact Statement (AIS) for proposed amendments to the approved Ryan Corner Wind Farm (hereafter referred to as the "wind farm") located approximately 15NM west of Warrnambool aerodrome, Victoria.

This report has been prepared in relation to a proposed amendment for the wind farm. The amendment seeks to alter the scale of the approved turbines, as well as minor alterations to the siting and number of turbines and realigned access tracks. This report assesses the potential impacts as a result of the proposed amendment.

The Ryan Corner wind farm received planning approval in 2008. On 21 August 2008, Planning Permit No. 20060222 was issued for Ryan Corner for the *'Use and development of land for a Wind Energy Facility'*. Condition 3 of the permit details the specifications of the wind farm, including the number and scale of the turbines. The permit originally specified the tower height of the wind turbines at 78 metres, with an overall height of 121.5 metres above natural ground level. On 12 August 2010, the Minister for Planning approved a minor amendment to the specifications of the wind turbines for the wind farm to allow a tower height of 80 metres and overall height of 126.3 metres.

Approval is now sought to further the turbine specifications as detailed on the permit. It is proposed to increase the tower heights to 117 metres, the rotor diameter to 130 metres and overall tip height to 180 metres. This would result in an overall increase in height of 53.7 metres from natural ground level. It is proposed to microsite a number of turbines and ultimately, reduce the number of turbines on the Ryan Corner wind farm from 68 to 56.

Given the nature of the amendment, any impacts above those approved would be limited to the change in the increase in turbine size, siting, realigned access tracks and the number of turbines on the wind farm.

This evaluation of the potential aviation impact has been undertaken with reference to applicable industry guidelines and relevant civil aviation safety regulations. This report details considerations within a 30NM bounding radius from the wind farm.

There are two airports with instrument approach procedures located within 30 NM of the wind farm. They are Warrnambool airport (registered) 14.6 NM /27.1 km to the east and Portland Airport (certified) 29.8NM/55.2 km to the west of the wind farm.

Other unregistered/uncertified private airstrips and landing grounds may be located within the bounding area, none of which have an OLS and are not noted in aeronautical charts or documents for the region. Pilots operating at such airstrips retain sole responsibility for ensuring that they are aware of the conditions on and surrounding these landing sites.

In summary, the Aviation Impact Statement has determined that:

1) The blade tip elevation of the highest WTG will not exceed 224 m (735 ft) AHD and as such:
    - Will not penetrate any OLS surfaces;

- Will not penetrate any PAN-OPS surfaces;
- Will not have an impact on nearby designated air routes;
- Will not have an impact on prescribed airspace;
- Is wholly contained within Class G airspace; and
- Will not have an impact on existing local aviation activities.

2) The WTG's are located outside the clearance zones associated with aviation navigation aids and communication facilities.

3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).

The development is considered approvable in accordance with the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

3 Overview, Methodology & Reference Criteria

Ryan Corner Development Pty Ltd seeks to develop a wind farm known as the Ryan Corner Wind Farm, approximately 27 km west of Warrnambool. The wind farm is to comprise 56 wind turbines (WTGs) with a maximum blade tip height not exceeding 180 m above ground level (AGL). The highest terrain on which a WTG will be located has an elevation of 44 m AHD (WTG B40) resulting in a maximum elevation of 224 m (735 ft) at the blade tip.

The following table identifies aerodromes with published instrument approach and landing procedures within the vicinity of the wind farm. Two aerodromes of this type exist within the 30NM bounding area.

Aerodrome	Status	Distance to Closest WTG	IAPs Avail
Warrnambool	Registered	14.5 NM/27 km	Yes
Portland	Certified	29.5 NM/55 km	Yes

Table 1: Aerodromes with published instrument procedures

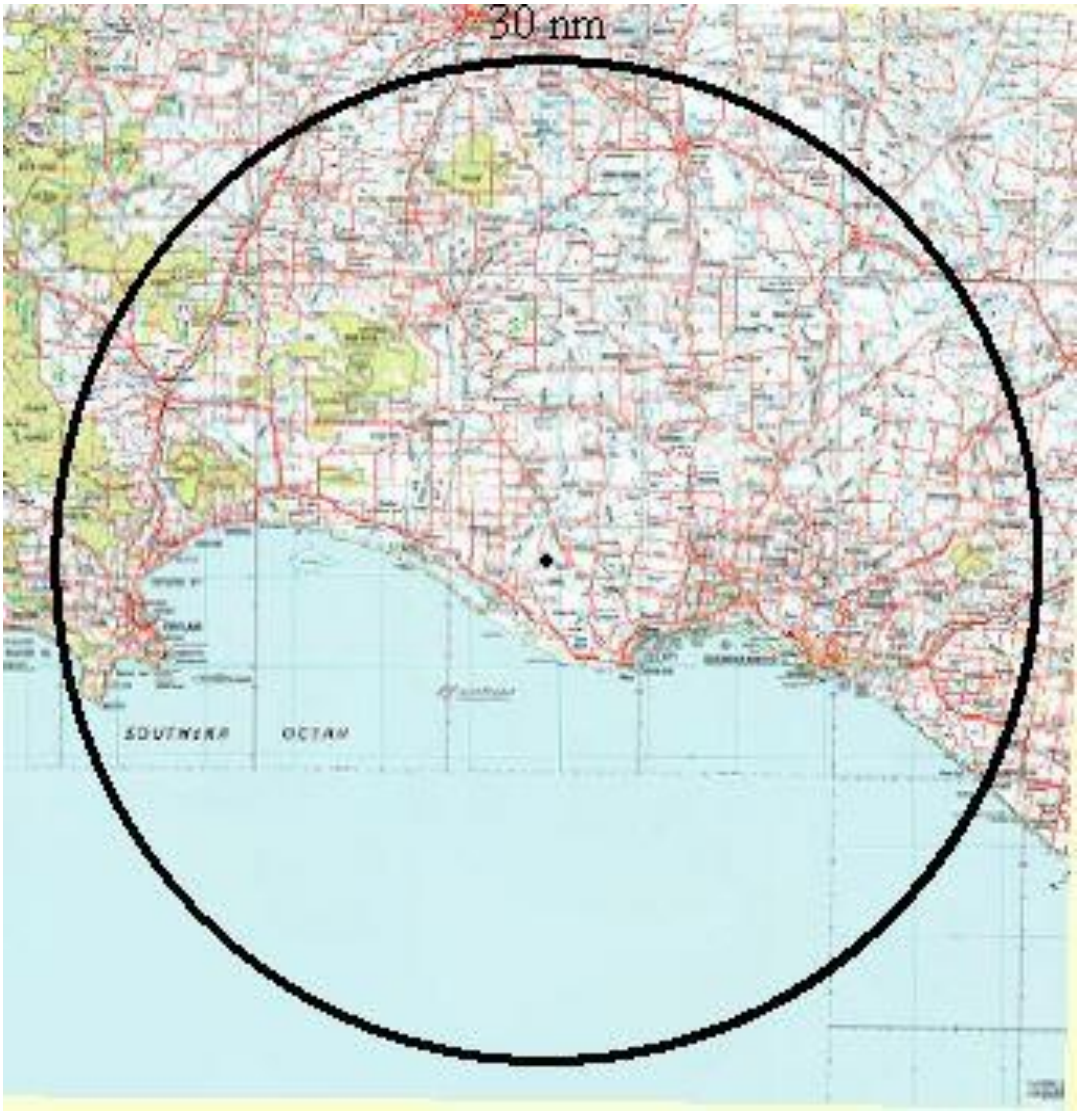


Figure 1: Aviation Impact Statement bounding area

The reference criteria on which impact assessments were made include the following:

- Civil Aviation Safety Regulations (CASR) 1988
    - Part 139 Manual of Standards (MOS) – Aerodromes, particularly:
        - Chapter 7: Obstacle Restriction and Limitation; and
        - Chapter 11: Standards for Other Aerodrome Facilities;
    - MOS Part 173 – Standards Applicable to Instrument Flight Procedure Design, particularly:
        - Section 1.1: General; and
        - Chapter 8: Design Standards;
- Civil Aviation Order 20.7.1B
- Civil Aviation Legislation Amendment (Part 175) 2014 (Effective 5 Mar 2015)
- ICAO Procedures for Air Navigation — Air Operations, Volume II - Construction of Visual and Instrument Flight Procedures, DOC 8168-OPS/611 Volume II
- ICAO Annex 14 Volume 1, Chapter 6 "Visual Aids for Denoting Obstacles"
- Airservices Australia publication "Airservices Aviation Assessments for Wind Farm Developments"
- EUROCONTROL Guidelines on how to Assess the Potential Impact of Wind Turbines on Surveillance Sensors

The methodology used in preparing the AIS has taken the following factors into consideration:

- Proximity of the wind farm to controlled airspace (both terminal and enroute);
- Proximity of the wind farm to PRD (prohibited, restricted and danger) classified airspace;
- Existing IFR (instrument flight rules) air routes were to determine the influence of any route lowest safe altitudes as published on various aeronautical charts and publications;
- Instrument approach procedures for aerodromes listed in Table 1 were examined in detail to determine whether any WTG's would penetrate any PANSOPS surfaces. Any restriction on the instrument approach procedures would have to be examined by the CASR Part 173 provider responsible for the procedure to determine if a change is possible to the procedures without imposing a restriction on aviation;
- Published instrument approach procedures only depict a "nominal" track, and not the airspace protection areas that exist around the nominal tracks for these procedures. Analysing the impact of the wind farm on these procedures requires generating the three dimensional buffers (as defined by ICAO and CASA) around these tracks and assessing if any obstacles will penetrate the buffers. IDS certified procedure designers use the FPDAM (flight procedure design and airspace management) software tool to conduct these analyses.
- Annex 14 Obstacle Limitation Surfaces (OLS) were examined to determine whether any WTG's would penetrate Annex 14 surfaces. Any restriction on the Annex 14 surfaces would have to

be examined by the aerodrome operator and Airservices Australia to determine if a change is possible to the procedures without imposing a restriction on aviation;

- Civil Aviation Order 20.7.1B relates to the minimum requirements for clearance of obstacles by an aircraft that has suffered a failure of a critical engine during take-off. The contingency procedures analyse the minimum safe altitudes (and therefore relate to the maximum allowable obstacle height) required in such an event. The influence that the wind farm would have on contingency procedures was considered;
- A preliminary assessment of potential impacts on aviation navigation aids, communication facilities and ATC radar installations.

A summary was made of the findings and conclusion as to whether the proposal should be approved from an aeronautical impact and aviation safety aspect.

The obstacle marking and lighting requirements specified in CASA MOS139/ICAO Annex 14, Chapter 6 are not detailed as part of this report. The applicability of these requirements is contingent on subsequent determination by CASA as to whether or not the wind farm constitutes a "hazard to aviation".

4 Potential Impacts, Risk Analysis & Mitigation

4.1 Aircraft Operators

Airspace

In Australia, all airspace that is not promulgated as Class A, C, D, and E (or restricted) is Class G airspace.

Class G airspace is non-controlled airspace. Both VFR and IFR aircraft are permitted, and neither requires ATC clearance to operate in class G airspace. Air Traffic Control directed separation is not provided, but IFR aircraft will receive information about other IFR aircraft operating in the vicinity.

The wind farm is located in Class G airspace with an upper limit of 18,000 feet. Above 18,000 ft (Flight level 180) Class E airspace exists. There are no Danger/Restricted Areas in the vicinity of the wind farm.

4.2 IFR (Instrument Flight Rules) Operations

En-route Airways

Airways are used in IFR operations and consist of defined corridors that connect specific locations. Historically they allowed aircraft to easily navigate between successive ground-based navigational aids, but with the advent of more advanced navigation systems such as RNAV and GNSS/GPS, airways can be defined without being dependent on a ground based navigation facility. IFR airways have a published lowest safe altitude (LSALT) which guarantees a minimum clearance from ground obstacles.

The figure below depicts IFR airways in close proximity to the wind farm.

Figure 2: IFR airways in proximity to wind farm

Table 2 (below) details the airways reviewed and the route lowest safe altitudes for each segment. The air routes were assessed with reference to Airservices Australia AIP enroute and terminal area charts effective 28th May 2015.

ROUTE NUMBER	Waypoint Names on Route	Published Route Lowest Safe
W635	POD - WBL	2200
V279	POD - STONE	2700

Table 2: Route numbers, Waypoints & Published LSALT

2200 ft is lowest of the LSALTs for the airways that overfly, or are in the vicinity of the wind farm. A minimum obstacle clearance of 1000ft below the published LSALT must be maintained along each airway. The highest obstacle (WTG B40) is approximately 465 ft below the protection area surface which starts at an altitude of 1200 ft.

A “grid” LSALT is specified on IFR charts that provides a LSALT for operations away from defined airways. The grid LSALT in the vicinity of the wind farm is 2500ft. The protection surface starts at 1500 ft and the controlling obstacle (WTG B40) is 765 ft below this surface.

The WTG’s do not infringe any grid LSALT or airway route segment protection areas. No other adjacent airway protection areas are penetrated by the obstacles. High level routes are for aircraft at or above FL200 (20,000ft). The wind farm at Ryan Corner does not affect high level routes.

Instrument Procedures

The nearest airfield with PANSOPS surfaces is Warrnambool aerodrome, located approximately 14.5 NM to the east of the wind farm. The following table details the published instrument flight procedure assessed.

Aerodrome	Procedure Title	Detailed Assessment required	Rationale	Wind Farm Impact on Procedure
Portland	NDB-A	NO	Procedure protection areas outside of wind farm	**Protection area not penetrated**
	RNAV-Z (GNSS) RWY 08	NO	Procedure protection areas outside of wind farm	**Protection area not penetrated**
	RNAV-Z (GNSS) RWY 26	**YES**	The wind farm overlays PODEB holding	**Protection area not penetrated**
	MSA	**YES**	Wind farm lies below the protection surfaces	**Protection area not penetrated**
Warrnambool	NDB-A	NO	Procedure protection areas outside of wind farm	**Protection area not penetrated**
	GNSS Arrival Procedure	**YES**	The wind farm lies below the initial protection area for this procedure.	**Protection area not penetrated**
	RNAV-Z (GNSS) RWY 31	NO	Procedure protection areas outside of wind farm	**Protection area not penetrated**
	RNAV –Z (GNSS) RWY 13	NO	Procedure protection areas outside wind farm	**Protection area not penetrated**
	MSA	**YES**	Wind farm lies below the protection surfaces	**Protection area not penetrated**

Table 3: Assessed procedures matrix

YWBL (Warrnambool)

Warrnambool airport is a registered airport located 11km North West of Warrnambool Township (ICAO CODE YWBL). It is presently served by an RPT (regular public transport) operator - Sharp Airlines. This service is operated between Warrnambool and Essendon Airport (SE of Melbourne) on a daily basis. The airport is equipped with two runways, one of which has non-precision instrument approach capability.

10 & 25 NM MSA (Minimum Sector Altitude)

The protection areas associated with the YWBL 25 NM and 10 NM MSA were generated using FPDAM and assessed with reference to the WTG's. The 25NM MSA has a minimum altitude of 3300 ft and the 10 NM MSA has an altitude of 1900 ft. The wind farm site lies between the 10 and 25NM MSA buffers. A minimum obstacle clearance of 1000ft below the MSA must be maintained within each protection area. The most critical WTG's (B21 & B28) are 179 ft below the protection surface for the 10 NM MSA protection surface.

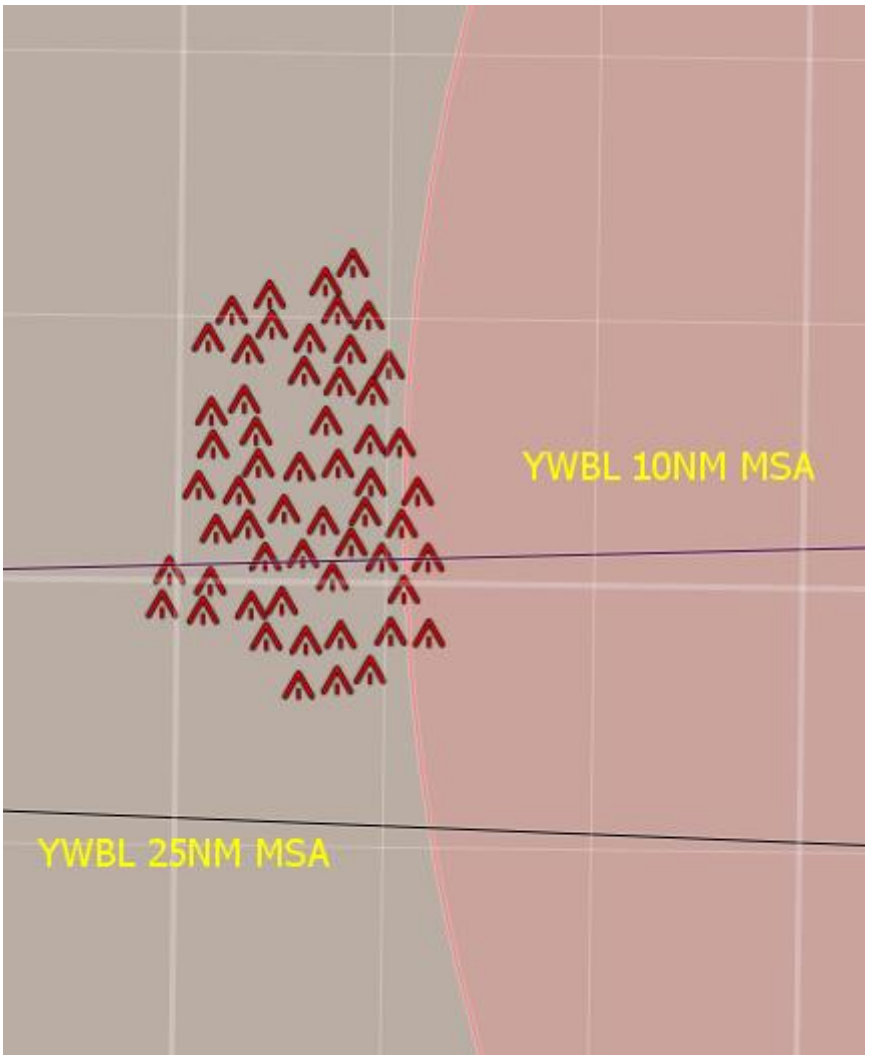


Figure 3: YWBL MSA protection areas

NDB-A Procedure

The protection areas associated with this procedure were generated using FPDAM and assessed with reference to the WTG's. This procedure lies to the east of the wind farm and the protection surfaces are not impacted.

RNAV-Z (GNSS) RWY 13 Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the east of the wind farm and protection surfaces are not impacted.

RNAV-Z (GNSS) RWY 31 Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the east of the wind farm and protection surfaces are not impacted.

YPOD (Portland)

Portland Aerodrome is a certified airport located 7nm North West of Portland township (ICAO Code YPOD). It is presently served by an RPT (regular public transport) operator - Sharp Airlines. This service is operated between Portland and Essendon Airport (SE of Melbourne) on a daily basis. The airport is equipped with two runways, one of which has non-precision instrument approach capability.

10 & 25 NM MSA (Minimum Sector Altitude)

The protection areas associated with the YPOD are the 25 NM and 10 NM MSA were generated using FPDAM and assessed with reference to the WTG's. The 25NM and the 10 NM MSA have a minimum altitude of 2000 ft. The wind farm site lies on the outer edge of the 25NM MSA buffer. A minimum obstacle clearance of 1000ft below the published MSA must be maintained within each protection area. The most critical WTG (B48) is 297 ft below the protection surface for the 25 NM MSA.

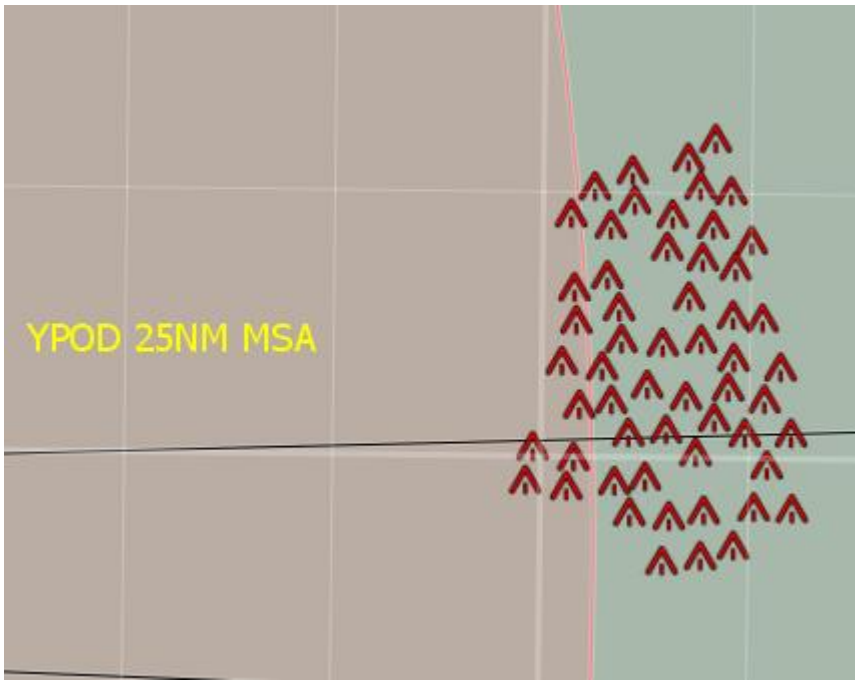


Figure 4: YPOD 25NM MSA boundary

NDB-A Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the west of the wind farm and does not impact the procedure.

RNAV-Z (GNSS) RWY 08 Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The procedure lies to the west of the wind farm and protection surfaces are not impacted.

RNAV-Z (GNSS) RWY 26 Procedure

The protection areas for this procedure were generated using FPDAM and assessed with reference to the WTG's. The holding procedure protection area overlies the wind farm however none of the obstacles impact on the procedure. The most critical WTG (B40) is 265 ft below the protection surface for the holding segment.

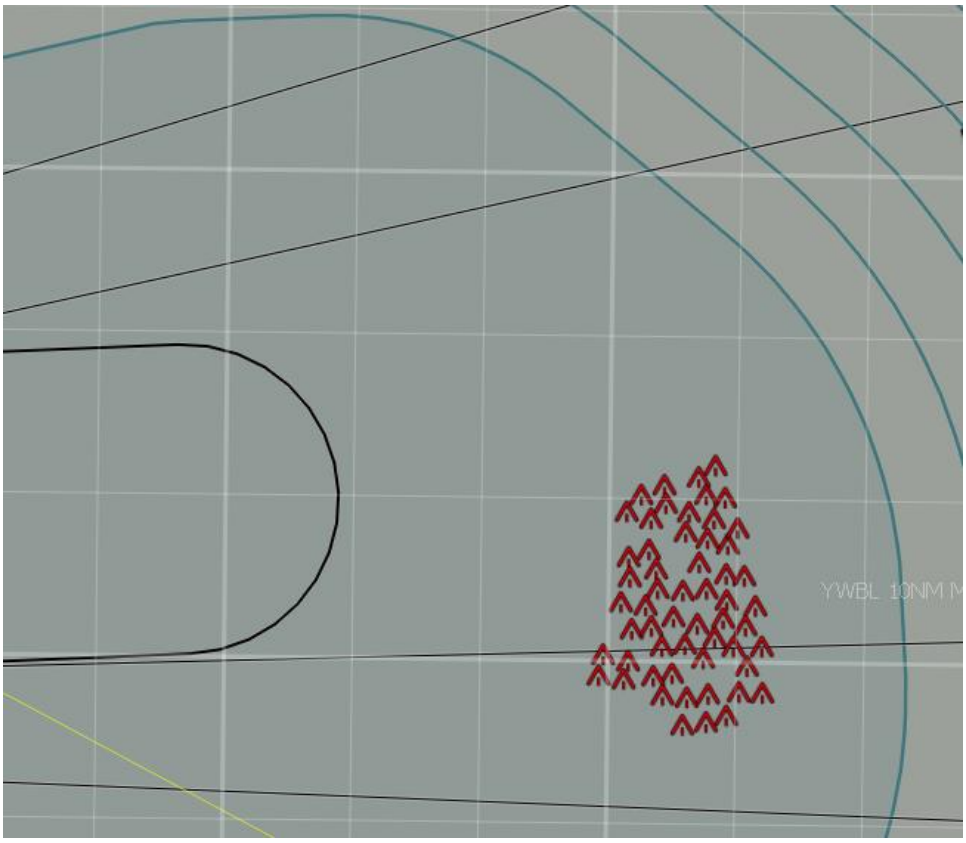


Figure 5: YPOD RNAV-Z (GNSS) RWY 26 Holding protection area

Engine Inoperative Flight Paths

The wind farm is considered to be sufficiently distant from nearby airfields to not have an impact on contingency procedures and engine inoperative flight paths.

5 Air Navigation Service Provider

Airservices Australia is the sole provider of civil air navigation services for Australia. They are responsible for the provision of aeronautical data, telecommunications, navigation services and aviation rescue and firefighting services. The impact of the wind farm on their relevant areas of responsibility is described below.

5.1 Surveillance Radar

A radar facility is located at Mt Macedon, positioned approximately 128nm/237.1 km north east of the wind farm. This is a Route Surveillance radar (RSR) and Airservices Australia advise that this is a SSR only facility.

Wind turbines can negatively impact on surveillance radars, particularly when in the line of sight of the radar facility and the turbine blades are rotating. Turbines can reflect radio frequency energy which may mask legitimate targets and as a result, display of false targets or generate "clutter".

CASA MOS 139 11.1.14.4 clearance requirements for radar sensor sites describe the required clearance area as follows: "No intrusion within 1 km of the radar into a height surface 5 m below the bottom of the antenna. No intrusion between the radar and the possible location of any desired targets, i.e. roughly speaking above 0.5 degrees elevation at any distance." Due to the distance from this radar facility, none of the WTG's penetrate the MOS139 protection area.

Airservices Australia require additional assessment of wind farms against EUROCONTROL guidelines. These guidelines categorise WTG's in a given zone depending on certain parameters. The zoning of a given WTG dictates the level of assessment required. The zoning criteria are listed in APPENDIX B.

Mt Macedon RSR (SSR) Facility

Radar line of sight analysis (LOS) was performed to ascertain the zoning of WTGs with respect to both the radar installations. This analysis was performed using Global Mapper v16 using the following parameters:

Mt. Macedon Radar Facility	
Latitude (WGS84)	-37.3833
Longitude (WGS84)	144.575
Antenna elevation (m AHD)	1047
Receiver (Turbine) height AGL (m)	180.0+10 (10m added to compensate for DEM error bounds)
View Radius	100km
Earth Curvature Correction	Enabled
Atmospheric Correction Factor	1.333
DEM model	Geoscience Australia 1sec SRTM DEM

Table 4: Mt Macedon LOS analysis

Mt. Macedon is approximately 128 nm from the wind farm and preliminary assessment indicates that no LOS is present between the Mt Macedon RSR (SSR) facility and the WTGs. EUROCONTROL guidelines advise that further assessment is required if LOS is present between the radar facility and WTG. Additionally the Mt Macedon facility is SSR only and further than 16km from the wind farm.

NOTE: EUROCONTROL guidelines recommend safeguarding of the area for the radar far-field monitor (FFM). At time of writing, information regarding this sensor had not yet been received from Airservices Australia. The potential impact of the wind farm on any FFM has not yet been established.

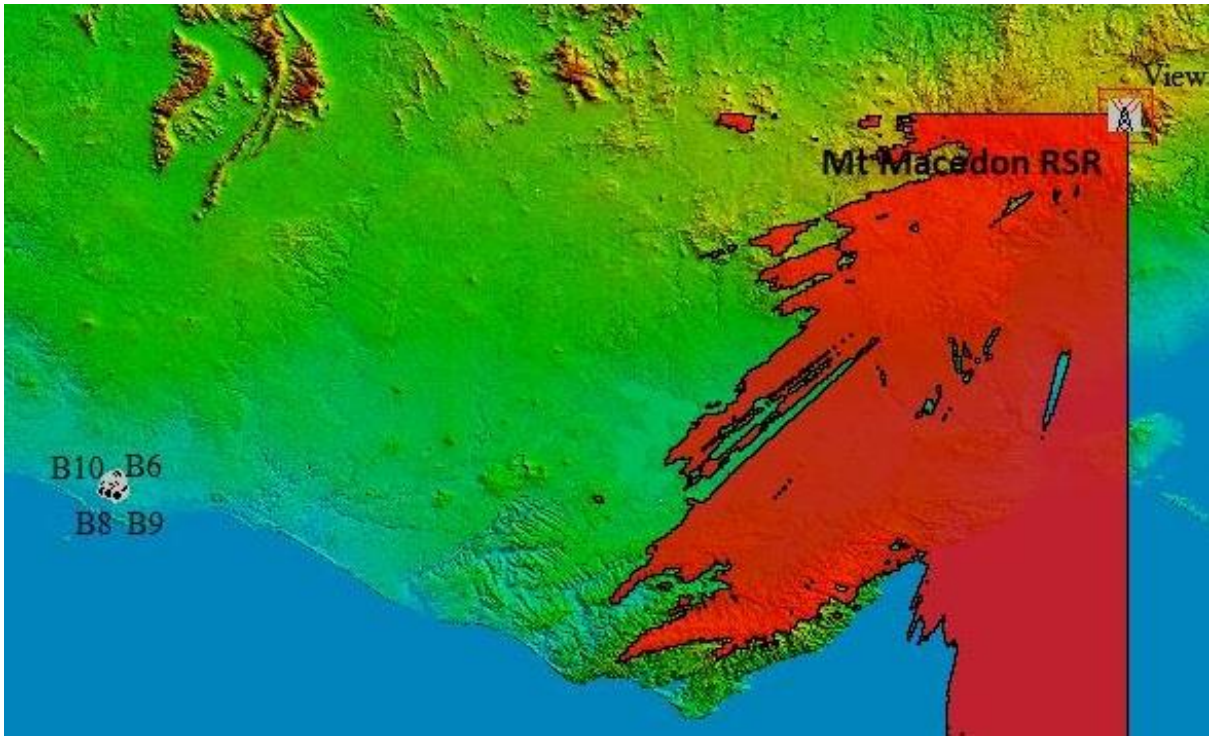


Figure 6: Mt Macedon RSR Line of sight analysis

5.2 Ground Based Navigation Aids

The potential impact on aviation navigation aids were assessed in accordance with CASR MOS Part 139. The wind farm is located outside the clearance zones associated with the nearest aviation navigation aids.

As part of the transition to satellite based navigation, Airservices Australia are undertaking a "Navigation Rationalisation Project" which will decommission approximately half of Australia's conventional navigation facilities. Portland and Warrnambool NDB's are not included in the "Backup Navigation Aid Network" and are proposed to be decommissioned from 26 May 2016, subject to CASA's final approval.

The following table identifies aviation navigation aids and approximate distances to the boundary of the wind farm.

NAVAID Type	Range	Distance to Closest WTG	MOS 139 Reference
NDB (WBL)	45 NM	14.8 NM (27.5km)	11.1.13
NDB (POD)	45 NM	29.2 NM (54.2km)	11.1.13

Table 5: Aviation Navigation Aids

5.3 Communication Facilities

The potential impact on communication facilities was assessed in accordance with CASR MOS Part 139 11.1.15.2. There will be no impact as the wind farm will not affect the line of sight path between aircraft and ground based communication facilities.

6 Aerodrome Operators

6.1 Annex 14 OLS (Obstacle Limitation Surfaces)

Annex 14 OLS defines the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Annex 14 surfaces are applicable to aerodromes where instrument approach procedures are conducted.

The wind farm is located beyond the distance from YPOD (Portland) and YWBL (Warrnambool) where Annex 14 surfaces apply. As the surfaces are not penetrated by any WTGs no further analysis is required.

7 Conclusion

The assessments and reviews contained in this Aviation Impact Statement were conducted in accordance with the relevant aviation and aeronautical regulations and standards. In summary, the Aviation Impact Statement has determined that:

1) The blade tip elevation of the highest WTG will not exceed 224 m (735 ft) AHD and as such:
    - Will not penetrate any OLS surfaces;
    - Will not penetrate any PAN-OPS surfaces;
    - Will not have an impact on nearby designated air routes;
    - Will not have an impact on prescribed airspace;
    - Is wholly contained within Class G airspace; and
    - Will not have an impact on existing local aviation activities.
2) The WTG's are located outside the clearance zones associated with aviation navigation aids and communication facilities.
3) A preliminary assessment on the impact of the wind farm on ATC radar surveillance facilities has been made. These facilities are located to the north of and to the east of Melbourne Airport (YMML) and are sufficiently distant from the wind farm to be outside line of sight (LOS).
4) The wind farm is sufficiently distant from airfields to not have an impact on contingency procedures and engine inoperative flight paths.

The development is considered approvable in accordance with the relevant civil aviation regulations. This Aviation Impact Statement can be used as supporting documentation for an application to CASA.

APPENDIX A. Ryan Corner Wind Farm:WTG Coordinates/Elevation

Assumptions:

- Shading denotes WTG's that have been moved (microsited) from Aug 2008 location
- 2M has been added to terrain base elevation for microsited WTG's
- Tip elevation based on assumed WTG maximum blade tip height 180m AGL.

Blade Length (m)	Rotor Diameter (m)	Hub Height (m)	Tip Height (m)
65	130	117	180

ID	LAT	LONG	ELEV (m)	ID	LAT	LONG	ELEV(m)
B6	-38.3111	142.131	212	**B43**	-38.2598	142.1274	223
B8	-38.3064	142.1403	212	**B44**	-38.2622	142.1231	218
B9	-38.3062	142.1342	212	**B45**	-38.2639	142.1142	221
B10	-38.3131	142.1196	207	**B46**	-38.266	142.1082	219
B13	-38.3075	142.1206	211	**B47**	-38.2677	142.1146	214
B14	-38.307	142.1143	211	**B48**	-38.2695	142.1044	214
B15	-38.3025	142.1167	210	**B49**	-38.2708	142.1108	213
B16	-38.297	142.114	212	**B52**	-38.2772	142.1104	210
B17	-38.2966	142.12	208	**B54**	-38.2787	142.1051	205
B18	-38.2994	142.1248	217	**B55**	-38.2812	142.1123	213
B20	-38.3009	142.1362	222	**B58**	-38.2829	142.1055	204
B21	-38.2969	142.14	220	**B59**	-38.2852	142.1127	206
B22	-38.2969	142.1326	217	**B60**	-38.2856	142.1193	214
B23	-38.295	142.1277	214	**B62**	-38.288	142.1032	201
B24	-38.2926	142.1357	221	**B63**	-38.2887	142.1097	200
B25	-38.2912	142.1299	212	**B64**	-38.2909	142.1169	213
B26	-38.2923	142.1232	214	**B66**	-38.2935	142.1061	210
B28	-38.2886	142.1382	220	**B67**	-38.2929	142.1112	208
B29	-38.2874	142.1307	219	**B69**	-38.2988	142.0987	213
B30	-38.2851	142.1255	216	**B70**	-38.3031	142.0976	205
B31	-38.2824	142.1353	222	**B72**	-38.3001	142.1052	214
B32	-38.282	142.1305	219	**B73**	-38.3031	142.1118	208
B33	-38.2759	142.1309	220	**B74**	-38.3038	142.1041	206
B34	-38.2797	142.1235	215	**B75**	-38.3067	142.1262	206
B35	-38.2726	142.1334	219	**B76**	-38.3125	142.1257	210
B36	-38.2748	142.1256	217				
B37	-38.2735	142.1199	216				
B38	-38.2707	142.1272	217				
B39	-38.2694	142.1207	217				
B40	-38.2664	142.13	224				
B41	-38.2658	142.1251	218				

APPENDIX B. EUROCONTROL Assessment Zones

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 - 500 m	500 m - 15 km and in radar line of sight	Further than 15 km but within maximum instrumented range **and in** radar line of sight	Anywhere within maximum instrumented range but **not in** radar line of sight or outside the maximum instrumented range.
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**Simple assessment**	**No assessment**

PSR Recommended Ranges (Source: EUROCONTROL)

Zone	Zone 1	Zone 2	Zone 4
Description	0 - 500 m	500 m - 16 km but within maximum instrumented range **and in** radar line of sight	Further than 16 km **or not** in radar line of sight
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**No assessment**

SSR Recommended Ranges (Source: EUROCONTROL)

ANNEXURE 2 – TURBINE COORDINATES AND HEIGHTS

Ryan Corner Development Pty Ltd, 20150622 - RCWF, List of Revised Turbine Coordinates (AGD66) v2-1, dated 22 June 2015.

Note: add 2 m to the height of base for any wind turbines that have moved from its original position.

Turbine ID	RCWF Approved Locations August 2008			RCWF Microsited Locations 22 June 2015			Comments (From Original)	Hub Height (m)
	Eastings AGD66 (m)	Northings AGD66 (m)	Height of base (m ASL)	Eastings AGD66 (m)	Northings AGD66 (m)	Movement From Original (m)		
B6	598757	5758884	32	598757	5758884	0	~	117
B8	599628	5759481	30	599580	5759399	95	South-West	117
B9	599046	5759451	30	599046	5759421	30	South	117
B10	597733	5758581	25	597757	5758672	94	North-East	117
B13	597858	5759298	31	597858	5759298	0	~	117
B14	597305	5759354	31	597305	5759354	0	~	117
B15	597565	5759924	28	597523	5759851	85	South-West	117
B16	597266	5760376	30	597291	5760468	95	North-East	117
B17	597818	5760511	28	597818	5760511	0	~	117
B18	598165	5760125	35	598232	5760192	95	North-East	117
B20	599214	5759950	40	599229	5760008	60	North-East	117
B21	599568	5760455	40	599568	5760455	0	~	117
B22	598922	5760458	37	598922	5760458	0	~	117
B23	598493	5760673	34	598493	5760673	0	~	117
B24	599196	5760931	41	599196	5760931	0	~	117
B25	598687	5761099	32	598687	5761099	0	~	117
B26	598099	5760974	34	598099	5760974	0	~	117
B28	599422	5761378	40	599422	5761378	0	~	117
B29	598768	5761563	37	598768	5761513	50	South	117
B30	598310	5761771	36	598310	5761771	0	~	117

Turbine ID	RCWF Approved Locations August 2008			RCWF Microsited Locations 22 June 2015			Comments (From Original)	Hub Height (m)
	Eastings AGD66 (m)	Northings AGD66 (m)	Height of base (m ASL)	Eastings AGD66 (m)	Northings AGD66 (m)	Movement From Original (m)		
B31	599265	5762065	40	599170	5762065	95	West	117
B32	598757	5762109	39	598757	5762109	0	~	117
B33	598834	5762722	38	598794	5762791	80	North-West	117
B34	598143	5762373	35	598143	5762373	0	~	117
B35	599085	5763085	37	599017	5763152	95	North-West	95
B36	598412	5762921	35	598332	5762921	80	West	117
B37	597836	5763071	36	597836	5763071	0	~	117
B38	598559	5763372	35	598479	5763372	80	West	117
B39	597911	5763523	37	597911	5763523	0	~	117
B40	598802	5763777	42	598734	5763844	95	North-West	117
B41	598384	5763969	36	598302	5763921	95	South-West	117
B43	598572	5764634	41	598516	5764577	80	South-West	117
B44	598189	5764373	36	598133	5764316	80	South-West	117
B45	597410	5764195	39	597353	5764138	81	South-West	117
B46	596825	5763915	39	596825	5763915	0	~	117
B47	597384	5763720	34	597384	5763720	0	~	117
B48	596493	5763534	34	596493	5763534	0	~	117
B49	596982	5763442	31	597048	5763375	95	South-East	117
B52	596964	5762705	28	596999	5762670	50	South-East	117
B54	596563	5762502	23	596538	5762502	25	West	117
B55	597067	5762224	31	597162	5762223	95	East	117
B58	596630	5761976	22	596563	5762043	95	North-West	117
B59	597195	5761778	26	597195	5761778	0	~	117
B60	597771	5761728	34	597771	5761728	0	~	117

Turbine ID	RCWF Approved Locations August 2008			RCWF Microsited Locations 22 June 2015			Comments (From Original)	Hub Height (m)
	Eastings AGD66 (m)	Northings AGD66 (m)	Height of base (m ASL)	Eastings AGD66 (m)	Northings AGD66 (m)	Movement From Original (m)		
B62	596360	5761472	21	596360	5761472	0	~	117
B63	596923	5761397	20	596923	5761397	0	~	117
B64	597556	5761138	33	597556	5761138	0	~	117
B66	596605	5760764	28	596605	5760859	95	~	117
B67	597053	5760926	28	597053	5760926	0	~	117
B69	595953	5760299	31	595952	5760279	20	South	117
B70	595849	5759805	25	595849	5759805	0	~	117
B72	596570	5760211	32	596522	5760128	95	South-West	117
B73	597094	5759789	28	597094	5759789	0	~	117
B74	596421	5759720	26	596421	5759720	0	~	117
B75	598345	5759377	26	598345	5759377	0	~	117
B76	598296	5758739	30	598296	5758739	0	~	117

ANNEXURE 3 – OBSTACLE LIGHTING DESIGN

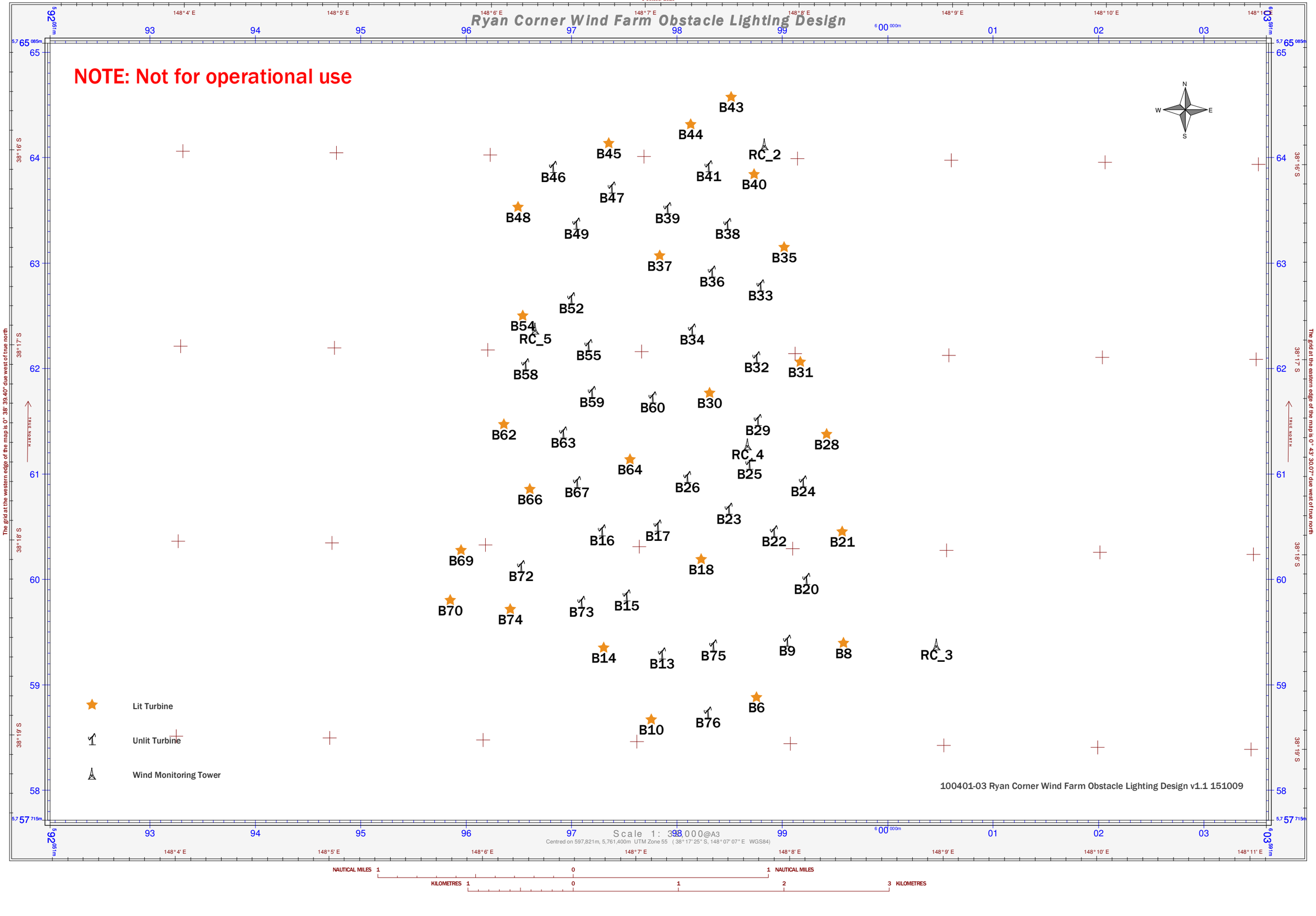
Aviation Projects, 100401-03 Ryan Corner Wind Farm Obstacle Lighting Design v1.1 151009.

AVIATION PROJECTS

Ryan Corner Wind Farm Obstacle Lighting Design

9 October 2015

NOTE: Not for operational use



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