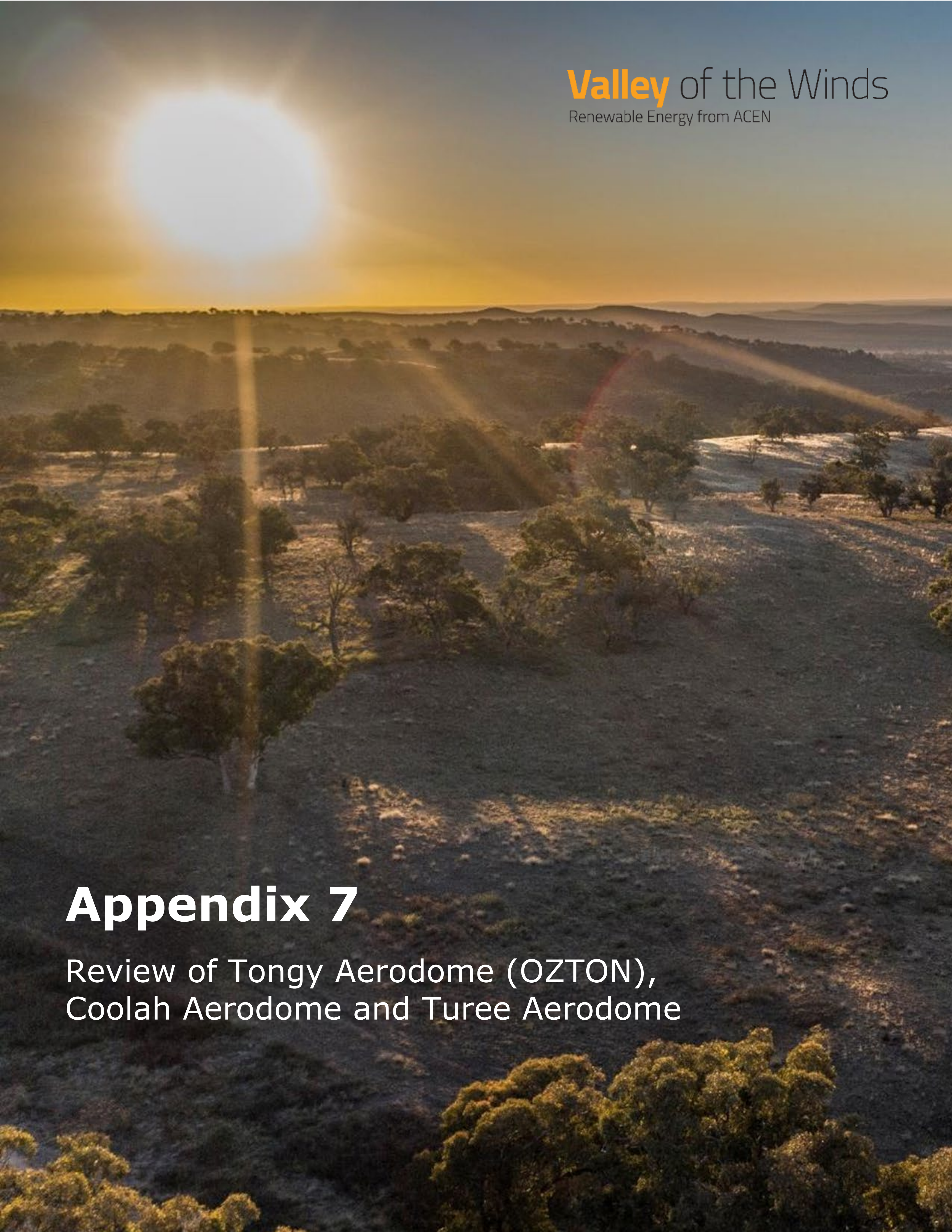


Valley of the Winds
Renewable Energy from ACEN

Appendix 7

Review of Tongy Aerodome (OZTON), Coolah Aerodome and Turee Aerodome

April 2024

SUPPLEMENTARY MEMO

ACEN AUSTRALIA

Re: Review of Tongy Aerodrome (OZTON), Coolah Aerodrome and Turee Aerodrome

This Supplementary Memo provides the results of the additional assessment undertaken by Aviation Projects in response to a request for information provided by the Department of Planning, Housing and Infrastructure (DPHI) dated 21 December 2023 requesting:

- assessment of impacts to small airstrips in proximity to the project, including the 'Turee' aerodrome (See section 1.5); and
- detailed analysis of impacts to Coolah aerodrome and Tongy aerodrome as per recommendations of the Aviation Impact Assessment(see section 1.3 and 1.4).

1.1. Background

The Aviation Impact Assessment (AIA) prepared by Aviation Projects in February 2022 considered the recommendations outlined in the National Airports Safeguarding Framework (NASF) Guideline D – *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers (2012).*

NASF Guideline D provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and wind monitoring towers.
Guidance regarding wind turbine wake turbulence states:

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

Since the preparation of the AIA, Aviation Projects, through desktop research of published scientific studies, has determined that any adverse turbulence would in most circumstances be confined to within 7 rotor diameters (RD) of a wind turbine generator (WTG), but considers that a conservative area of 10 RD is likely to be the maximum area where wake turbulence from WTGs would be felt by pilots of light aircraft operating downstream of a WTG. These studies also indicated that where any such turbulence is experienced, the pilot would be able to control the aircraft using normal control inputs.

Two of those studies are referred to below.

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

> *In neutral conditions, the largest of these hazards are classified as medium hazards and exist 6.5 D downwind of the turbine in the bottom-left portion of the rotor disk. The highest hazards in the stable*

case also remained within the medium threshold and are located in two separate regions of the wake: approximately 4 D downwind in the bottom-right quadrant of the rotor and 6 D downwind in the top-left quadrant of the rotor.

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

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

1.2. Assessment

Since 2022 Aviation Projects has conducted reviewed desktop research of various wind farm turbulence theoretical studies to gain a detailed understanding of the extent and impact of turbulence that may be created by WTGs.

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

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

The studies referenced above also indicate that aircraft controllability is maintained when experiencing the likely turbulence when the aircraft is approximately 5 RD from a WTG.

The project AIA referred to a maximum case of a RD of 180 m which provides the following distances for possible turbulence from the WTGs in Table 1, based on WTG RD.

An area of interest of 5556 m (3 nm) from a publicly available aerodrome defines an area where:

- Aircraft are manoeuvring into/out of the standard circuit area and may conflict with other traffic operating at that aerodrome
- Where aircraft operating at night are permitted to descend below lowest safe altitudes above terrain and obstacles.

None of the aerodromes in the vicinity of the Project are equipped with suitable lighting to allow flights to operate at night.

Tongy and Turee Aerodromes are privately owned. All aircraft operating there must be permitted by the respective aerodrome owner.

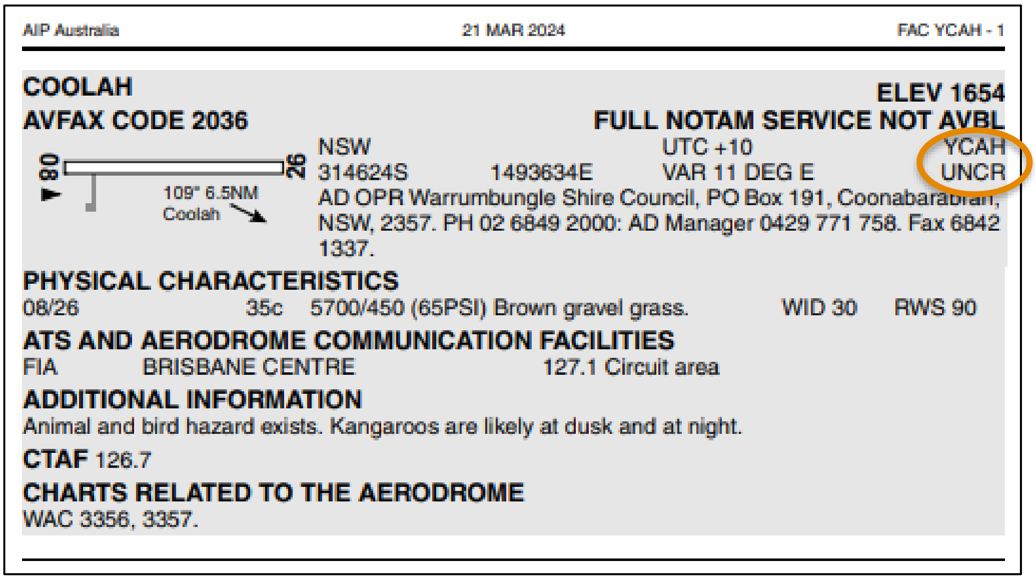
Table 1 Wake Turbulence Distances

1 RD (m)	16 RD (m)	10 RD (m)	7 RD (m)
180	2880	1800	1260

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

1.3. Coolah Aerodrome

Coolah Aerodrome was referred to in the AIA as a Certified Aerodrome, which was the case when the AIA was prepared. It has since been de-certified and currently holds the status of an Uncertified Aerodrome (ALA) as shown in Figure 1. (Source: Aeronautical Information Publication (AIP) – Airservices Australia)


AIP Australia 21 MAR 2024 FAC YCAH - 1

COOLAH **ELEV 1654**
AVFAX CODE 2036 **FULL NOTAM SERVICE NOT AVBL**

08 26 109° 6.5NM Coolah

NSW UTC +10 YCAH
314624S 1493634E VAR 11 DEG E UNCR
AD OPR Warrumbungle Shire Council, PO Box 191, Coonabarabran, NSW, 2357. PH 02 6849 2000: AD Manager 0429 771 758. Fax 6842 1337.

PHYSICAL CHARACTERISTICS
08/26 35c 5700/450 (65PSI) Brown gravel grass. WID 30 RWS 90

ATS AND AERODROME COMMUNICATION FACILITIES
FIA BRISBANE CENTRE 127.1 Circuit area

ADDITIONAL INFORMATION
Animal and bird hazard exists. Kangaroos are likely at dusk and at night.

CTAF 126.7

CHARTS RELATED TO THE AERODROME
WAC 3356, 3357.

Figure 1 Coolah Aerodrome listing in AIP

Coolah Aerodrome is located approximately 6185. 7 m (3.34 nm) from the nearest WTG within the VoW wind farm. It is a publicly available aerodrome and can be used at any time during daylight hours. It is outside the area of interest for aviation activity at Coolah Aerodrome (3 nm / 5.6 km). It is shown in Figure 2 in relation to the WTGs.

1.3.1. Summary – Coolah Aerodrome

The VoW wind farm will not create any adverse operational safety impacts to flight operations at Coolah Aerodrome.

Figure 2 Coolah Aerodrome in relation to the VoW wind turbines

1.4. Tongy Aerodrome

Tongy Aerodrome is a privately owned aerodrome located approximately 3200 m (1.73 nm) from the nearest WTG to the threshold of Runway 09. Details of the aerodrome were sourced from OzRunways.

Aircraft conducting circuit area operations either in preparation to land or climbing after take-off from an uncontrolled aerodrome such as Tongy, would normally remain within a 1852 m (1 nm) area until they reach a minimum height in accordance with CASR 91.267 and pilot endorsements.

This 1 nm area is shown in Figure 3. Circles of 1800 m radius from nearby WTGs are shown in relation to the standard circuit area at Tongy aerodrome.

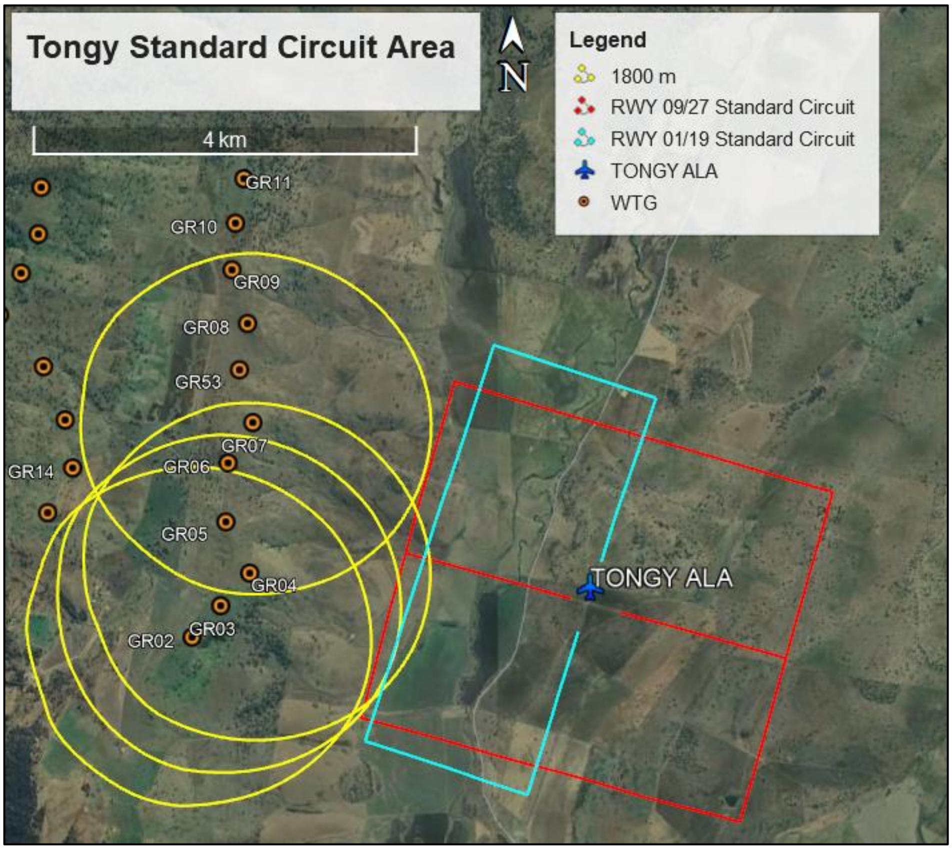


Figure 3 Tongy standard circuit and turbulence areas from WTGs (1800 m = 10 RD)

Based on the conservative measurement of 10 RD, there is a small overlap of potential turbulence from WTG GR03, and GR04 could be felt by aircraft operating in the western edge of the standard circuit area of Tongy Aerodrome. The potential turbulence from WTG GR02 and GR07 are very close to the standard circuit area of Tongy Aerodrome.

The aerodrome is located in a valley and there may also be some mechanical turbulence evident in the circuit area and over the aerodrome, created by the undulating terrain. Trees may also create some mechanical turbulence. This turbulence would help to break up any turbulence created by the closest VoW WTGs.

It may be possible for owners of the Tongy Aerodrome to limit circuits to a right hand pattern for Runway 27 to alleviate potential WTG turbulence impacts. This is a common occurrence for aerodromes and information would need be provided to Airservices Australia for publication in the Aeronautical Information Publication as required by CASA for aerodromes with non-standard circuit directions.

Priority may be given to the use of Runway 18/36 with a circuit direction contained to the east of that runway, without causing a significant impact to flight operations at Tongy Aerodrome.

Low level aerobatics can be conducted by pilots holding the appropriate endorsement under CASR Part 61, Division S, Table 61.1145, items 1 – 5 shown in Figure 4.

The likely turbulence experienced within the standard circuit area will not exceed the pilot’s ability to control the aircraft attitude using normal control inputs in a normal category aircraft. The additional manoeuvrability of an aerobatic category aircraft will allow the pilot to control the aircraft even more effectively.

Subpart 61.S—Flight activity endorsements

61.1145 Kinds of flight activity endorsement

The kinds of flight activity endorsement are set out in column 1 of table 61.1145.

Table 61.1145 Flight activity endorsements

Item	Column 1 Endorsement	Column 2 Activities authorised	Column 3 Requirements
1	Aerobatics flight activity endorsement	Conduct aerobatic manoeuvres in an aeroplane above 3 000 ft AGL	Aeroplane category rating Spinning flight activity endorsement
2	Aerobatics (1 500) flight activity endorsement	Conduct aerobatic manoeuvres in an aeroplane above 1 500 ft AGL	Aeroplane category rating Aerobatics flight activity endorsement
3	Aerobatics (1 000) flight activity endorsement	Conduct aerobatic manoeuvres in an aeroplane above 1 000 ft AGL	Aeroplane category rating Aerobatics (1 500) flight activity endorsement
4	Aerobatics (500) flight activity endorsement	Conduct aerobatic manoeuvres in an aeroplane above 500 ft AGL	Aeroplane category rating Aerobatics (1 000) flight activity endorsement
5	Aerobatics (unlimited) flight activity endorsement	Conduct aerobatic manoeuvres in an aeroplane at any height	Aeroplane category rating Aerobatics (500) flight activity endorsement

Figure 4 CASR Part 61, Table 61.1145, aerobatic endorsements

Aerobatics are conducted in aircraft specifically constructed and authorised for high energy manoeuvres that place significant load factors onto the airframe. Such modern civilian aircraft are usually highly manoeuvrable and equipped with a powerful engine to enable aerobatics. The dimensions of the Tongy aerodrome appears to be suitable for the safe operation of such aircraft.

Figure 3 shows that flight operations to the east of Tongy Road (an obvious ground feature) are not impacted by downwind turbulence from the proposed WTGs. Aerobatic manoeuvres to the east of Tongy Rd avoid any WTG generated turbulence.

The indicated low level aerobatic flight contained in the vicinity of the aerodrome and to the east of Tongy Road would not be impacted by the presence of WTGs at any altitude.

Whilst some WTG generated turbulence may be felt by pilots during flight within the standard circuit area to the west of Tongy aerodrome, options are available to avoid the area if necessary.

The likely turbulence experienced within the standard circuit area will not exceed the pilot’s ability to control the aircraft attitude using normal control inputs in a normal category aircraft. The additional manoeuvrability of an aerobatic category aircraft will allow the pilot to control the aircraft even more effectively.

1.4.1. Summary – Tongy Aerodrome

Possible downwind turbulence from 2 WTGs may exist in the western area of the standard circuit area of Tongy Aerodrome.

The likely turbulence experienced within the standard circuit area will not exceed the pilot’s ability to control the aircraft attitude using normal control inputs in a normal category aircraft. The additional manoeuvrability of an aerobatic category aircraft will allow the pilot to control the aircraft even more effectively.

Aerobatic manoeuvres to the east of Tongy Rd avoid any WTG generated turbulence.

1.5. Turee aerodrome

Details of Turee Aerodrome via searches of appropriate aeronautical systems were not available at the time that the project AIA was compiled.

Turee Aerodrome is privately owned and currently indicated on Ozrunways and is visible on Google Earth. It is located approximately 3200 m (1.72 nm) northeast of the nearest WTG as shown in Figure 5.

It has a single flight strip containing a northeast to southwest runway. Apart from its location, no other details are currently available.

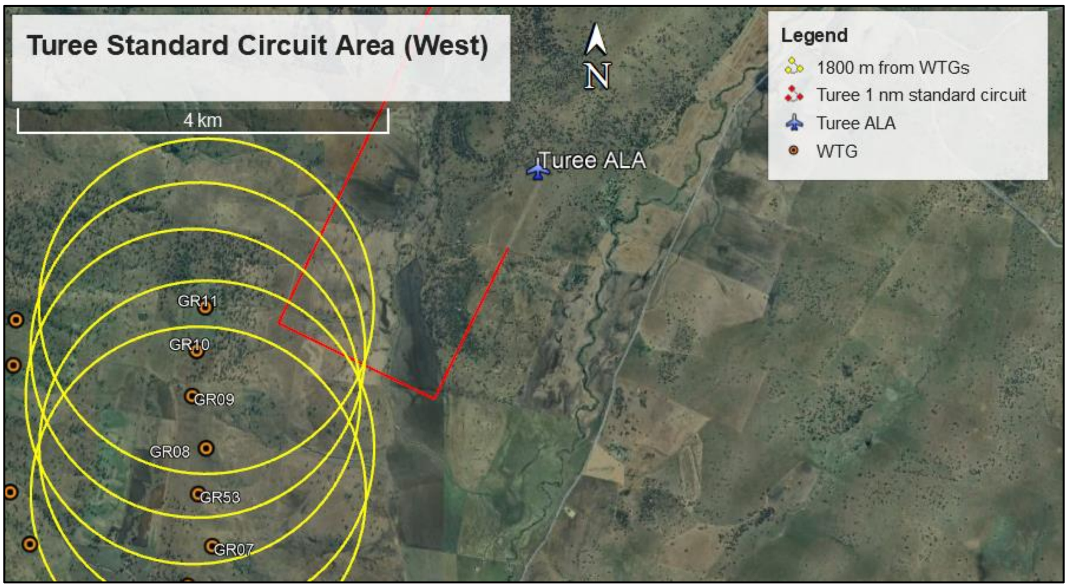


Figure 5 Turee ALA standard circuit area - southwest

Based on the conservative measurement of 10 RD, there is a small overlap of potential turbulence from WTG GR08, GR09, GR10 and GR11 that could be felt by aircraft operating in a left hand circuit for a landing to the northeast. in the south western edge of the standard circuit area of Turee Aerodrome.

The likely turbulence experienced within the standard circuit area is not expected to exceed the pilot's ability to control the aircraft attitude using normal control inputs in a normal category aircraft.

It may be possible for the Turee Aerodrome owner to limit circuits to a right hand pattern for the northeast facing runway to alleviate the potential WTG turbulence impacts. This is a common occurrence for aerodromes and information would need to be provided to Airservices Australia for publication in the Aeronautical Information Publication as required by CASA for aerodromes with non-standard circuit directions.

1.5.1. Summary – Turee Aerodrome

Turbulence generated by WTGs to the southwest of the Turee aerodrome is likely to exist in the outer edges of the standard circuit for the northeast facing runway.

Options remain available for circuits to be conducted to the east of the runway that will avoid any potential WTG generated turbulence.

1.6. Conclusion

Whilst the NASF Guideline D refers to a distance of 16 RD where downwind turbulence may be felt by pilots of light aircraft, research papers indicates that the turbulence is only likely to be felt up to a distance of 7 RD from a WTG.

Aviation Projects considers that a conservative distance of 10 RD is more appropriate.

All WTGs are located outside the area of interest for Coolah Aerodrome and will not impact flight operations there.

At Tongy Aerodrome the likely turbulence experienced within the standard circuit area will not exceed the pilot's ability to control the aircraft using normal control inputs in a normal category aircraft. The additional manoeuvrability of an aerobatic category aircraft will allow the pilot to control the aircraft even more effectively.

In all cases at Tongy Aerodrome, aerobatics conducted to the east of Tongy Road would not be impacted by the presence of the WTGs at any altitude.

Turbulence generated by WTGs to the southwest of the Turee aerodrome is likely to exist in the outer edges of the standard circuit for the northeast facing runway and will not exceed the pilot's ability to control the aircraft altitude using normal control inputs in a normal category aircraft.

1.7. References

Material used for the preparation of this report include:

- Aviation Projects Aviation Impact Assessment (AIA) ref 104101-01, dated 25 February 2022.
- Civil Aviation Safety Authority, Civil Aviation Safety Regulation (CASR):
    - Part 61, Division S – Flight Activity Endorsements, Table 61.1145, items 1 – 5.
    - Part 91 Manual of Standards 2020 – *General Operating and Flight Rules*
    - AC 91-10 v1.1, *Operations in the vicinity of non-controlled aerodromes*, dated November 2021
- "Report – Do wind turbines pose roll hazards to light aircraft?" - https://www.nrel.gov/docs/fy19osti/73919.pdf
- " Report – CAA Wind Turbine Wake Encounter Study" - https://www.liverpool.ac.uk/media/livacuk/flightscience/projects/cfd/wakeencounter/caa_wind_turbine_report.pdf
- NASF Guideline D – *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* (2012)
- Ozrunways Electronic Flight Bag software on 02 April 2024.