ATTACHMENT J

AERONAUTICAL IMPACT AND OBSTACLE MARKING AND LIGHTING ASSESSMENT

CONFIDENTIAL

AERONAUTICAL IMPACT and OBSTACLE MARKING and LIGHTING ASSESSMENT

of proposed

Bulgana wind farm

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REFERENCE
PN 14-0129-01

HART AVIATION

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

SGS HART Aviation undertook an aviation assessment, including investigating local aircraft movements and locations of nearby airfields, to determine the potential impact on aviation operations of the proposed Bulgana Wind Farm and the need or otherwise for obstacle lighting.

As a result of this aviation assessment, SGS HART Aviation reached the considered view that, whilst the overall risk to civil aviation operations in the vicinity of the proposed Bulgana Wind Farm is low, there is sufficient doubt in respect of the impact on the obstacle limitation surfaces for Stawell Aerodrome for the future development to warrant the installation of obstacle lights on the wind turbines, regardless of the type of wind turbine chosen.

CASA needs to be advised of the proposed wind farm development in accordance with CASR 139.365 and it is considered likely to make a determination in accordance with CASR 139.370. SGS HART Aviation considers that CASA may very well require the installation of obstacle lights but can not anticipate any other matter which might be determined by CASA. SGS HART Aviation was informed that CASA has been so advised.

Airservices needs to be advised of the proposed wind farm development as the potential impact on the recently established RNAV (GNSS) instrument approach procedures for Stawell Aerodrome can not be ignored and needs to be assessed by Airservices. SGS HART Aviation was informed that Airservices has also been so advised.

The risk to aviation operations would be further reduced if, in the fullness of time, the wind turbines were identified on the relevant aeronautical charts, i.e., both the civil WACs and the RAAF produced chart series. This is considered essential risk mitigation.

Pending such identification on maps, it would be advisable to ensure that all aviation operators are made aware of the proposed existence of the wind farm. Airservices, if they were made aware of the proposed wind farm, would normally do this via NOTAM action covering both the construction phase and prior to identification on maps. It is, therefore, essential that the wind farm developer advise both Airservices and the RAAF AIS. SGS HART Aviation was informed that the latter has been done.

Advice to CASA, Airservices and the Department of Defence should also include details of the Met Masts – both existing and proposed, and it is understood that this has also been done.

1. TERMS OF REFERENCE

The **principal objectives** have been identified as follows: -

- Undertake a detailed assessment of the potential aviation impacts of the proposed wind farm development, in accordance with relevant guidelines.
- The assessment should meet the requirements of statutory regulations, aviation and transport industry requirements and guidelines, and government policies.
- Such requirements should include, but not be limited to relevant CASA regulations and recommendations in relation to rural structures and specifically wind turbines including management, avoidance or mitigation of potential risks.
- The assessment should also present a clear recommendation with regards to any potential requirements for aviation lighting.

2. SCOPE OF CONSIDERATIONS

The **Assessment Scope** was defined as follows: -

1) Identify the nearest registered aerodrome and other airfields to the proposed wind farm site, including those located within thirty kilometres (or other relevant distance) of the proposed wind farm site and assess the risks the proposed wind farm could pose to activities at these airfields;

2) Identify and assess any CASA and other relevant civil aviation regulations and, in particular, any regulations that relate to wind farms, obstacles and aerodromes;

3) Assess the potential risks the proposed wind farm could have on relevant instrument approach procedures for the relevant region around the proposed wind farm site;

4) Examine existing air routes in relation to the proposed wind farm development to determine if there would be any influence on the Lowest Safe Altitudes published for these routes;

5) Identify and assess any risks the proposed wind farm development could pose for:

   a) aeronautical navigation aids;

   b) air traffic services;

   c) Obstacle Limitation Surfaces;

   d) any military aircraft conducting low flying operations in the area and the operation of civilian aircraft undertaking recognised low flying activities (in consultation with RAAF);

   e) any aerial fire fighting activities that may be undertaken in the region;

   f) any rural air ambulance activities that may be undertaken in the region;

   g) any aerial agricultural and agricultural activities that may be undertaken in the region;

   h) any contingency procedures and engine inoperative flight paths (in the context of a scenario where an aircraft suffers an engine failure after takeoff from an aerodrome in the region); and

   i) any other relevant factor.

6) Assess and advise on applicable Civil Aviation regulations in regard to notification of tall structures that may present obstacles and hazards to aviation activities;

7) Assess the potential cumulative impact of the proposed wind farm in combination with other approved and constructed wind farms in the region;

8) Assess and make recommendations with regards to obstacle lighting requirements for the proposed wind farm development;

9) Document any limitations associated with the aeronautical impact and obstacle marking and lighting assessment;

10) The assessment should consider the theoretical maximum turbine dimensions of a hub height of 140 metres, rotor diameter of 128 metres and a ground to blade tip height of 196 metres.

    a. Reference should also be made to the following alternative candidate turbines: -

        i. Acciona AW 116 (100m hub height, approximate blade tip height 158m)
        ii. Acciona AW 125 (120m hub height, approximate blade tip height 182.5m)
        iii. Siemens SWT 113 (92.5m hub height, approximate blade tip height 149m)
        iv. Enercon E115 (92m hub height, approximate blade tip height 149.5m)

11) Assess and discuss any other relevant matter;

12) Provide recommendations to manage, mitigate or avoid identified risks;

13) Provide conclusions.

3. REVIEW OF PROPOSED BULGANA WIND FARM

3.1 METHODOLOGY

Consistent with the ***Assessment Scope*** as detailed above, SGS HART Aviation approached the tasks using the following methodology: -

1) Exchanged information with Wind Prospect Pty Ltd personnel (representing Bulgana Wind Farm Pty Ltd) to: -

    a. discuss the aviation assessment process / methodology,

    b. collect all the background information and materials, and

    c. arrange a mutually suitable time to visit the proposed wind farm site.

2) Undertook an assessment investigating aircraft movements and airfields in the surrounding area, including both civil and military operations.

    a. In addressing this element of the **Assessment Scope**, SGS HART Aviation identified the extent to which aviation activities in the proposed wind farm area may or may not be an issue for concern, which included, inter alia: -

        i. Review of Bulgana Wind Farm detailed layout, taking particular note of:-
            1. map of area,
            2. surrounding terrain,
            3. site plan,
            4. number of wind turbines, positions, and heights.

        ii. Review of relevant aviation charts for the area concerned, including: -
            1. relevant World Aeronautical Chart (WAC),

2. designated airspace (including PRDs) and other airspace considerations,
3. relevant En Route Charts (ERC),
4. departure & arrival procedures for any aerodromes in the vicinity,
5. relevant Visual Terminal Charts (VTC) if any, for the area,
6. available airfield and airstrip guides / directories for the area, and
7. any other matter considered relevant.

iii. Visit to proposed wind farm site and surrounding areas to assess issues, including: -
   1. identifying any nearby aviation related sites / airfields / Aircraft Landing Areas (ALA), etc, which may be, or may not be, evident on available maps, and
   2. Identifying and assessing whether any risks the proposed wind farm development could pose on any aviation related matter, including those particular issues identified in the Aviation Scope as detailed in Section 2 5) above.

3) Reviewed relevant aviation legislation, including: -

a. CASA's current position: -
   i. recognising the withdrawal of its Advisory Circular AC 139-18(0) and its current review of wind farms and aviation safety,
   ii. the CASA requirements as reflected in the Manual of Standards 139, and
   iii. the implications of Advisory Circular AC 139-08(0) dealing with the Reporting of Tall Structures.

b. Including consideration of the following guidelines, standards and frameworks: -
   i. Department of Planning and Community Development (DPCD) "Policy and planning guidelines for development of wind energy facilities in Victoria", July 2012,
   ii. Clean Energy Council Best Practice Guidelines for Implementation of Wind Energy Projects in Australia, 2013,
   iii. Auswind Best Practice Guidelines for Implementation of Wind Energy Projects in Australia, December 2006,
   iv. Northern Grampians Planning Scheme, 15 July 2013,
   v. Relevant provisions of the Victorian State Planning Policy Framework (SPPF) September 2010 and the Local Planning Policy Framework (LPPF)
   vi. Airspace Act 2007
   vii. Airspace Regulations 2007 (updated 9 August 2013), and
   viii. Any previous aviation investigations with relevant areas,
      1. including aviation assessments undertaken for other relevant proposed developments in the region for proposed wind farm developments and power plants where available.

4) Reviewed and updated Australian and International literature regarding wind farm projects, aviation safety and aircraft safety, as appropriate to the particular aviation assessment.

5) Assessed the potential cumulative impact of the construction of approved and constructed wind farms in the region using data provided by Wind Prospect Pty Ltd.

6) Assessed other relevant matters as considered relevant.

7) Based on the above, provided conclusions and recommendations to manage, mitigate or avoid identified risks,

a. Including the need, or otherwise, for obstacle marking and / or aviation safety lights at the wind farm.

3.2 ASSUMPTIONS, LIMITATIONS & EXCLUSIONS

No specific assumptions, limitations and exclusions exist.

The information and any assessments contained within are based on the information provided by Wind Prospect Pty Ltd, observations made during a visit to the proposed Bulgana Wind Farm site and independent research.

3.3 OVERVIEW OF PROPOSED WIND FARM

The site of the proposed Bulgana Wind farm covers approximately 7,524 hectares of private and public land located within the Bulgana, Joel Joel, South Joel, Congongella and Great Western districts, in central western Victoria. It lies approximately 11.7 kilometres north of Ararat, at its southern extent, and 11.2 kilometres east of Stawell, at its north-west extent. Great Western is the nearest significant sized settlement approximately two kilometres to the south-west of the site.

Large areas of the site are currently utilised for stock grazing (principally sheep) on improved dry-land pastures, with some cropping land in isolated locations. Much of the site has been cleared of native woodland and forest vegetation. Where vegetation does remain, it is limited in extent to small isolated clumps and linear windbreaks on private land, and linear strips along road reserves. Numerous indigenous scattered trees exist throughout the site and locality. Areas of revegetation are present on the site, and these comprise indigenous and non-indigenous native planted trees between approximately three and 15 years old.

The study area supports a number of soil types, derived principally from sedimentary and granitic underlying geologies. The topography of the majority of the study area comprises gentle to steep sloping hills and ridgelines, and undulating plains dissected by numerous water courses and drainage lines. Named waterways include Concongella Creek, Allanvale Creek, Salt Creek, Surridge Creek, Six Mile Creek, Seven Mile Creek and Wattle Creek, with numerous drainage lines feeding these named waterways.

The road network that runs through the site and locality comprises a range of sealed and unsealed local roads including Allanvale Road, Tuckers Hill Road, Wattle Gully Road, Green Hill Lane, Stocks Road, Metcalfe Road, Salt Creek Road, Bulgana Road, Gibsons Road, Joel South Road, Thomas Road, Landsborough Road, Joel Forest Road, Wyndarra Road, Vances Crossing Road and Vineyard Road. To the south and west of the site runs the Western Highway between Melbourne and Adelaide. Other improvements on the site and in the locality comprise typical farm residences and infrastructure including houses, outbuildings, sheds, dams of varying size and depth, fences, private roads and dirt tracks.

The entire site falls within the area of the North Grampians Shire Council and within the Wimmera catchment. With the exception of road reserves, the entire study area is zoned Farm Zone (FZ). Road reserves are zoned Road Zone (RZ). An Environmental Significance Overlay – Schedule 1 (ESO1) currently covers most of the ridge lines on the site.

Short Project Description

The proposed Bulgana Wind Farm comprises a maximum of 67 wind turbines and associated permanent and temporary infrastructure. Permanent infrastructure will include:

- Approximately 53 km of site access tracks,
- Creation and improvement of up to 8 access points from public roads,
- Permanent anemometry masts,
- Approximately 49 km of underground cabling,
- Approximately 11.4 km of overhead wires,
- A collector substation and connection of underground cables to overhead line,
- A terminal substation and connection to the existing SP Ausnet 220kV high voltage transmission line located at the northern end of the site.

Temporary infrastructure will include construction compounds, turbine component lay down areas, and a concrete batching plant/s.

The need for and location of borrow pits and dams for use during construction and for fire fighting purposes are also being considered. It is the intention of the proponent to only seek consent for these items after planning permit approval is given for the wind farm, at which stage more detailed geotechnical assessments and construction planning will be undertaken.

Long Project Description

The following permanent infrastructure is proposed:

- 67 wind turbines of between 2MW and 4MW rated capacity each.
- Turbine configurations generally consisting of hub heights up to 140 metres, rotor diameters up to 128 metres and tip heights up to 196 metres. The turbines will be constructed from tubular steel or concrete sectional towers and will support a nacelle, nose cone and blade assembly. Four turbine models have been selected to aid in assessment and modelling for environmental and planning purposes, these are listed below. However, the specific height and configuration of the turbines to be installed on the Bulgana Wind Farm site will be determined following a commercial tendering process that will occur after a planning permit is granted. The turbines selected through the commercial tendering process will be within the envelope provided by the aforementioned dimensions. Turbine types that are being considered for the project include, but are not limited to, the following:
    i. Acciona AW 116 (100m hub height, approximate blade tip height 158m)
    ii. Acciona AW 125 (120m hub height, approximate blade tip height 182.5m)
    iii. Siemens SWT 113 (92.5m hub height, approximate blade tip height 149m)
    iv. Enercon E115 (92m hub height, approximate blade tip height 149.5m)

Typical of area for proposed Bulgana Wind Farm.

The proposed wind farm development will also include: -

- Permanent anemometry masts up to 100 metres high for wind resource and data validation purposes during operation of the wind farm. The actual number will be determined after a planning consent is received, but is not anticipated to be more than three.
    - At the time of site inspection, a 50m Met Mast (wind monitoring mast) was seen to exist on the proposed site as shown on the map of the project area at Appendix 6.2. A 100m Met Mast is also proposed as shown in the afore-mentioned Appendix.
- Associated infrastructure including new access tracks, underground cabling, substations and hard stand areas. This work will be complemented by improvements to local roads at the access points, at local intersections and along road sections as required to meet council requirements and to ensure safe and efficient traffic movements.

The location of the proposed wind farm is shown in the maps in Appendices 6.1 & 6.2, the first being an excerpt from the World Aeronautical Chart [WAC] (3469) HAMILTON and the second being a map of the project area.

3.4 SPECIFIC ISSUES

3.4.1 Airfields in the vicinity of the proposed wind farm.

A comprehensive search of all available documentation on airfields (including the En Route Supplement Australia [ERSA], the Aircraft Owners and Pilots Association [AOPA] National Airfield Directory and the FightAce® Country Airstrip Guide) was undertaken. This was supported by a visit to the proposed site and surrounding areas.

Appendix 6.3 shows the proposed Bulgana Wind Farm site and the positions of competitor wind farms and also shows airfields identified within the vicinity of the Bulgana Wind Farm as a result of the above-mentioned search, with specific emphasis on those within 30km from the wind farm site itself.

Some private airstrips were also identified as described later.

This is not to say that ad-hoc airfields may appear in the vicinity from time to time to support, such as, aerial agricultural operations. See also Section 3.4.7.

Stawell Airport.

The nearest Registered or Certified aerodrome is Stawell, a Registered aerodrome which is approximately 15km to the west of the most western edge of the proposed wind farm site.

The aerodrome would seem to be largely used for light aircraft and aerial agricultural operations but, as a result of extensive upgrading works, can handle heavy twin engine aircraft and small airline passenger aircraft, no doubt principally to accommodate visitors to the Stawell Gift event during the Easter period each year.

Stawell Aerodrome tarmac and hangars.

Stawell Airport upgrade information.

During this aviation assessment advice was received from the Stawell Airport management that new Area Navigation (RNAV) Global Navigation Satellite System (GNSS) instrument approach procedures were established on 5 March 2014 and these have since been formally published in the Airservices' Departure and Approach Procedures documentation on 29 May 2014. These procedures were previously included as Notice to Airmen (NOTAM) SUP H15/14 on the Airservices' web site and were known to SGS HART Aviation.

Take off operations from the main 11/29 runway in the 11 direction will be directly towards the proposed wind farm site. Landing to the 29 runway has the potential to be over the proposed wind farm site.

It is assessed that the RNAV (GNSS) instrument approach procedures may be affected by the establishment of the proposed Bulgana Wind Farm. Minimum descent altitudes and go round procedures should be above the proposed wind farm turbines. However, there is a question regarding the established circling altitude established for Category A & B aircraft of 2,170ft when the potential highest wind turbine (BU_67 – see Appendix 6.5) could be at 2,140.74ft. However, it has been noted that candidate wind turbines could have a tip height of up to 196m which would make the potential highest wind turbine at 2,184ft. For Category C aircraft, the circling altitude is 2,470ft, which may also need to be raised as well to ensure at least a 500ft clearance.

Further, there are indications that, even though the proposed wind farm development will be some 15km from the Stawell Aerodrome and at the limit of Obstacle Limitation Surface (OLS) considerations, the Obstacle Limitation Surface for the extended OLS associated with the future development of the aerodrome may be penetrated by any wind turbine higher than 100m (328ft). This is of potential concern and, although considered unlikely, may have an effect on future aircraft operations from the Stawell Aerodrome. A copy of the Obstacle Limitation Surface chart established for a future proposal for the development of Stawell Aerodrome is included at Appendix 6.9.

Consultation with the operators of Stawell Aerodrome was limited to brief email exchanges with the Northern Grampians Shire Council Contract Engineer, who provided the OLS chart for the future development of Stawell Aerodrome and expressed some concern that the proposed wind turbines may penetrate the identified obstacle limitation surfaces and impact on operational procedures to and from the aerodrome and indicated that he intended to notify Airservices and CASA for an assessment. Both Airservices and CASA were subsequently approached and this matter and their views are reflected within Sections 3.4.5 b) & c) of this report.

Under the current operations undertaken at Stawell Aerodrome SGS HART Aviation considers there will be no penetration of the existing OLS for Stawell Aerodrome by any of the proposed wind turbines within the Bulgana Wind Farm. However, the potential for such to occur with the extended OLS associated with the future development can not be ignored, particularly in view of the long life of wind farms, typically being 25 years or so. Consequently, obstacle lighting is proposed as a conservative and duty of care approach to the matter as addressed in Section 3.4.11.

The aerodrome has two runways –11/29 1,403m (Code 3) sealed and 18/36 854m sealed. Operations from the 18/36 runway should not be affected by the presence of the Bulgana Wind Farm.

The airport is equipped for night operations off the 11/29 (approximately east/west) runway and such operations may very well be undertaken using the recently established RNAV (GNSS) procedures mentioned above.

Gliding operations are reported to occur from the Stawell Aerodrome but the presence of the Bulgana Wind Farm would have no impact on any such operations.

Ararat Aerodrome.

The next nearest Registered or Certified aerodrome is Ararat, a registered aerodrome which is approximately 16km to the south south-east of the most southern edge of the proposed wind farm site. This is beyond the limits for an Obstacle Limitation Surface (OLS) required to be determined for this aerodrome and the aerodrome is sufficiently far away from the proposed

Bulgana Wind Farm site such that obstacle limitation surfaces for this aerodrome would not be penetrated by any wind turbine which might exist on the Bulgana Wind Farm.

No active NOTAMs currently exist for this aerodrome.

Aircraft operations from the Ararat Aerodrome would not be affected in any way by the presence of the Bulgana Wind Farm.

The aerodrome has two runways –12/30 1,240m sealed and 04/22 660m grass.

The airport is equipped for night operations off the 12/30 runway but such operations would not be affected by the existence of the Bulgana Wind farm.

No formally published GPS arrival procedures or NDB and RNAV (GNSS) arrival and missed approach procedures exist so no issues arise as a result.

Gliding operations are reported to occur from the Ararat Aerodrome but the presence of the Bulgana Wind Farm would have no impact on any such operations.

The operators of Ararat Aerodrome were not consulted as it was not thought necessary to do so.

No other Registered or Certified aerodromes have been identified within 30km from the proposed Bulgana Wind farm site.

Several small uncertified / unregistered airfields have been identified in the vicinity as follows: -

Navarre (Hillview).

This airfield is situated some 17km to the north east of the northern edge of the proposed Bulgana Wind Farm site.

Reports differ as to this airfield. Navarre is reported to have an unsealed grass strip oriented 05/23 or 04/22, with reports also differing between 740m & 853m as to the actual length of the strip. The state of the airfield's wind sock is also in question. Permission is required to use this strip.

Any operations from this strip would not be affected by the presence of the Bulgana Wind Farm.

Pomonal.

This airfield is reported to be closed according to all available airfield and airstrip guides / directories for the area. However, a representative of the Northern Grampians Shire Council advises that operations are still being conducted there. Although not completely clear, it would seem that there may be two grass strips available at this airfield; one oriented roughly 05/23 and the other roughly 14/32. Only light aircraft would operate from this airfield which is some 24km west of the proposed wind farm site.

Any operations from this strip would not be affected by the presence of the Bulgana Wind Farm.

Moonambel (Summerfield Wines).

This airfield is situated some 27km to the north east of the eastern edge of the proposed Bulgana Wind Farm site.

The airfield has an unsealed grass strip oriented 13/31. Permission is required to use this strip.

Any operations from this strip would not be affected by the presence of the Bulgana Wind Farm.

Glenpatrick.

This airfield is closed. It did exist some 30km east of the proposed wind farm site.

Three private airstrips have also been identified within the 30km boundary and these are indicated in Appendix 6.3. No details of these airstrips appear in any aviation related documentation, such as the Aircraft Owners and Pilots Association [AOPA] National Airfield Directory and the FightAce® Country Airstrip Guide. Advice as to the existence of these airstrips was obtained from a representative of Northern Grampians Shire Council and following a site visit.

Those airstrips are as follows: -

Holden Airstrip.

This private airstrip is on Landsborough Road some 4.5 – 5km west of the western edge of the wind farm site.

There is a new yellow wind sock at the site and an apparent unmarked grass strip oriented roughly east – west. Any take offs to the east in the direction of the proposed wind farm site, or landings from the east, would be directly over the house and associated buildings on the property at the eastern end of the strip – a most undesirable operation from a safety perspective.

Takeoffs to the west or landings from the west would be much more desirable from a safety perspective.

Holden airstrip showing wind sock near homestead.

It is considered that the site of the proposed Bulgana Wind Farm and associated wind turbines will be sufficiently far away from this airstrip not to cause any concerns.

Boatman Airstrip.

This private airstrip is approximately 5km to the north north-west of the most northern edge of the proposed Bulgana Wind Farm Boundary. The property would seem to have a grass airstrip oriented approximately 02/20; i.e. almost north – south.

It is considered that any operations from this strip would not be affected by the presence of the Bulgana Wind Farm.

Kypers Airstrip.

This private airstrip is approximately 10km to the north-west of the most northern edge of the proposed Bulgana Wind Farm Boundary. The property would seem to have a grass airstrip oriented approximately 09/27; i.e. almost east - west.

It is considered that any operations from this strip would not be affected by the presence of the Bulgana Wind Farm.

There may be other such private airstrips but none was identified.

Six others have been identified just outside the 30km boundary as indicated in Appendix 6.3.

Dadswells Bridge, Chute & Avoca airstrips are reported to be closed.

Ampitheatre is for emergency use only.

Victoria Valley is operated by the Department of Sustainability and Environment and is a fire bombing base not intended for recreational use.

Raglan is some 40km to the south east with a 700m unsealed grass strip oriented 18/36.

In any event, operations from any of the above mentioned airfields would not be affected by the presence of the Bulgana Wind Farm.

3.4.2 Aviation operations – general.

Visual Flight Rules (VFR) Operations

Whilst there are some exceptions in respect of operations that require low flying (e.g., during takeoff and landing, search & rescue and agricultural spraying operations) pilots undertaking VFR operations (i.e., during daylight hours) must not fly over: -

- any city, town or populous area, at a height lower than 1,000ft; or
- any other area at a height lower than 500ft.

The regulations define the height specified above as the height above the highest point of the terrain vertically below the aircraft, and any object in it, within a radius of 600m for aircraft and 300m for helicopters. In principle, therefore, all VFR aircraft operations should be above the level of any wind turbines. However, any objects extending higher than 500ft above the terrain clearly penetrate navigable airspace and this should not be overlooked in assessing the potential impact of wind farms on aviation operations.

In any event, the wind turbines should be clearly visible to pilots undertaking VFR operations.

It should be noted that any aviation operations from those other airstrips identified as in the vicinity of the proposed Bulgana Wind Farm site would all be under visual flight rules (VFR).

Instrument Flight Rules (IFR) and Night VFR Operations.

Such operations would be undertaken under either Night VFR of IFR flight plan conditions, which require operations not below the lowest safe altitude (LSALT), except when landing or taking off.

In principle: -

a. where the highest obstacle is more than 360ft above the height determined for terrain, the LSALT must be 1,000ft above the highest obstacle; or
b. where the highest obstacle is less than 360ft above the terrain, or there is no charted obstacle, the LSALT must be 1,360ft above the elevation determined for terrain; except that
c. where the elevation of the highest terrain or obstacle in the tolerance area is not above 500ft, the LSALT must not be less than 1,500ft.

Civil Aviation Regulations require that, unless it is necessary for takeoff or landing, a Night VFR aircraft must not be flown at a height less than 1,000ft above the highest obstacle within a 10nm (~18.5km) radius of the aircraft in flight.

In the circumstances, the proposed Bulgana Wind Farm should have no impact on civil Night VFR or IFR operations which may occur in the vicinity, possibly originating from the closest two Registered Aerodromes, Stawell and Ararat. However, the exception may very well be those operations using the recently established RNAV (GNSS) procedures at Stawell Airport.

As per VFR operations, the altitude limitations in respect of both civil Night VFR and IFR operations as mentioned above are important in the context of assessing whether obstacle lights are required or not for the wind turbines.

Night operations and IFR operations can occur from both Stawell and Ararat Aerodromes. Ararat Aerodrome is too far away for such operations to be adversely affected by the presence of the proposed Bulgana Wind Farm. The situation with Stawell Aerodrome is not quite as clear as mentioned above and penetration of the OLS for that aerodrome may very well occur and some changes may be required to certain elements of the recently established RNAV (GNSS) procedures.

Under the Civil Aviation Regulations, VFR operations, except during take off and landing, are required to maintain a minimum height above ground level (AGL) of 500ft outside of built up areas and 1,000ft over built up areas.

It was noted that, with two exceptions, the wind turbines proposed to be used for the Bulgana Wind Farm will be higher than 152m (~ 500ft) AGL. {See Section 2 10)} This is important to note in the context as to whether obstacle lighting might be required or not. {See Section 3.4.11} For wind turbines of a height less than 152m (~500ft) AGL, with the exception of special low level operations as would occur with, such as, agricultural operations, VFR operations should be clear of any such wind turbines. For wind turbines of a height more than 152m (~500ft) AGL, the situation in respect of VFR operations is in doubt.

The Civil Aviation Regulations further require that, unless it is necessary for takeoff and landing, an instrument flight rules (IFR) or a Night VFR aircraft must not be flown at a height less than 1,000ft above the highest obstacle within a 10nm radius of the aircraft in flight. This defines the Lowest Safe Altitude (LSALT) for any such operation which, by definition, will be higher than any wind turbine in the proposed Bulgana Wind Farm development – but that does not necessarily apply when an aircraft is operating using the recently established RNAV (GNSS) instrument approach procedures.

3.4.3 High voltage transmission lines.

An assessment of the Bulgana Wind Farm site identified the presence of high voltage transmission lines running through the northern edge of the proposed site. This was confirmed during the site visit and these are clearly shown in Appendix 6.6, being an excerpt from the Visual Navigation Chart (VNC) Melbourne based on data held by the Aeronautical Information Service (AIS) at 21 June 2013.

High voltage transmission lines running through the northern section of the proposed wind farm site.

Since these transmission lines are already appropriately identified on aviation charts they do not present any increased risk to aviation operations as a direct result of the establishment of the Bulgana Wind Farm.

Note that transmission lines are also identified south of the wind farm site (see Appendix 6.6) but, on visiting the site, these proved to be low voltage transmission lines and not of any concern in respect of the development of the wind farm.

The proposed position of the wind turbines themselves would seem to be well clear of the existing high voltage transmission lines at the northern edge. However, in the event that the positions of the wind turbines may change, it is worthwhile noting that an electricity company does not prescribe a minimum set back for the wind turbines from the power lines.

If the wind turbines were to be proposed somewhat closer to the high voltage power lines, it would seem wise to adopt a set back figure in excess of the maximum wind turbine height to blade tips (say, 10% more) for those wind turbines close to the transmission lines. This would nominally protect against a worst case scenario should the turbine fall.

It should be noted that some electricity providers use helicopters for live line maintenance and insulator washing.

Washing insulators using a MD 500 helicopter.

For such operations the minimum clearance usually required when working between circuits is 25m from the outside wire of one circuit to the outside wire of another circuit. This advice is based on operator experience when positioning a helicopter safely between circuits with the lines energised. Prima facie, therefore, a set back as suggested above would enable such aviation operations to be undertaken, but not without the necessary due care, of course.

However, whether or not such operations could be undertaken would be an operational decision for the particular operator. Informal advice indicates that most would prefer not to work near wind farms and, in the cases they do, they fly well above the wind turbines / wind farms.

It is understood that electricity authorities, when building new high voltage lines, either avoid wind farms or install the high voltage lines underground in these areas.

3.4.4 Reference towers for meteorological monitoring.

SGS HART Aviation was advised of the presence of one 50m Met Mast (wind monitoring tower) and one proposed 100m Met mast in the southern section of the site as indicated in Appendix 6.2.

50m Met Mast.

Close up of orange marker balls on top of mast.

As will be observed from the photo above, the 50m Met Mast is quite difficult to pick out. For this reason, such towers are of particular concern to any local aerial agricultural operators; if indeed there would be any in the area concerned as no evidence was found of such during this assessment. Nevertheless, it is very important that advice as to the presence of these towers is readily available.

In accordance with the National Airports Safeguarding Framework Guideline D (copy at Appendix 6.12) wind farm developers should take appropriate steps to minimise the potential hazards of wind monitoring towers, particularly in areas where aerial agricultural operations occur and recommends such measures include: -

a) the top 1/3 of wind monitoring towers to be painted in alternating contrasting bands of colour.

Examples of effective measures can be found in the Manual of Standards for Part 139 of the Civil Aviation Safety Regulations 1998. In areas where aerial agriculture operations take place, marker balls or high visibility flags can be used to increase the visibility of the towers;

b) marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;

c) ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or

d) a flashing strobe light during daylight hours.

SGS HART Aviation observed that the 50m Met Mast has four orange balls near the top of the mast (as shown in the photo above) and that action taken is most commendable. However, SGS HART Aviation recommends that, as a minimum, further action should be taken to include the complete measures a) & b) on the Met Masts positioned within the proposed Bulgana Wind Farm site. Items c) & d) are not considered to be necessary.

The height of the existing Met Mast is 50m and the proposed one, 100m. As such, these masts are not required to be reported to the Civil Aviation Safety Authority (CASA) under CASR 139.365, which requires CASA to be informed of structures 110m or more above ground level.

However, the CASA Advisory Circular AC 139-08 (0) of April 2005 “Reporting of Tall Structures” refers to the need to have a database of tall structures and the fact that the RAAF Aeronautical Information Service (AIS) has been assigned the task of maintaining that database of tall structures defined as those structures, the top of which is above: -

- 30m or more above ground level, that are within 30km of an aerodrome, or
- 45m or more above ground level elsewhere.

SGS HART Aviation recommends that the RAAF AIS should be advised of the existence of the afore-mentioned Met Mast in accordance with the procedures mentioned in the referenced AC. See also 3.4.5 d) below. Surrounding land owners should also be advised of the existence of the Met Mast.

SGS HART Aviation considers it would also be appropriate to notify the Aerial Agriculture Association of Australia (AAAA) of the afore-mentioned existing and proposed Met Masts.

SGS HART Aviation was informed by Wind Prospect Pty Ltd that the RAAF AIS, the AAAA and surrounding land owners had been advised as to the above mentioned matters.

As a matter of interest, during the site visit another Met Mast (believed to be about 50m high) was observed situated off the western edge of the most northern point of the proposed wind farm site boundary on the top on Concongella Hill north of Landsborough Road. It is understood that this mast was installed by another developer looking in the area many years ago and it is no longer in use. It is not apparently featured on any aviation maps. As such, it is commented that, if indeed the mast is no longer in use it should be removed as it is a potential hazard to local aerial agricultural operations.

3.4.5 Airspace considerations.

a) General.

In assessing the potential impact on aviation operations the En Route Charts (ERC). Visual Terminal Charts (VTC), Visual Navigation Charts (VNC) and Terminal Area Charts (TAC) potentially relevant to the area concerned were studied in depth.

In addition, the Designated Airspace Handbook and the relevant World Aeronautical Chart [WAC] (3469) HAMILTON were studied for any issues of concern.

The proposed Bulgana Wind Farm is outside any designated airspace and any airport control zones. Hence there are no aircraft traffic control issues nor is there any potential influence on aeronautical navigation aids.

There are no Prohibited, Restricted or Danger (PRD) areas anywhere near the proposed Bulgana Wind farm site. The nearest one is R325A/B, some 125km to the north east, which will not be affected in any way.

The only active Notice to Airmen (NOTAM) discovered which might impact on the development of the wind farm is that previously mentioned for Stawell Aerodrome (reference SUP H15/14) relevant to the RNAV (GNSS) procedures recently established.

Although no general airspace issues of concern have been identified, it is considered that there is still a need for consultation with CASA, Airservices and the Department of Defence and particular comments on this follow.

b) CASA.

It is considered essential that CASA be informed of the proposed Bulgana Wind Farm, particularly since it is assessed that the proposed wind turbines may very well penetrate the OLS for Stawell Aerodrome. This will give an opportunity to CASA to comment. It will also serve to alert CASA as to the number and proposed heights of the wind turbines in anticipation of the formal requirement to advise CASA of any obstacles which will be 110m or more above ground level – CASR 139.365 refers. Whilst this is not designed to anticipate any requirements for obstacle lights or to seek a CASA view on such, advice to CASA may very well lead to a "determination" being given by CASA consistent with the requirements of CASR 139-370. The need or otherwise for obstacle lights is discussed further in Section 3.4.11.

CASA was provided with a copy the draft assessment report and invited to comment. The response from the Airspace and Aerodrome Regulation Group was as follows: -

"--- notice that the Northern Grampians Shire emailed Airservices on 29 July '*we are therefore notifying ASA and CASA of this proposal for an assessment of any impact on those (PANS OPS) surfaces, and any implications to the airport operations'*. The impact of the monitoring mast on the PANS OPS surfaces is a matter for Airservices to evaluate.

The SGS HART DRAFT 'Aeronautical Impact and Obstacle Marking and Lighting Assessment for the proposed Bulgana Wind Farm includes some sound advice on marking the wind monitoring mast to make it conspicuous. The Assessment also includes sound recommendations on the provision of advice to the RAAF AIS and the AAAA. The Assessment also includes the National Airports Safeguarding Framework – Guideline D 'Managing the Risk to Aviation Safety of Wind Turbine Installations and Wind Monitoring Masts'.

The monitoring mast is outside the Obstacle Limitation Surfaces for any Certified or Registered Aerodrome and CASA does not have the regulatory authority to require lighting of the mast."

c) Airservices.

The proposed Bulgana Wind Farm will not affect any sector altitude. However, the proposed Bulgana Wind Farm may have an effect on circling altitudes associated with the recently

established RNAV (GNSS) instrument approach procedures as mentioned above. It is assessed that approach or departure altitudes will not be affected even though the proposed wind turbines may penetrate the OLS for Stawell Aerodrome. However, CASA may impose particular requirements under CASR 139-370 to ensure continued safety of such operations from Stawell Aerodrome.

It is necessary to consider in some more detail the possible effect on en route lowest safe altitudes (LSALT).

The highest wind turbine as per the proposed plan (i.e. BU_67 – see Appendix 6.5) could be at 2,140.74ft. However, it has been noted that candidate wind turbines could have a tip height of up to 196m which would make the potential highest wind turbine at 2,184ft.

By definition, the minimum LSALT required to ensure clearance of the all the wind turbine "obstacles" would then be 2,184ft + 1,000ft = 3,184ft.

In reviewing the particular routes which pass over or within 10nm of the proposed wind farm, the following have been identified: -

Route	**Way points**	**LSALT**
W291	Yarrowee to Horsham	LSALT 4,800ft
H345	Melbourne to Bordertown	LSALT 5,200ft
V223	Melbourne to Burra	LSALT 4,800ft
V223	Burra to Horsham	LSALT 4,700ft
W306	Yarrowee to Burra	LSALT 4,800ft
W306	Burra to Warracknabeal	LSALT 4,700ft

The above routes are identified on the En Route Chart (ERC) Low L2 – excerpt shown at Appendix 6.7.

The ERC High H3 covering the area concerned was also studied. An excerpt is shown at Appendix 6.8. In reviewing the particular routes which pass over or within 10nm of the proposed wind farm, the following have been identified: -

Route	**Way points**	**LSALT**
Q158	Melbourne to Crena	LSALT 4,700ft
H345	Nevis to Bordertown	LSALT 5,200ft

It will be seen that in all cases the defined LSALT for the listed routes are more than 1,000ft higher than the highest proposed wind turbine and, as such, the proposed Bulgana Wind Farm development will not impact on LSALT of any of the identified routes which pass over or within 10nm of the proposed wind farm.

Following the above considerations, therefore, SGS HART Aviation is of the view that there will be no effect on any en route LSALTs as a result of the establishment of the Bulgana Wind Farm as proposed.

It is well appreciated that Airservices will likely undertake its own independent assessment after receiving the data on the proposed wind farm. Whilst considered to be unlikely in this case, Airservices may very well reach a different view regarding the effect on established LSALTs for the various routes. In that event, there may be a charge imposed on the proponent for any assessment exercise and any necessary changes which Airservices might consider need to be made to the relevant aeronautical charts.

It should be noted that Airservices was provided a copy of this assessment but informal advice would indicate that no comments are likely to be forthcoming until after the project has been considered by the interested parties and the wind farm approved to proceed.

Regardless, any changes to LSALTs that might arise would have limited, if any, adverse impact on aircraft operations over the routes concerned.

The proposed Bulgana Wind Farm will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links. No such devices exist anywhere near the vicinity of the proposed wind farm site.

In respect of civil radar sites, the nearest radar identified is at Mt. Macedon some 145km to the east of the proposed Bulgana Wind Farm site. This is a Route Surveillance Radar (RSR). There is also a Primary Surveillance Radar (PSR) and a Secondary Surveillance Radar (SSR) at Gellibrand Hill a little further to the east. The remoteness of these radars from the proposed Bulgana Wind Farm site is such that SGS HART Aviation is of the view that the presence of the wind farm will have no adverse effect on the operation of such radars.

Whilst Airservices works closely with CASA in respect of airspace considerations and other matters, there is value in advising that organisation separately, in respect of the proposed wind farm development and for any met masts / wind monitoring masts. Sometimes Airservices chooses, in consultation with CASA, to issue a Notice to Airmen (NOTAM) advising of associated hazards. There is also a close link between Airservices Aeronautical Information Service (AIS) and the RAAF AIS.

As indicated earlier, SGS HART Aviation undertook a search of the Airservices' web site and, apart from that NOTAM specifically relevant to the recently established RNAV (GNSS) procedures for Stawell Aerodrome (since formally published in the Airservices' Departure and Approach Procedures documentation on 29 May 2014), did not discover any other NOTAMs relevant to the proposed Bulgana Wind Farm site.

d) Department of Defence & RAAF AIS.

Among other things, the RAAF (AIS) issues (military) aviation charts defining low level operational routes used by the RAAF aircraft. These often cover low level jet aircraft operations.

SGS HART Aviation has held discussions with the Department of Defence in an endeavour to obtain specific information on the above matters in respect of the proposed Bulgana Wind Farm. The Department of Defence proved reluctant to provide specific information and advised formally as follows: -

> *"Land Planning & Spatial Information (LPSI) coordinates the Defence assessment of wind farm proposals. The Defence assessment not only ascertains any impact on the aviation activities of RAAF, Army and Navy but also any impact on Defence communications and the operation of Defence Radars. Please forward any proposals to **LPSI.Directorate@defence.gov.au** for Defence assessment."*

Despite the above formal position, which clearly needs to be taken into account, SGS HART Aviation undertook its own assessment of the situation.

It is noted that in one other wind farm development known to SGS HART Aviation the RAAF raised one concern to do with the marking of temporary meteorological masts and improved marking was implemented. As noted above in 3.4.4 there is one 50m Met Mast present now in the area of the proposed Bulgana Wind Farm and a 100m Met Mast proposed. Consequently, there is a need to advise the RAAF of those masts. Indeed, SGS HART Aviation was informed that had already been done.

Existing civil charts show no evidence of any military operations in the vicinity of the proposed Bulgana Wind Farm.

No military Restricted or Danger areas were identified anywhere near the proposed Bulgana Wind Farm.

SGS HART Aviation has not identified any adverse effects on primary radar (civil or military) or secondary surveillance radar which would arise as a result of the establishment of the Bulgana Wind Farm.

The nearest military radar identified is believed to be at East Sale. The remoteness of this radar from the proposed Bulgana Wind Farm site (some 300km to the east) is such that SGS HART Aviation is of the view that the presence of the wind farm will have no adverse effect on the operation of that radar.

The above view has not the least been influenced by a decision of the US Federal Aviation Administration (FAA) in September 2012 in respect of a wind farm planned off the coast of Massachusetts. In this case the FAA said that, because the wind farm will be located more than 2.4nm (4.4km) from the closest radar sites, there will be no effect on radar images.

Consequently, SGS HART Aviation considers that there will be no adverse effects on any Defence-related operations associated with the presence of the proposed Bulgana Wind Farm.

Note that it is the RAAF AIS which keeps and manages a central aeronautical data base of tall structures, including those reported in accordance with the advice detailed within the AC 139-08(0), mentioned in Section 3.4.4 above. This data base is made available for use by other mapping agencies and the RAAF AIS liaises closely with Airservices' AIS in this respect.

3.4.6 Aerial fire fighting activities

Some concern is often raised about the potential adverse impact on the possible need for aerial fire fighting services, should such be needed in the vicinity of wind farms.

Aerial fire fighting activities can be separated into two elements – those using helicopters and those using fixed wing aircraft.

SGS HART Aviation is of the opinion that any operations of fixed wing aircraft for fire fighting purposes within the confines of the proposed Bulgana Wind Farm would be hazardous and are not recommended, particularly if the wind turbines were operating. This is a position held in respect of all wind farms.

The operation of helicopters within the confines of a wind farm is perhaps possible.

It is also possible that aerial fire fighting could be undertaken above the level of the wind turbines {i.e., above the potential maximum turbine height of 196m (643ft)}, but dropping water or retardant from this height would reduce the effectiveness. This is a matter for the expert fire fighting operators to assess.

The position in respect of the proposed Bulgana Wind Farm is no different from any other wind farm.

Helicopter or fixed wing aircraft operations within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended.

3.4.7 Aerial agricultural operations

As indicated earlier, the wind farm site is predominantly cleared land used for cattle and sheep farming although some of the properties are also used for cropping. It is possible that aerial agricultural operations have occurred in this area in the past. Although no evidence was found of any airstrips within the proposed site, it is not unusual for temporary aerial agricultural airstrips to appear overnight and be established on existing farm land. Certainly the site and immediate surrounds as observed have sufficient flat areas for such temporary airstrips. Also, no doubt any of the identified airstrips in the vicinity could be used.

The Aerial Agricultural Association of Australia (AAAA) holds the view that wind farms and their pre-construction wind monitoring towers are a direct threat to aviation safety and especially aerial application.

It should be noted that aerial application includes not only spraying but also seeding and the spreading of fertilisers.

From the perspective of the AAAA, there are two quite distinct issues arising from wind farms that affect aerial application: -

- safety of the aircraft and pilot, and
- economic impact on aerial applications.

Aerial agricultural operations generally occur between 20 – 30m from the ground. There is no doubt, therefore, that any objects that penetrate the airspace above 20 – 30m will impact on aerial agricultural operations and will need to be taken into account in planning to undertake such operations.

SGS HART Aviation agrees that the presence of wind turbines will adversely impact the ability of aerial agricultural operators to safely undertake aerial spraying, seeding or fertilising within the confines of a wind farm. As it is for fire fighting activities, this position in respect of the proposed Bulgana Wind Farm is no different from that for any other wind farm.

However, the safety issue can be addressed by "seeing and avoiding" the wind turbines or, preferably in SGS HART Aviation's view, not undertaking any aerial agricultural operations within the confines of a wind farm and amongst the wind turbines. The latter action would address any concerns with respect to the safety of the operation. It needs to be recognised, though, that any aerial agricultural operations undertaken within the confines of a wind farm would be constrained to ensure avoidance of the wind turbines and any cessation of any such operations would have the potential to decrease the productivity of, not only the agricultural operator, but also the land owner. In SGS HART Aviation's view, this is probably a prime reason for the AAAA's opposition to wind farms in general – the issues being largely of a "commercial" nature as opposed to "safety" per se.

Aerial agricultural operations from airstrips on the fringes of the proposed wind farm and clear of any wind turbines could be undertaken satisfactorily as agricultural operators are familiar with operating from constrained areas.

It should be added that some aerial agricultural operations occur at night related to special crops, e.g. peas. This is mainly to spray for destructive grubs which rise to the top of such crops in the cool of the night. Such operations are quite unlikely to be necessary in the vicinity of the proposed Bulgana Wind Farm and are, therefore, excluded from considerations.

As noted before, the wind farm site is predominantly pastured and there is no evidence of any aerial agricultural activity taking place at present. It should also be noted that the decision to undertake any such activity rests with the landowners whose agreement with the Bulgana Wind Farm Pty Ltd precludes them for an action that would interfere with the wind turbines.

In summary, aerial spraying, seeding or fertilising operations, be they by helicopter or fixed wing aircraft, within the confines of any wind farm and below the top of the wind turbines is potentially hazardous and not recommended.

3.4.8 Rural air ambulance services

It has been suggested that the presence of wind farms may impact on the ability for rural air ambulance services to operate in the region.

Certainly, the existence of wind turbines has the potential to limit the flexibility of operations of helicopter ambulance services within the confines of the wind farm and there is little that can be done about that. This is a common factor for all wind farms.

For fixed wing air ambulance operations it is an issue which is not considered relevant to proposed Bulgana Wind Farm. Such services do not exist within the confines of the proposed wind farm site now and the presence of the wind farm will not change that position. In the event that an air ambulance operation is required, it is probable that the aerodromes at Stawell or Ararat would be used and transfer of any patients arranged either via helicopter of road transport to and from those aerodromes. This option is available now and will not change with the construction of the Bulgana Wind Farm.

Air ambulance operations using the recently established RNAV (GNSS) procedures should not be limited but previously made points in respect of circling altitudes and OLS penetration need to be considered in that light.

3.4.9 Contingency procedures and engine inoperative flight paths

These issues are considered to be of questionable relevance in respect of the proposed Bulgana Wind Farm.

In the event of an engine failure, aerial agricultural aircraft and any other single engine aircraft would force land in the nearest suitable field. This is standard practice.

Helicopters would auto-rotate down to the nearest available field. This is also standard practice.

Twin engine aircraft may be taking off in the direction of the proposed Bulgana Wind Farm site from both Stawell and Ararat aerodromes. In the event of an engine failure occurring to any such twin engine aircraft a return to either the Stawell or Ararat aerodrome (whichever would be adjudged as closest) would be the most likely action. Procedures for such an event are not usually defined; rather the consequential action required is left to the judgement of the operating pilot. It is considered that the presence of the proposed Bulgana Wind Farm would not place any constraints on such operations.

It is noted, however, that missed approach procedures are a feature of the recently established RNAV (GNSS) procedures. It is adjudged that the procedures will ensure that any aircraft involved in using such should be well clear of any wind turbine within the proposed Bulgana Wind Farm.

3.4.10 Wind farm layout issues

a) Micro-siting of wind turbine positions

SGS HART Aviation has noted that Bulgana Wind Farm Pty Ltd has established a set layout for the wind turbines as shown in Appendices 6.2, 6.4 & 6.5, but will also be seeking a micro-siting to 50m from the submitted turbine coordinates as shown in Appendix 6.5.

It is further noted that the type of wind turbines to be used, on the proposed Bulgana Wind Farm site has not been formally defined.

SGS HART Aviation is of the view that, subject to previous comments regarding necessary clearances from any airstrips and high voltage transmission lines, the actual positions of the wind turbines within the proposed Bulgana Wind Farm site boundaries will have little, if any, effect on the risk profile associated with aviation operations identified in the vicinity.

b) Cumulative impact of wind farms in region

As will be seen from the map at Appendix 6.3, there are three other wind farms within the 30km boundary of the proposed Bulgana Wind Farm site and several outside that boundary.

Whilst it is considered that each individual wind farm needs to be assessed from an aviation risk perspective to ensure that no special aspects are present, SGS HART Aviation is of the view that the cumulative effect of the presence of four wind farms within the shown 30km site boundary would have little, if any, effect on the overall risk profile to aviation operations in the area concerned. In fact, there is a possibility that the very large number of wind turbines which may very well end up being present may have the reverse effect.

It is an essential risk mitigation requirement that all wind farms be identified on all aeronautical maps. The very size of the overall development would increase the overall awareness of the presence of the wind farms / wind turbines, hence reducing the risk of operators not knowing of the existence of the developments.

There is always the risk that the very size of the development will encourage sight seeing and, perhaps, an associated increase in aircraft operations in the area for that purpose. This has been

shown to occur. Nevertheless, any such operations should be above the height of the wind turbines, whether such operations be VFR, Night VFR or IFR, and the risk of collision is considered to be minimal.

If obstacle lighting exists, there have been cases of Night VFR or IFR operations occurring for sight seeing purposes. Whilst one would question the desirability of such action, the fact that the turbines are lit reduces the associated risks.

3.4.11 Obstacle lighting needs

Before commenting on the need, or otherwise, for obstacle lighting on the proposed wind turbines within the Bulgana Wind Farm, it is thought necessary to summarise the current regulatory position in this respect within Australia.

The Civil Aviation Safety Authority (CASA) powers in respect of the control of obstacles in and around aerodromes flow from the Civil Aviation Regulations 1988 (CAR), Part 9, Subpart 95, which provides for the marking or removal of hazardous objects within the obstacle limitation surfaces (OLS) of any aerodrome.

Civil Aviation Safety Regulation 1998 (CASR) Subpart 139.E covers the specific definitions of hazardous objects and the reporting requirements.

In summary CASR 139.E requires: -

1. Aerodrome operators to monitor the surrounding airspace for any object that might infringe the OLS and to notify CASA;
2. Any person who proposes to construct any structure which will be 110m or more AGL to inform CASA; and
3. CASA may determine whether the proposed structure(s) will be a hazardous object because of its location, height or lack of marking or lighting.

Detailed aerodrome design requirements are within the CASA Manual of Standards Part 139 – Aerodromes. Chapter 7 covers the detailed requirements for Obstacle Restriction and Limitation.

In support of the above regulations, CASA issued two Advisory Circulars; viz:

- AC 139-08(0) “Reporting of Tall Structures” April 2005
- AC 139-18(0) “Obstacle Marking and Lighting of Wind Farms” December 2005.

There is no doubt that CASA has the necessary regulatory powers to control the marking and removal of hazardous objects in and around aerodromes and for the reporting of tall structures. However, there is some question as to CASA’s powers to insist on marking and / or lighting of obstacles outside the immediate area of an aerodrome. Further, the approach by CASA expressed within the AC 139-18(0) raised concerns amongst the wind farm industry. This was particularly raised in those cases where independent expert aviation advice recommended that marking and lighting was not needed because of low risks, yet CASA recommended to the contrary and noted that failure to follow the CASA advice would mean that the proponent of the wind farm would be “responsible for creating the hazard to aircraft safety and may be liable for their actions”.

As a consequence, in September 2009, CASA withdrew Advisory Circular AC139-18(0) after CASR 139 (Aerodromes) was found not to be applicable to areas located away from aerodromes regulated under CASR 139. CASA then embarked on a review of the risk to aviation by wind farms located away from aerodromes. The Department of Infrastructure and Transport (now Department of Infrastructure and Regional Development) then chose to address the impact of wind farms on aviation through The National Airports Safeguarding Framework – specifically issuing Guideline D “Managing the Risk to Aviation Safety of Wind Turbine Installations (wind farms) / wind Monitoring Towers” – a copy of which is at Appendix 6.12.

Further, CASA moved to amend the MOS 139 to include reference to wind farms, specifically within Section 9.4: Obstacle Lighting (copy at Appendix 6.10) with obstacle lighting requirements basically consistent with those within ICAO Annex 14 – copy of relevant part at Appendix 6.11.

In assessing the proposed Bulgana Wind Farm, SGS HART Aviation is of the view that there will be no penetration of the OLS in respect of current operations from Stawell Aerodrome. In respect of operations associated with the future development of Stawell Aerodrome, there could be a small, but

considered low risk to aviation operations in the vicinity due to the fact that any wind turbine higher than 100m (~328ft) AGL may be likely to penetrate the OLS established for the Stawell Aerodrome for the future development – copy at Appendix 6.9.

Whilst the risk is considered low because the wind farm itself is at the limit of OLS considerations, SGS HART Aviation is of the view that the risk is sufficiently high such that obstacle lights should be required, regardless of the wind turbine model chosen from the four types being considered. This is considered to be the appropriate conservative and duty of care approach to be taken.

Obstacle lights should be installed consistent with the requirements detailed in the CASA MOS 139 Section 9.4 – a copy of which is at Appendix 6.10.

The risk itself is largely only related to the potential for the wind turbines to penetrate the OLS for Stawell Aerodrome associated with the planned future development and the possibility of the need to amend the RNAV (GNSS) procedures in respect of circling altitudes associated with those procedures (a matter to be assessed by Airservices) as other potential impacts on the aviation aspects are considered to be not of concern.

This latter view is based on the following: -

- Apart from Stawell Aerodrome (which is some 15km west of the proposed wind farm site and at the outside fringe of the OLS for that aerodrome) there are no certified or registered aerodromes within the wind farm area or in the near vicinity. The nearest certified or registered aerodrome other than Stawell is Ararat, approximately 16km to the south-east of the most southern edge of the proposed wind farm site. This latter aerodrome is sufficiently far away from the proposed Bulgana Wind Farm site such that obstacle limitation surfaces for this aerodrome would not be penetrated by any wind turbine existing on the Bulgana Wind Farm.

- The nearest unlicensed airfield identified in available airfield and airstrip guides / directories for the area is Navarre, situated approximately 17km to the north east of the wind farm site. Operations from this airfield will not be impacted at all due to the presence of the Bulgana Wind Farm.

- Other identified unlicensed / unclassified airstrips identified in available airfield and airstrip guides / directories for the area are 24km or more from the proposed wind farm site and will not be affected.

- Three small private airstrips have been identified closer to the proposed wind farm site itself, none of which is identified on any aviation charts or any other aviation documentation. Operations for these airstrips would be unlikely to be affected.

- With the exception of approved low level operations (such as aerial agricultural spraying, search and rescue, fire fighting, etc.) aircraft are required to operate at minimum heights above the highest point of any of the wind turbines.

- Any approved low level operations, by their very nature, are required to check for any obstacles which might impact on such operations, before undertaking any such operations. All such operations will be day VFR.

- The proposed Bulgana Wind Farm turbines will not affect any sector altitude, or any enroute or grid lowest safe altitudes (LSALT). They will not impact on Precision/Non-Precision Navigational Aids, HF/VHF Communications, Advanced Surface Movement Guidance and Control Systems, Radar or Satellite/Links.

- There are no known low level military flight routes or military aircraft training areas within the vicinity.

The risk to aviation operations would be further reduced if, in the fullness of time, the wind turbines were identified on the relevant aeronautical charts, i.e., both the civil WACs and the RAAF produced chart series. This is considered essential risk mitigation. Pending such identification on maps, it would be advisable to ensure that all aviation operators are made aware of the existence of the wind farm. Airservices, if they were made aware of the wind farm, would normally do this via NOTAM action

covering both the construction phase and prior to identification on maps. It is, therefore, essential that the wind farm developer advise Airservices and the RAAF AIS as well as CASA. As advised before, such organisations have already been informed of the proposed development.

4. SUMMARY COMMENTS AND RECOMMENDATIONS

SGS HART Aviation is of the view that, whilst the overall risk to aviation operations in the vicinity of the proposed Bulgana Wind Farm is low, there is the potential for the wind turbines proposed to penetrate the OLS for Stawell Aerodrome for the future development to the extent that obstacle lights are considered to be required for the wind turbines, regardless of the particular wind turbine model chosen as listed in Section 2.10.

CASA needs to be advised of the proposed wind farm development in accordance with CASR 139.365 and it is considered likely that CASA would make a “determination” in accordance with CASR 139.370. SGS HART Aviation considers that CASA may very well require the installation of obstacle lights but can not anticipate any other matter which might be determined by CASA.

Airservices needs to be advised of the proposed wind farm development as the potential impact on the recently established RNAV (GNSS) instrument approach procedures for Stawell Aerodrome can not be ignored and needs to be assessed by Airservices.

As advised earlier, both CASA and Airservices were given access to this assessment report (in draft form) so they are already well aware of the proposal.

The risk to aviation operations would be further reduced if, in the fullness of time, the wind turbines were identified on the relevant aeronautical charts, i.e., both the civil WACs and the RAAF produced chart series. This is considered essential risk mitigation.

Pending such identification on maps, it would be advisable to ensure that all aviation operators are made aware of the proposed existence of the wind farm.

Airservices, if they were made aware of the wind farm, would normally do this via NOTAM action covering both the construction phase and prior to identification on maps. It is, therefore, essential that the wind farm developer advise both Airservices and the RAAF AIS.

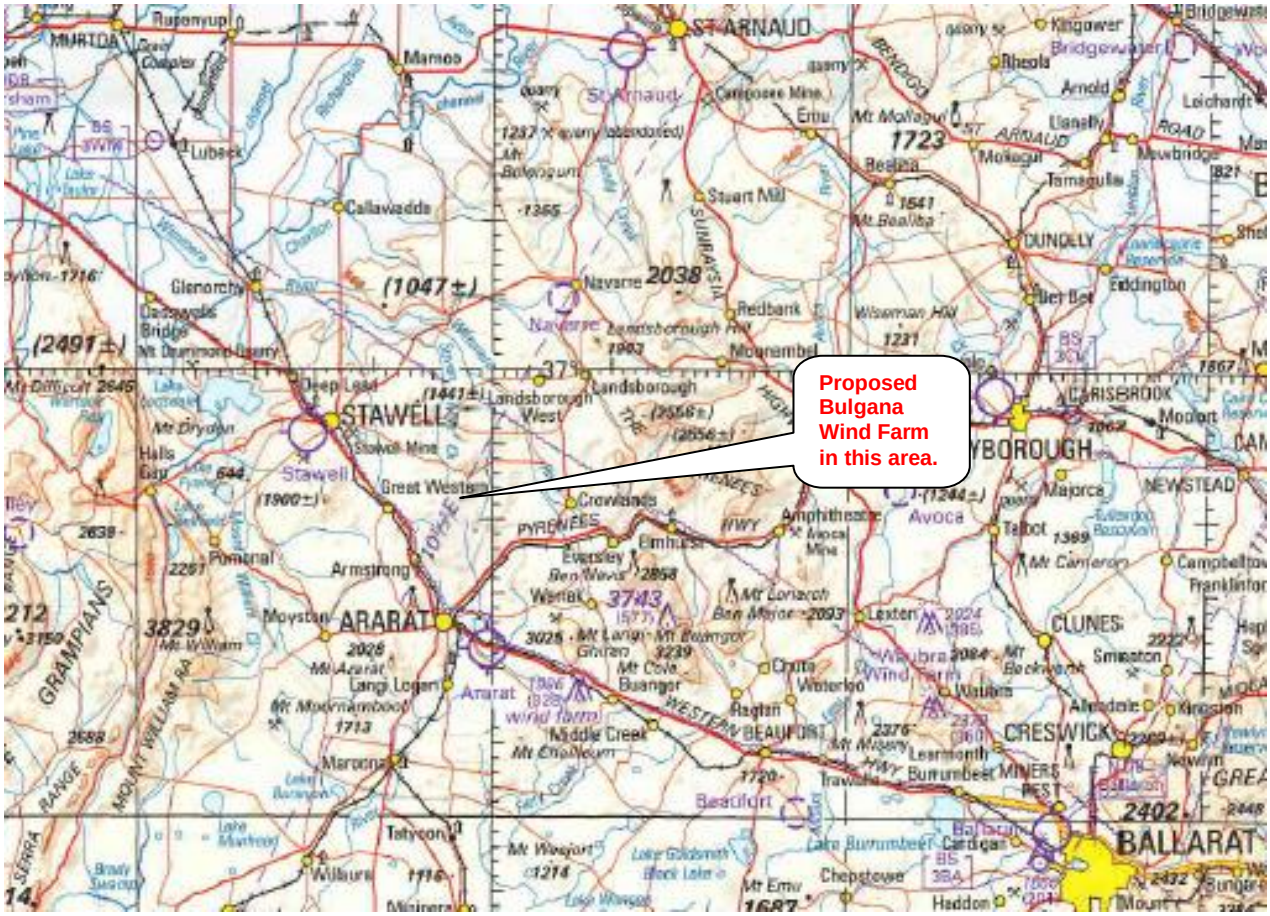
Advice to CASA, Airservices and the Department of Defence should also include details of the Met Masts – both existing and proposed – and SGS HART Aviation was informed that such action had already been undertaken by Wind Prospect Pty Ltd, representing Bulgana Wind Farm Pty Ltd.

5. ABBREVIATIONS USED IN THIS REPORT

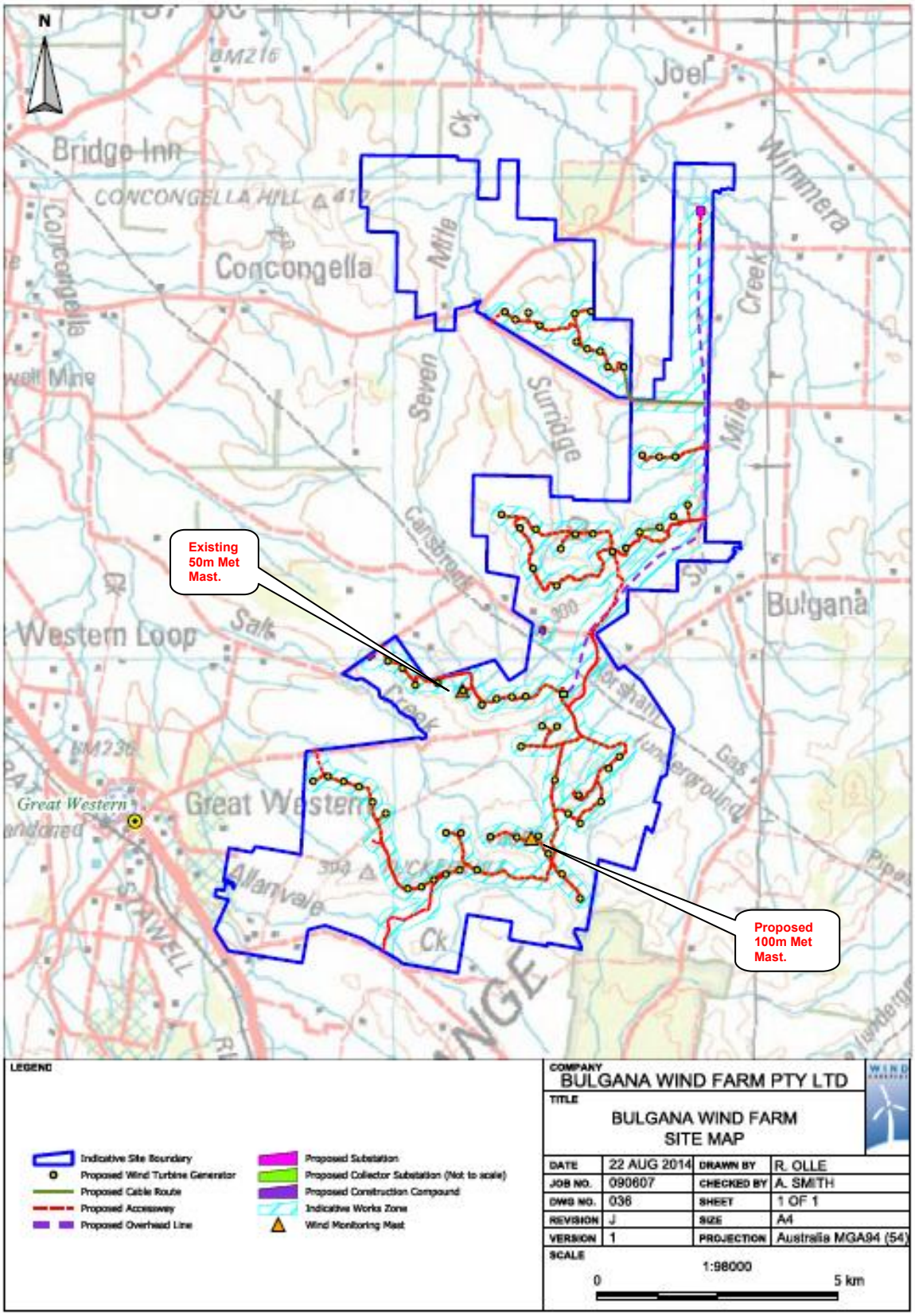
AAAA	Aerial Agricultural Association of Australia	LPPF	Local Planning Policy Framework
AC	Advisory Circular	LPSI	Land Planning & Spatial Information
AGL	Above Ground Level	LSALT	Lowest Safe Altitude
AIS	Aeronautical Information Services	m	Metre
ALA	Authorised Landing Area	MOS	Manual of Standards
AMSL	Above Mean Sea Level	NASAG	NATIONAL AIRPORTS SAFEGUARDING FRAMEWORK – GUIDELINE
AOPA	Aircraft Owners and Pilots Association of Australia	NDB	Non Directional Radio Beacon
CAR	Civil Aviation Regulation	NOTAM	Notice to Airmen
CASA	Civil Aviation Safety Authority (Australia)	OLS	Obstacle Limitation Surfaces
CASR	Civil Aviation Safety Regulation	PRD	Prohibited, Restricted, Danger areas
DPCD	Department of Planning and Community Development	PSR	Primary Surveillance Radar
ERC	En Route Chart	RAAF	Royal Australian Air Force
ERSA	En Route Supplement Australia	RNAV	Area Navigation
FAA	Federal Aviation Administration	SPPF	Victorian State Planning Policy Framework
ft	Feet	SSR	Secondary Surveillance Radar
GNSS	Global Navigation Satellite System	TAC	Terminal Area Chart
GPS	Global Positioning System	VFR	Visual Flight Rules
ICAO	International Civil Aviation Organisation	VHF	Very High Frequency
IFR	Instrument Flight Rules	VNC	Visual Navigation Chart
HF	High Frequency	VTC	Visual Terminal Chart
km	Kilometre	WAC	World Aeronautical Chart

6. APPENDICES

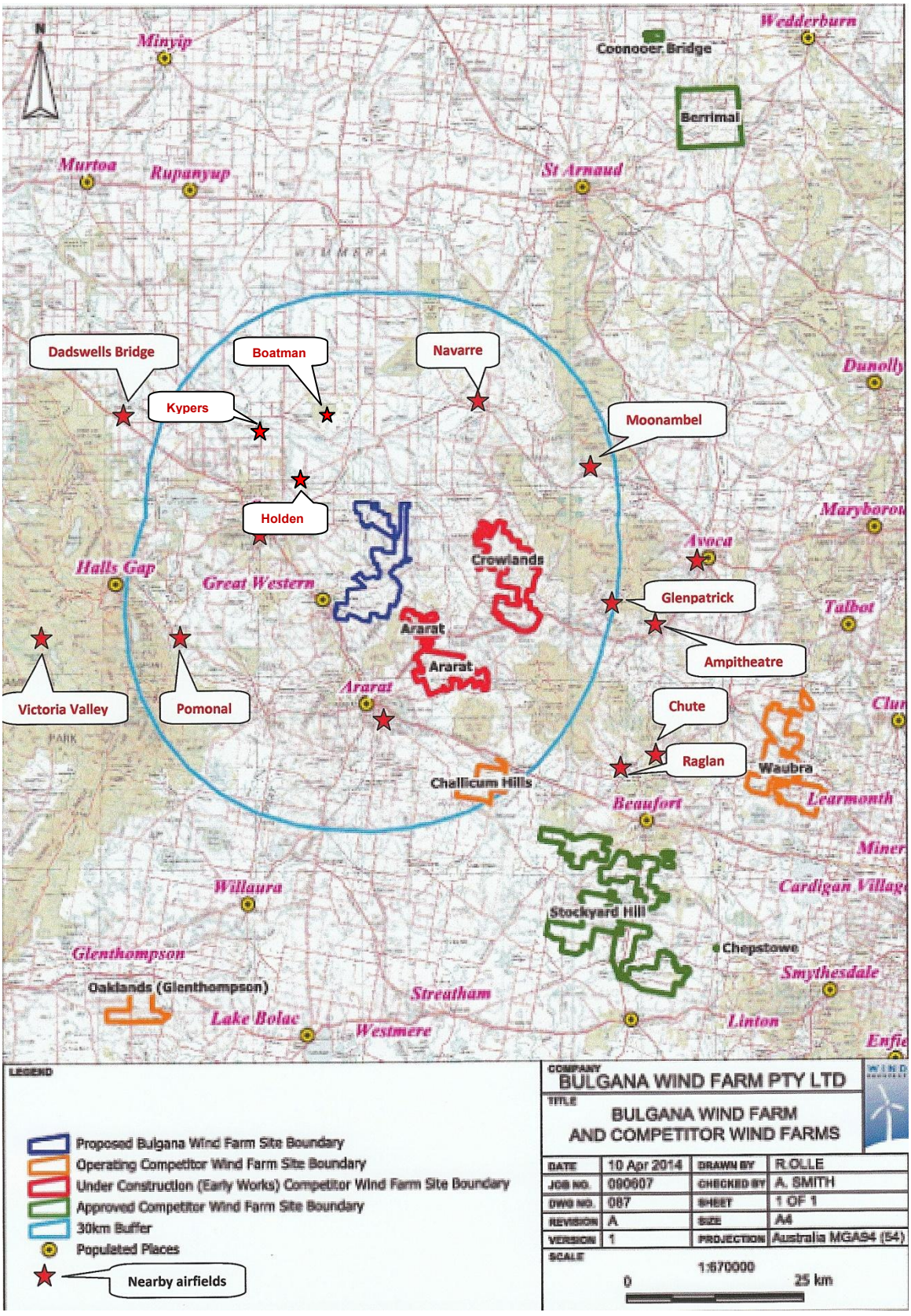
6.1 EXCERPT FROM WAC 3469 – HAMILTON



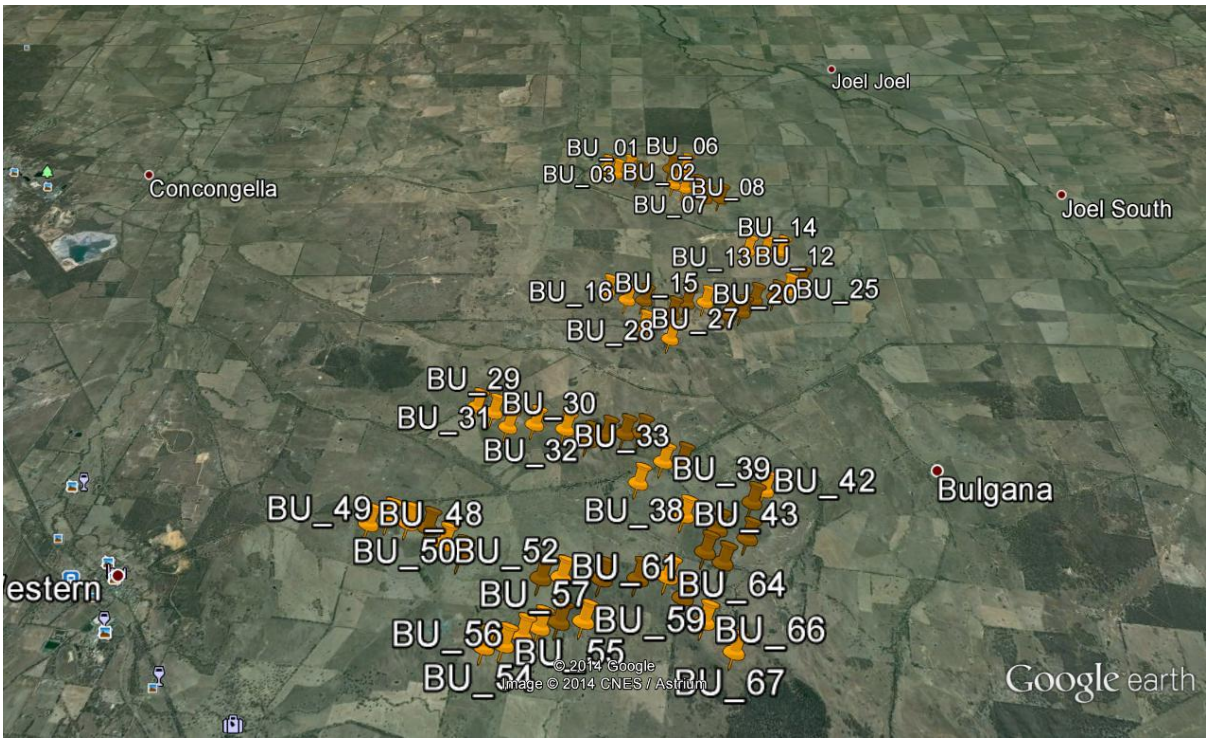
6.2 PROJECT AREA MAP SHOWING OUTLINE OF WIND FARM AREA



6.3 BULGANA WIND FARM & COMPETITOR WIND FARMS SHOWING AIRFIELDS IDENTIFIED IN THE VICINITY.



6.4 PROPOSED BULGANA WIND FARM WIND TURBINE LAYOUT



6.5 PROPOSED BULGANA WIND FARM WIND TURBINE COORDINATES

Proposed Bulgana Wind Farm Wind Turbine Coordinates (WTG_BUL_v018) 67 Wind Turbines
Projection: GDA 94, MGA 94 (54)

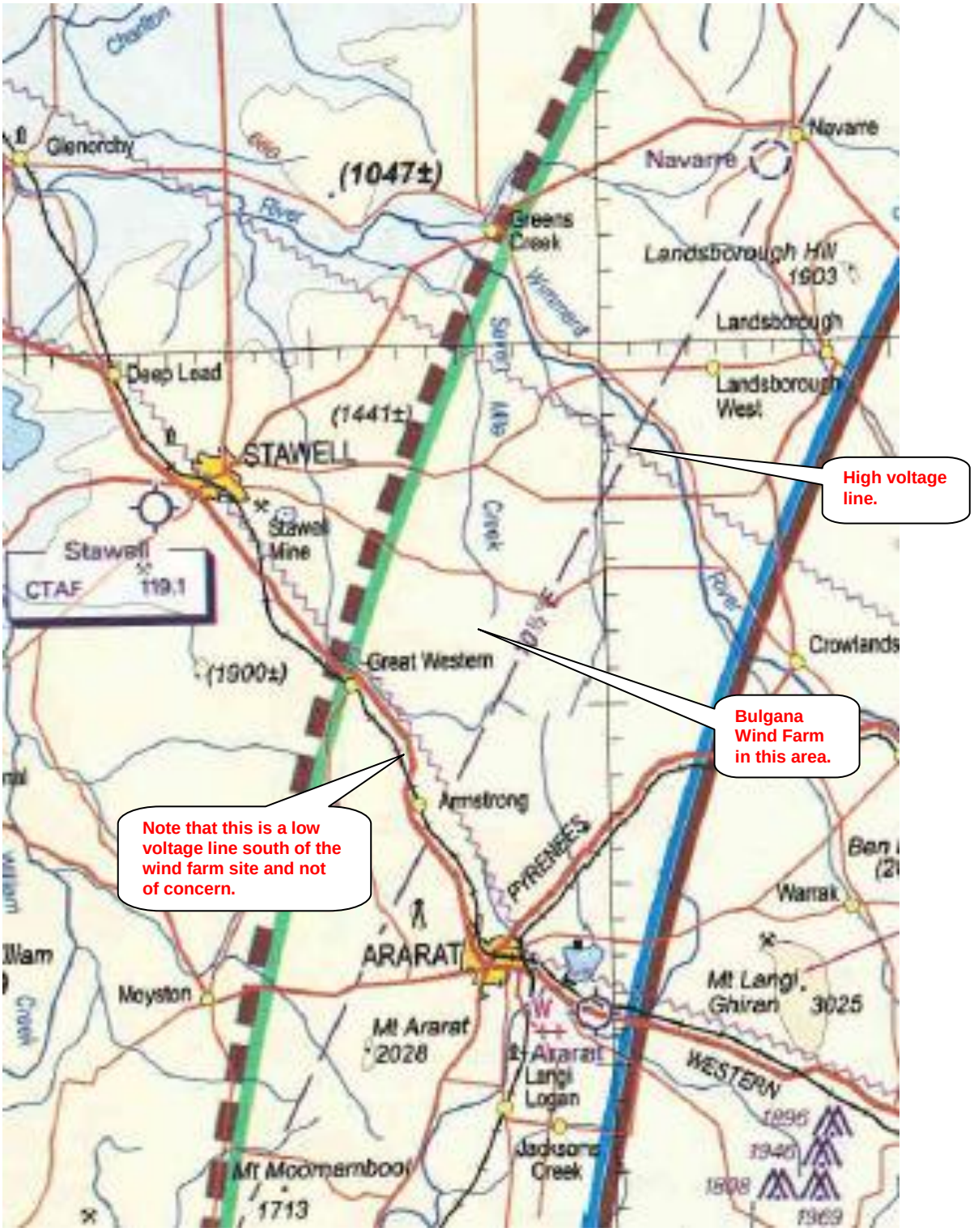
ID 2	X	Y	Longitude	Latitude	ELEVATION (m)	AMSL (feet)
BU_01	672343.957	5897186.57	142.9383	-37.0557	236	774.2782164
BU_02	672565.709	5897026.73	142.9408	-37.0571	241	790.6824159
BU_03	672836.18	5897170.1	142.9438	-37.0558	265	869.4225735
BU_04	673070.803	5896900.58	142.9465	-37.0582	273	895.6692927
BU_05	673799.876	5897149.08	142.9547	-37.0558	296	971.1286104
BU_06	674135.418	5897196.44	142.9584	-37.0553	311	1020.341209
BU_07	673834.268	5896560.24	142.9552	-37.0611	306	1003.937009
BU_08	674059.219	5896418.7	142.9577	-37.0623	317	1040.026248
BU_09	674327.59	5896365.18	142.9608	-37.0628	318	1043.307088
BU_10	674489.779	5896039.68	142.9627	-37.0657	310	1017.060369
BU_11	674818.23	5896039.05	142.9664	-37.0656	272	892.3884528
BU_12	675200.605	5894203.77	142.9711	-37.0821	281	921.9160119
BU_13	675556.197	5894170.3	142.9751	-37.0823	271	889.1076129
BU_14	675892.197	5894170.3	142.9789	-37.0823	267	875.9842533
BU_15	672277.23	5892970.28	142.9385	-37.0937	302	990.8136498
BU_16	672660.826	5892685.06	142.9429	-37.0962	331	1085.958007
BU_17	672992.392	5892663.98	142.9466	-37.0964	298	977.6902902
BU_18	673510.602	5892255.61	142.9525	-37.1	301	987.5328099
BU_19	673813.027	5892560.59	142.9559	-37.0971	290	951.443571
BU_20	674176.97	5892566.46	142.96	-37.097	286	938.3202114
BU_21	674581.772	5892195.91	142.9646	-37.1003	296	971.1286104
BU_22	674862.848	5892271.29	142.9677	-37.0996	330	1082.677167
BU_23	675143.203	5892601.75	142.9708	-37.0965	358	1174.540684
BU_24	675563.361	5892706.34	142.9755	-37.0955	297	974.4094503
BU_25	675845.456	5892932.14	142.9786	-37.0934	271	889.1076129
BU_26	676149.061	5893170.23	142.982	-37.0912	263	862.8608937
BU_27	672933.897	5891851.34	142.9461	-37.1037	362	1187.664044
BU_28	673423.833	5891484.13	142.9517	-37.1069	399	1309.05512
BU_29	669916.029	5889919.01	142.9126	-37.1217	275	902.2309725
BU_30	670218.076	5889771.83	142.9161	-37.1229	307	1007.217849
BU_31	670485.612	5889421.97	142.9192	-37.126	312	1023.622049
BU_32	670947.145	5889462.75	142.9243	-37.1256	317	1040.026248
BU_33	671476.5	5889305	142.9303	-37.1269	381	1250.000002
BU_34	671870.711	5889006.93	142.9348	-37.1295	420	1377.952758
BU_35	672176.56	5889133.04	142.9382	-37.1283	387	1269.685041
BU_36	672493.624	5889172.73	142.9418	-37.1279	404	1325.45932
BU_37	672779.199	5889186.15	142.945	-37.1277	379	1243.438322
BU_38	672683.9	5888140.91	142.9442	-37.1372	295	967.8477705
BU_39	673119.418	5888566.65	142.949	-37.1333	323	1059.711288
BU_40	673432.245	5888560.18	142.9525	-37.1333	316	1036.745408
BU_41	674502.793	5887683	142.9648	-37.141	362	1187.664044
BU_42	674729.281	5887930.22	142.9673	-37.1387	342	1122.047246
BU_43	673386.205	5887442.77	142.9523	-37.1433	330	1082.677167

BU_44	673881.176	5887129.02	142.9579	-37.1461	427	1400.918637
BU_45	673661.529	5886746.18	142.9555	-37.1496	335	1099.081367
BU_46	673914.573	5886542.36	142.9584	-37.1513	328	1076.115487
BU_47	674345.525	5886994.08	142.9632	-37.1472	309	1013.779529
BU_48	668363.337	5887419.94	142.8957	-37.1445	284	931.7585316
BU_49	668673.384	5887519.3	142.8992	-37.1435	289	948.1627311
BU_50	668997.963	5887414.07	142.9029	-37.1444	300	984.25197
BU_51	669315.071	5887302.99	142.9065	-37.1453	323	1059.711288
BU_52	669602.664	5886987.84	142.9098	-37.1481	331	1085.958007
BU_53	669874.771	5886752.52	142.9129	-37.1502	312	1023.622049
BU_54	670332.403	5885185.44	142.9184	-37.1642	330	1082.677167
BU_55	670615.545	5885220.14	142.9216	-37.1639	325	1066.272968
BU_56	670870.824	5885364.76	142.9244	-37.1625	311	1020.341209
BU_57	671123.11	5885483.13	142.9272	-37.1614	318	1043.307088
BU_58	671409.445	5885568.81	142.9304	-37.1606	319	1046.587928
BU_59	671770.354	5885573.59	142.9345	-37.1605	319	1046.587928
BU_60	671123.589	5886347.98	142.927	-37.1536	308	1010.498689
BU_61	671436.416	5886341.51	142.9306	-37.1536	316	1036.745408
BU_62	672047.398	5886258.65	142.9375	-37.1543	419	1374.671918
BU_63	672595.284	5886252.15	142.9436	-37.1542	404	1325.45932
BU_64	673044.891	5886280.58	142.9487	-37.1539	404	1325.45932
BU_65	673250.144	5885910.04	142.9511	-37.1572	393	1289.370081
BU_66	673531.618	5885489.74	142.9543	-37.1609	403	1322.17848
BU_67	673909.88	5884976.04	142.9587	-37.1655	470	1541.994753

Wind Monitoring Masts

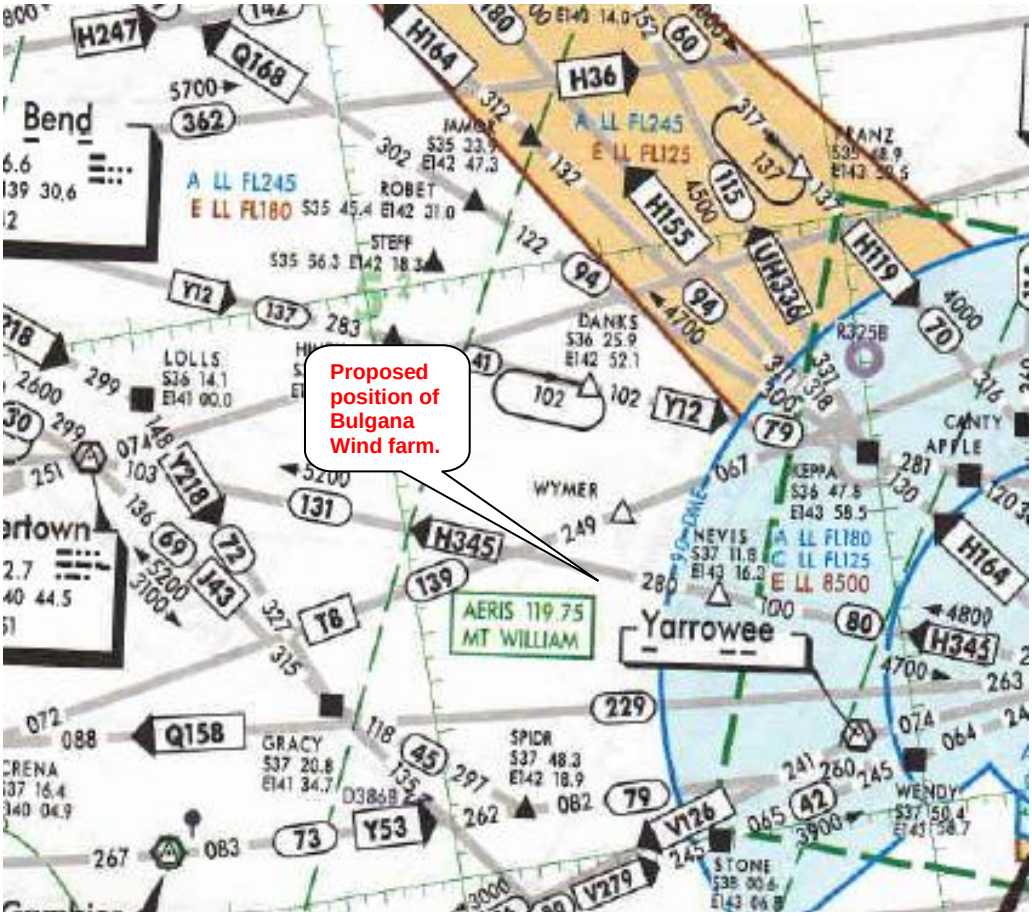
	X	Y	Longitude	Latitude	ELEVATION (m)	AMSL (feet)
BUL01 (50m mast)	671464	5889305	142.9302	-37.1269	381	1250.000002
BUL02 (100m mast)	672895.693	5886235.78	142.947	-37.1543	400	1312.33596

6.6 EXCERPT FROM VISUAL NAVIGATION CHART MELBOURNE

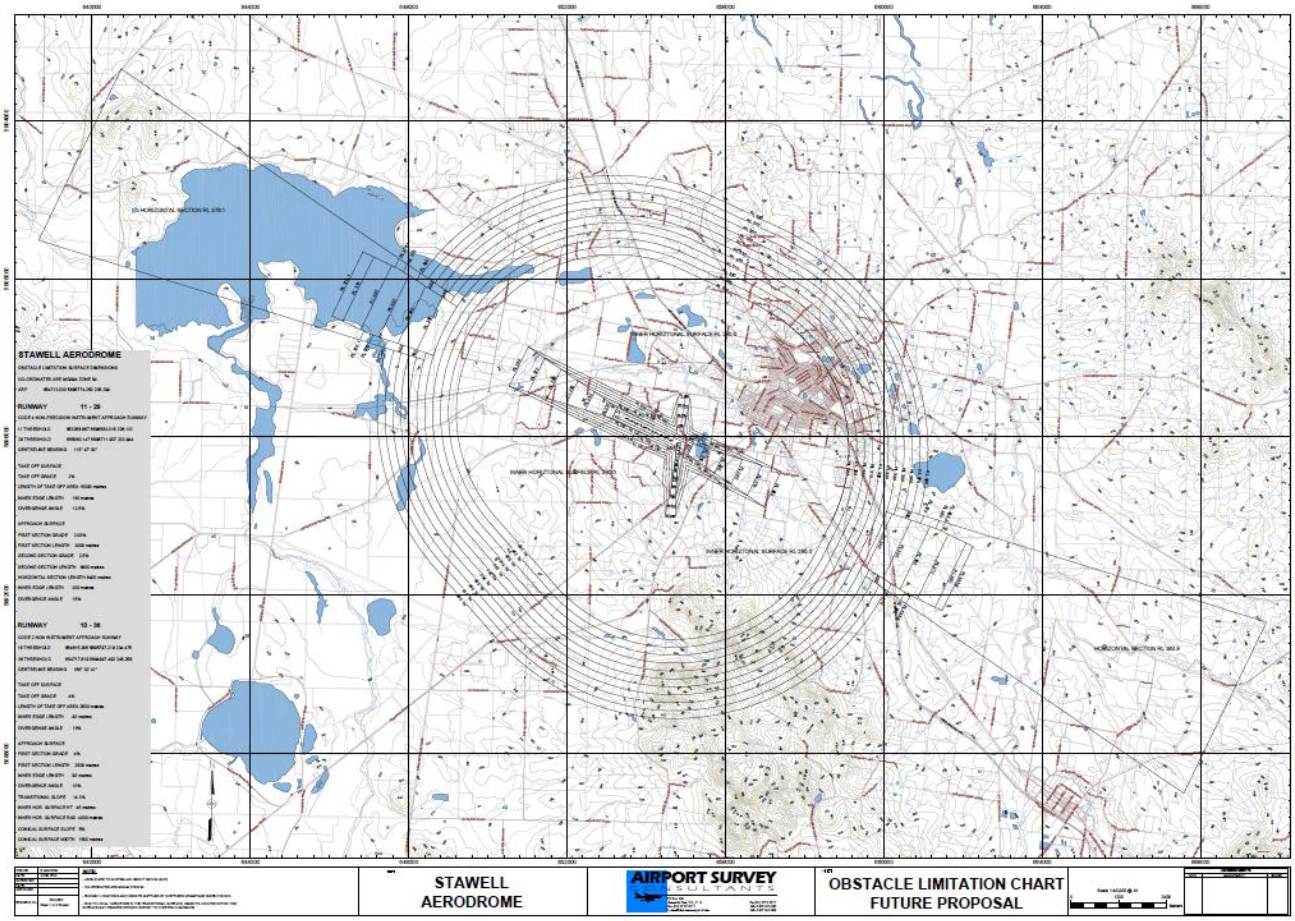


6.7 EXCERPT FROM EN ROUTE CHART (ERC) LOW L2

6.8 EXCERPT FROM EN ROUTE CHART (ERC) HIGH H3



6.9 OBSTACLE LIMITATION CHART FOR STAWELL AERODROME – FUTURE DEVELOPMENT



6.10 EXCERPTS FROM CASA MANUAL OF STANDARDS (MOS) 139

Section 9.4: Obstacle Lighting

9.4.1 General

9.4.1.1 Under the Civil Aviation Regulations, CASA may determine that an object or a proposed object which intrudes into navigable airspace requires, or will be required to be provided with, obstacle lighting. Responsibility for the provision and maintenance of obstacle lighting on a building or structure rests with the owner of the building or structure. Within the limits of the obstacle limitation surfaces of an aerodrome, responsibility for the provision and maintenance of
obstacle lighting on natural terrain or vegetation, where determined necessary for aircraft operations at the aerodrome, rests with the aerodrome operator.

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 110m above ground level.

9.4.3.4A In the case of a wind farm whose wind turbines must have obstacle lighting, medium intensity lights are to be installed as follows:

(a) if any part of the wind turbine, including the rotating blades, penetrates the obstacle limitation surface (OLS) of an aerodrome, top lights must mark the highest point reached by the rotating blades;

Note: Because it is not practicable to install obstacle lights at the tip of the blades, these lights may be located on a separate structure, adjacent to the wind turbine, at a height that corresponds to the highest point of the rotating blade of the turbine.

(b) if the rotating blades do not penetrate the OLS, the top lights must be placed on top of the generator housing;

(c) obstacle lights must be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, with intervals between lit turbines not exceeding 900m;

(d) all of the obstacle lights on a wind farm must be synchronised to flash simultaneously;

(e) the downward component of obstacle lighting may be shielded to the extent mentioned in either or both of the following sub-subparagraphs:

(i) so that no more than 5% of the nominal light intensity is emitted at or below 5^0 below horizontal;

(ii) so that no light is emitted at or below 10^0 below horizontal;

(f) to prevent obstacle light shielding by the rotating blades, 2 lights must be provided on top of the generator housing in a way that allows at least 1 of the lights to be seen from every angle in azimuth.

6.11 EXCERPT FROM ICAO ANNEX 14 RE WIND FARM LIGHTING

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.

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, 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.*

6.12 NASAG – NATIONAL AIRPORTS SAFEGUARDING FRAMEWORK – GUIDELINE D "Managing the Risk to Aviation Safety of Wind Turbine Installations (wind farms) / wind Monitoring Towers"

REVISION DATE	VERSION NUMBER	CHANGES MADE	APPROVED BY
Feb 2012	4.1.1	Document Creation	NASAG
Apr 2012	4.1.2	Drafting changes post consultation process	SCOTI
15/7/12	4.1.3	Version control table added. Page numbers added.	S. Stone, GM Aviation Environment, DOIT.

Purpose of Guideline

1. This document 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.

Why it is important

2. The *Principles for a National Airports Safeguarding Framework* acknowledge the importance of airports to national, state/territory and local economics, transport networks and social capital.
3. Wind farms can be hazardous to aviation as they are tall structures with the potential to come into conflict with low flying aircraft. Temporary and permanent wind monitoring towers can be erected in anticipation of, or in association with, wind farms and can also be hazardous to aviation, particularly given their low visibility. These structures can also affect the performance of Communications, Navigation and Surveillance equipment operated by Airservices Australia (Airservices) and the Department of Defence (Defence).

How it should be used

4. Some States/Territories already have planning guidelines or polices in place and this document provides guidance for review. For those without policies in place, these Guidelines (in addition to the associated Safeguarding Framework) will provide input to new polices.
5. These guidelines provide general information and advice to:
   a) proponents of wind farms (including single wind turbines); and
   b) planning authorities with jurisdiction over the approval of such structures.
6. These guidelines also provide specific advice on measures to reduce hazards to aviation, and how to implement them.

Wind Turbine Guidelines

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7. The guidelines are intended to provide information to proponents of wind farms and planning authorities to help identify any potential safety risks posed by wind turbine and wind monitoring installations from an aviation perspective.
8. The guidelines rely on an approach of risk identification and management to ensure risks to aviation are minimised in the most effective and efficient manner possible. It is not the intention to adopt an overly restrictive approach to wind farm development, rather to ensure risks are identified early and mitigation measures are able to be planned and implemented at an early stage.

Roles and Responsibilities

9. State/Territory and local governments are primarily responsible for land use planning in the vicinity of all airports.
10. Australia's 19 major airports are under Australian Government planning control and are administered under the Airports Act 1996 (the Airports Act). Planning on other airports is undertaken by State, Territory Governments and Local Governments or private operators.
11. Commonwealth airports are protected from tall structures in the vicinity of airports based on standards established by the International Civil Aviation Organization (ICAO). These standards have been implemented in Australia by the Airports Act 1996 and the Airports (Protection of Airspace) Regulations 1996 which apply at leased Commonwealth airports, and by the Defence (Areas Control) Regulations 1989 which apply at Defence airports.
12. This legislation can be used to ensure wind farms hazardous to aviation are not erected in the vicinity of Commonwealth airports. The implementation of these guidelines will have the outcome of conferring a similar level of protection to non-Commonwealth airports.
13. Australia is a signatory to the Convention on International Civil Aviation. Signatories are obliged to implement ICAO Standards unless they lodge a formal difference. ICAO Annex 14 specifically addresses the issue of wind turbines. In summary, ICAO has recommended the need for lighting of wind turbines if determined to be an obstacle.
14. Annex 14 includes a provision for an aeronautical study as to the need, or otherwise, for marking and/or lighting. This is consistent with provisions in Australia for risk-based assessments of potential hazards to aviation safety. These guidelines are consistent with ICAO Annex 14.

Key considerations for managing risks to aviation safety of wind turbine installations (wind farms)/wind monitoring towers

15. The guidelines apply to:

    (a) a single wind turbine;

    (b) a group of wind turbines, referred to as a wind farm, which may be spread over a relatively large area; and

    (c) wind monitoring towers.

16. The height of a wind turbine is defined as the maximum height reached by the tip of the turbine blades at their highest point above ground level. The marking and lighting described in this document addresses aviation requirements only. For offshore wind farms, in addition

to these requirements, separate lighting and marking may be required for the safety of marine navigation.

17. Implementation of the guidelines will have the additional benefit of being applicable in areas away from airports to address the risk posed by wind farms to air navigation in those areas.
18. Adoption of the guidelines will ensure that aviation safety agencies can examine and address the risk to aviation safety from proposed wind turbine farms at the planning stage. This will enable the use of wind energy to continue to grow, while protecting aviation safety.
19. Wind farm operators should check if proposed wind turbines and wind monitoring towers will be located near areas where low flying operations are likely to be conducted, and if so, consider their duty of care to such activities.

GUIDELINES FOR LAND USE PLANNERS AND DEVELOPERS TO MANAGE THE RISK TO AVIATION SAFETY OF WIND TURBINE INSTALLATIONS (WIND FARMS) /WIND MONITORING TOWERS

20. When wind turbines over 150 metres above ground level are to be built within 30 kms of a certified or registered aerodrome, the proponent should notify the Civil Aviation Safety Authority (CASA) and Airservices. If the wind farm is within 30km of a military aerodrome, Defence should be notified.

CASA should be notified through the nearest CASA Regional or Field Office. Location and contact details of CASA Aerodrome Inspectors may be obtained by calling CASA on 131 757. Airservices should be notified through the Airports Relations Team on 02-6268-4111. Defence should be notified through the Defence Support Group on 02-6266-8191.

21. The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) maintains a database of tall structures in the country. The RAAF AIS should be notified of all tall structures meeting the following criteria:
    - 30 metres or more above ground level for structures within 30km of an aerodrome; or
    - 45 metres or more above ground level for structures located elsewhere.
22. The contact details for the RAAF AIS are: Tel- 03-9282-5750; ais.charting@defence.gov.au.
23. Operators of certified aerodromes are required to notify CASA if they become aware of any development or proposed construction near the aerodrome that is likely to create an obstacle to aviation, or if an object will infringe the Obstacle Limitation Surfaces (OLS) or Procedures for Air Navigation Services –Operations (PANS-OPS) surfaces of an aerodrome. Operators of registered aerodromes should advise CASA if the proposal will infringe the OLS; CASA will ask Airservices to determine if there is an impact on published flight procedures for the aerodrome.
24. ***Note:*** *Obstacle Limitation Surfaces are a complex of virtual surfaces associated with an aerodrome. They are designed to protect aircraft flying in good weather conditions from colliding with tall structures. PANS-OPS surfaces are designed to protect aircraft flying in poor weather conditions from colliding with tall structures. Aerodrome operators can provide details for their particular aerodrome.*

Consultation

25. Consultation with aviation stakeholders is strongly encouraged in the early stages of planning for wind turbine developments. This should include:

    a) early identification of any nearby certified or registered aerodromes;

    b) immediate consultation with any nearby aerodrome owners;

    c) preliminary assessment by an aviation consultant of potential issues;

    d) confirmation of the extent of the OLS for any nearby aerodromes;

    e) registration of all wind monitoring towers on the RAAF AIS database;

    f) consultation with local agricultural pilots and nearby unlicensed airstrip owners; and

    g) consultation with CASA and Airservices.

Risk assessment

26. Following preliminary assessment by an aviation consultant of potential issues, proponents should expect to commission a formal assessment of any risks to aviation safety posed by the proposed development. This assessment should address any issues identified during stakeholder consultation.
27. The risk assessment should address the merits of installing obstacle marking or lighting. The risk assessment should determine whether or not a proposed structure will be a hazardous object. CASA may determine, and subsequently advise a proponent and relevant planning authorities that the structure(s) have been determined as:

    (a) hazardous, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking; or

    (b) hazardous and should not be built, either in the location and/or to the height proposed as an unacceptable risk to aircraft safety will be created; or

    (c) not a hazard to aircraft safety.

28. If CASA advice is that the proposal is hazardous and should not be built, planning authorities should not approve the proposal. If a wind turbine will penetrate a PANS-OPS surface, CASA will object to the proposal. Planning decision makers should not approve a wind turbine to which CASA has objected.
29. In the case of military aerodromes, Defence will conduct a similar assessment to the process described above if required. Airservices or in the case of military aerodromes, Defence, may object to a proposal if it will adversely impact Communications, Navigations or Surveillance (CNS) infrastructure. Airservices /Defence will provide detailed advice to proponents on request regarding the requirements that a risk assessment process must meet from the CNS perspective.

Marking of wind turbines in the vicinity of an aerodrome

30. During the day, large wind turbines are sufficiently conspicuous due to their shape and size, provided the colour of the turbine is of a contrasting colour to the background. 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. Other colours are also acceptable, unless the colour of the turbine is likely to blend in with the background.

Lighting of wind turbines in the vicinity of an aerodrome

31. Siting of wind turbines in the vicinity of an aerodrome is strongly discouraged, as these tall structures can pose serious hazards to aircraft taking-off and landing. Where a wind turbine is proposed that will penetrate the OLS of an aerodrome, the proponent should conduct an aeronautical risk assessment. The risk assessment, to be conducted by a suitably qualified person(s), should examine the effect of the proposed wind turbines on the operation of aircraft. The study should be made available to CASA to assist assessment of any potential risk to aviation safety.
32. CASA may determine that the proposal is:

(a) hazardous and should not be built, either in the location and/or to the height proposed, as an unacceptable risk to aircraft safety will be created; or

(b) hazardous, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking.

Lighting of wind turbines not in the vicinity of an aerodrome, with a height of 150m or more

33. Where a wind turbine 150m or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment.
34. The risk assessment, to be conducted by a suitably qualified person(s), should examine the effect of the proposed wind turbines on the operation of aircraft. The study must be submitted to CASA to enable an assessment of any potential risk to aviation safety. CASA may determine that the proposal is:

(a) hazardous, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking; or

(b) not a hazard to aircraft safety.

Obstacle lighting standards for wind turbines

35. When lighting has been recommended by CASA to reduce risk to aviation safety, medium-intensity obstacle lights should be used. Where used, lighting on wind farms should be installed:

(a) to identify the perimeter of the wind farm;

(b) respecting a maximum spacing of 900m between lights along the perimeter, unless an aeronautical study shows that a greater spacing can be used;

(c) where flashing lights are used, they flash simultaneously; and

(d) within a wind farm, any wind turbines of significantly higher elevation are identified wherever located.

36. To minimise the visual impact on the environment, obstacle lights may be partially shielded, provided it does not compromise their operational effectiveness. Where obstacle lighting is

provided, lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind farm should be turned on simultaneously and off simultaneously.

37. Where obstacle lighting is provided, proponents should establish a monitoring, reporting and maintenance procedure to ensure outages, including loss of synchronisation, are detected, reported and rectified. This would include making an arrangement for a recognised responsible person from the wind farm to notify the relevant CASA office, so that CASA can advise pilots of light outages.

Alternatives to fixed obstacle lighting

38. In some circumstances, it may be feasible to install obstacle lights that are activated by aircraft in the vicinity. This involves the use of radar to detect aircraft within a defined distance that may be at risk of colliding with the wind farm. When such an aircraft is detected, the wind farm lighting is activated. This option may allow aviation safety risks to be mitigated where obstacle lighting is recommended while minimising the visual impact of the wind farm at night.

Marking and lighting of wind monitoring towers

39. Before developing a wind farm, it is common for wind monitoring towers to be erected for anemometers and other meteorological sensing instruments to evaluate the suitability or otherwise of a site. These towers are often retained after the wind farm commences operations to provide the relevant meteorological readings. These structures are very difficult to see from the air due to their slender construction and guy wires. This is a particular problem for low flying aircraft including aerial agricultural operations. Wind farm proponents should take appropriate steps to minimise such hazards, particularly in areas where aerial agricultural operations occur. Measures to be considered should include:

a) 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;

b) marker balls or high visibility flags or high visibility sleeves placed on the outside guy wires;

c) ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground/vegetation; or

d) a flashing strobe light during daylight hours.

Reporting of structures less than 150m in height

40. There is no requirement for CASA to be notified if a proposed wind turbine or wind monitoring tower is less than 150m in height and does not infringe the OLS of an aerodrome. However, they should still be reported for inclusion in the national database of tall structures maintained by the Royal Australian Air Force (RAAF). Information on reporting of tall structures may be found in an advisory circular issued by CASA 'AC 139-08(0) Reporting of Tall Structures'.

Voluntary provision of obstacle lights

41. CASA's regulatory regime for obstacle lighting provides an appropriate level of safety for normal aircraft operations. Certain flying operations, by their nature, involve lower than normal flying, for example aerial agricultural spraying, aerial mustering, power line inspection, helicopter operations including search and rescue, some sports aviation, and some military training. Pilots conducting such operations require special training and are required to take obstacles into account when planning and conducting low flying operations.
42. In making decisions regarding the marking and lighting of wind farms and wind monitoring towers, wind farm operators should take into account their duty of care to pilots and owners of low flying aircraft.

Turbulence

43. 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. CASA will also raise awareness of this risk with representatives of aerial agriculture, sport aviation and general aviation.

Wind Turbine Guidelines

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6.13 REFERENCES

1. Airspace Act 2007.
2. Airspace Regulations 2007 (updated 9 August 2013).
3. Auswind Best Practice Guidelines for Implementation of Wind Energy Projects to Australia – December 2006.
4. CASA Advisory Circular AC 139-08(0) “Reporting of Tall Structures” April 2005.
5. CASA Manual of Standards (MOS) 139 Version 1.11: November 2013.
    a. In particular Section 9.4: Obstacle Lighting
6. Civil Aviation Safety Regulations (CASR),
    a. In particular CASR Subpart 139.E – Obstacles and hazards.
7. Clean Energy Council Best Practice Guidelines for Implementation of Wind Energy Projects in Australia, 2013.
8. Department of Planning and Community Development (DPCD) “Policy and planning guidelines for development of wind energy facilities in Victoria”, July 2012.
9. NASAG - National Airports Safeguarding Framework – Guideline D – “Managing the Risk to Aviation Safety of Wind Turbine Installation (Wind Farms) / Wind Monitoring Towers”
10. National Grampians Planning Scheme, 19 January 2006.
11. Relevant provisions of the Victorian State Planning Policy Framework (SPPF) September 2010 and the Local Planning Policy Framework (LPPF).

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