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Stockyard Hill Wind Farm Development Submission

1. Background

1.1 On 15 Jan 2017 Mr Philip Hawker contacted me regarding concerns he had associated with the location of certain elements of The Stockyard Hill Wind Farm Development and their potential effects on areas of his property and aviation operation. His primary concern was that wind turbine generated turbulence could have an adverse effect on the following aviation activities:

1. Aerially and ground dispersed crop treatments applied to Hawkwood Farm's agricultural land.
2. Firefighting operations for the protection of Hawkwood Farm.
3. Safe operation of flights to and from The Beaufort Authorised Landing Area (ALA) YBFT.

1.2 This report outlines the criteria currently used within the UK to assess areas where turbulence is likely to be encountered when operating near wind turbines, the nature of this turbulence and how this criterion could be applied in the case of The Stockyard Hill Wind Farm Development regarding the areas of concern outlined above.

1.3 In addition to the turbulent effects of the wind turbines this report also briefly touches on physical issues associated with the areas of concern outlined above.

2. Credentials

2.1 My primary role within the UK CAA was as a Civil Aviation Safety Regulator with the responsibility for the creation and implementation of UK civil aviation industry policy, regulations and guidance. This role required the provision of clear and consistent policy interpretation, advice and guidance to UK CAA inspecting colleagues and where appropriate, the provision of clear technical leadership, advice, guidance and support to other policy specialists within the CAA and in the wider national and international aviation industry.

2.2 Part of these responsibilities concerned the identification of issues associated with locating renewable energy sources on or near aerodromes. One of these renewable energy sources was wind energy in the form of wind turbines. Wind turbines create several problems when located near aviation assets, one of which is the turbulent effect they create in the wake of the turbine. As part of my role, I commissioned, from the University of Liverpool, research on behalf of the UK CAA to identify the nature of the turbulence associated with wind turbines. Professor George Barakos, at the time, CFD Laboratory Academic Director within the Department of Engineering, University of Liverpool was tasked with defining the nature and characteristics of the turbulence associated with wind turbines. Professor Barakos has been consulted regarding the quality and accuracy of the content of this report.

2.3 From the results of this research both Professor Barakos and I created the guidance for the avoidance of turbulence associated with wind turbines which is held within the current version of UK CAA CAP 764 (Policy and Guidelines on Wind Turbines).

3. Turbulence - General

3.1 In the early part of the decade, within the United Kingdom, "easy wins" regarding the location of wind turbine developments in relation to built-up or populated areas began to diminish. Wind turbine developers were, therefore, beginning to propose developments

closer to more densely populated urban areas. These areas included aviation assets such as airports and smaller air strips. Due to this change in policy wind developers and those responsible for these aviation assets were coming into conflict more often concerning siting of turbines particularly in respect to their physical nature and the turbulence created by them.

- 3.2. Whilst the CAA published well established physical avoidance and aerodrome safeguarding regulations, advice and guidance based on national and international criteria, there was nothing of a similar quality or nature regarding the turbulence associated with wind turbines and how it might affect aviation operations. Because of the lack of well researched regulatory material regarding wind turbine turbulence both developers and those responsible for aviation assets were “cherry picking” research of varying quality to justify their positions in planning meetings. This situation proved unsatisfactory for wind developers, those responsible for aviation assets, UK Local Planning Authorities and the UK CAA who were now, more regularly, being asked to provide expert input into planning meetings to validate the information produced on either side of the argument.
- 3.3. To mitigate this situation the UK CAA decided to fund some bespoke research to be undertaken by the University of Liverpool with the express intention of producing a report that clearly identified the nature of the turbulence associated with wind turbines and the likely effects of this turbulence on light aircraft operating within areas affected by the turbulence. It was also intended that the output of this research would imbue both wind turbine developers and those responsible for aviation assets with unequivocal, high quality, world leading data so that more informed decisions regarding the siting of wind turbines close to aviation assets could be made by representatives of both the aviation and wind industries alike.
- 3.4. In 2013, Professor Barakos and his team from University of Liverpool began the research project that would create a turbulence model and identify its likely effects on light aircraft. As part of this project there was a requirement to validate the turbulence model created by University of Liverpool with “real world” data. To do this a separate campaign, funded by The Aviation Investment Fund Company Ltd (AIFCL) **Reference 1**. This company was established as an action under the Aviation MOU signed in 2008 under the leadership of Renewable UK, the UK wind developer’s trade body. The purpose of the fund was to bring together wind energy companies with a common interest to invest in research and development projects that would help to address issues facing their industry both on-and off-shore within the UK.
- 3.5. The money received from this fund allowed University of Liverpool to undertake research using a Lidar (**See note 1**) to measure the turbulence associated with the Wind Turbines. The findings of this research validated the model that was created by the University of Liverpool for smaller wind turbines and were presented as part of the final research report. **Reference 2**.
- 3.6. The model that was created by the University of Liverpool allowed both Professor Barakos and myself to produce, with confidence, the guidance for the avoidance of turbulence associated with wind turbines that is, today, found within UK CAA. CAP 764 (Policy and Guidelines on Wind Turbines) September 2016. **Reference 3**.
- 3.7. The basic guidance outlined within the CAP 764 states that for wind turbines of 30m/Approximately 90 feet and less turbulence associated with the operation of the wind turbine is likely to dissipate 5 Rotor Diameter (RD) downwind from the turbine and likely to be experienced within a 2 RD cylinder from the centre of the nacelle, again, downwind of the turbine. **Reference 4**.
- 3.8. Furthermore, as part of our discussions concerning guidance for the avoidance of turbulence associated with larger wind turbines it was agreed that for all turbines larger than 30m/Approx.90 feet in size the current guidance of 16 RD, concerning how far downwind turbulence could be expected, would be maintained as a safe default

Note 1 - Light Detection & Ranging - A detection system which works on the principle of radar, but uses light

Reference 5. This safe default was agreed because the size of the wind turbine used to validate the model only allowed the provision of more precise avoidance criteria for smaller wind turbines. The next step for the validation of the model was to undertake further research, again using a LIDAR, which would then allow the provision of more accurate avoidance criteria for larger turbines. Unfortunately, this research is still to be initiated.

4. Turbulence - Stockyard Hill Wind Farm Development v Hawkwood Farm

4.1 The Stockyard Hill Wind Farm Development wind turbines have an RD of 142m/Approx. 465ft, therefore, a 16 RD (2272m/Approx.7452ft) x 2 RD (284m/Approx.931ft) cylinder will be used to identify areas where the turbulent effects of the wind turbines may be experienced regarding the areas of concern outlined by Philip Hawker in para 1.1 of this report. The map provided by Mr Philip Hawker **Attachment A**, will be used for the purposes of this assessment. **Attachment B**.

1. Aerially and ground dispersed crop treatments used for Hawkwood Farm's agricultural land.
 - a. For winds from direction 270 degrees through to 350 degrees turbulence associated with turbines J5 & J6 could be experienced over some element of the agricultural area which may affect the deposition of crop treatments by both aerial and ground application.
 - b. Moreover, after discussions with Mr Phillip Hawker regarding likely aircraft spraying profiles it became apparent that due to rising terrain and trees in the landscape to the North of Hawkwood Farm, the block of land with the airstrip within it can only be practically treated by aircraft operating an East to West run direction. This would mean that J4 and J3 as well as J5 and J6 could produce turbulent air that may affect aircraft to the West of Hawkwood Farm's agricultural land, pulling up at the end of their spray runs to turn back around for further passes.
2. Firefighting operations for the protection of Hawkwood Farm.
 - a. All wind turbines within the development could create turbulence in a circle around them of diameter 4544m. From the map, **Attachment C** and after discussions with Mr Hawker it appears that J1 – J6 K1 – K3 are the turbines that may cause problems with firefighting operations for the protection of Hawkwood Farm. To what extent this turbulence affects aerial operations by firefighting aircraft will depend on their type, operational procedures, the wind direction and where the fire is in relation to the turbine.
3. Safe operation of flights to and from The Beaufort Authorised Landing Area (ALA) YBFT.
 - a. For winds from direction 270 degrees through to 300 degrees' turbulence associated with J3, J4, J5 & J6 could be experienced by aircraft in the critical phases of flight approaching runway 11 and taking off from runway 29 at The Beaufort Authorised Landing Area (ALA) YBFT. **Attachment D**.

5. Physical – General

5.1 This element of the report will provide a very rudimentary assessment of the physical threat posed by certain turbines within the Stockyard Hill Wind Farm Development to aerial agricultural and aerial firefighting operations near Hawkwood Farm and to flights in and out of The Beaufort Authorised Landing Area (ALA) YBFT.

5.2 Whilst the assessment will identify whether aircraft undertaking the activities outlined above could, through the course of their operations, come into proximity with certain wind turbines within the Stockyard Hill Wind Farm Development, it is for the operators of the aircraft associated with these activities to provide the planning meeting with more information as to how much of a physical threat or issue the various

turbines pose to their specific operations and how they intend to mitigate these threats or issues.

5.4 Aircraft

1. Civil Aviation Regulations 1988 - Reg 157. (**Reference 6**)

a. Low flying.

(1) The pilot in command of an aircraft must not fly the aircraft over:

- (a) any city, town or populous area at a height lower than 1,000 feet; or
- (b) any other area at a height lower than 500 feet.

(3) A height specified in sub regulation (1) is the height above the highest point of the terrain, and any object on it, within a radius of:

- (a) in the case of an aircraft other than a helicopter--600 metres; or
- (b) in the case of a helicopter--300 metres;

from a point on the terrain vertically below the aircraft.

(4) Sub regulation (1) does not apply if:

- (b) the aircraft is engaged in private operations or aerial work operations, being operations that require low flying, and the owner or operator of the aircraft has received from CASA either a general permit for all flights or a specific permit for the flight to be made at a lower height while engaged in such operations; or

2. It is assumed, regarding the above regulation, that aircraft involved in any aerial agricultural or aerial firefighting operations in relation to Hawkwood Farm would have attained the relevant CASA general or specific permit to undertake these activities and will, therefore, be entitled to legally operate below 500 ft. and as such could come into direct physical conflict with certain turbines within the development. (Turbine height 180m high (590 ft.))

5.5 Airstrips

1. UK

- a. 'Safeguarding' is a term used in planning departments to describe the process whereby the effects of planning permissions on other interests' can be assessed. The UK publishes CAP 738 'Safeguarding of Aerodromes' **Reference 7**, as a guidance document for developers considering projects close to an aerodrome or indeed an aerodromes operational flight paths. The CAP is also used by aerodrome operators to ensure developments within the safeguarded area do not constitute an obstacle to operations be it physical, electronic or another phenomenon. In the UK, for licensed aerodromes, developers of non-aviation projects are required to assess a project from an aviation viewpoint particularly where the development would constitute a hazard to aviation or to the public. Whilst this is the case in the UK for licensed aerodromes, it is not mandatory for unlicensed aerodromes.
- b. The UK CAA publishes CAP 793 Safe Operating Procedures at Unlicensed Aerodromes **Reference 8**, and considers it best practice to take into consideration unlicensed aerodrome or strip operations, facilities and flight paths when large obstacles are being proposed in their vicinity.
- c. Moreover, unlicensed operators are actively encouraged to build a relationship with their Local Planning Authority to ensure that they a kept informed should wind turbine or other such developments be considered in their area.

2. Australia

- a. In Australia, there are several documents that point towards similar concerns regarding physical issues associated with wind turbines and a similar, if not identical approach to unlicensed strip operations.
- b. For example, Factsheet: National Airports Safeguarding Framework **Reference 9**, which “is intended to provide guidance to state, local and territory governments which can in turn be used to guide assessment and approvals for land use and development on and around identified airports” recognises that wind turbines can constitute a risk to low-flying aviation operations such as agricultural pilots. Additionally, it explains that 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.
- c. Further guidance regarding how to ensure safe operations from small strips such as is in operation at Hawkwood Farm is outlined within Civil Aviation Advisory Publication (CAAP) 92 – (1) July 1992 – Guidance for Aeroplane Landing Areas **Reference 10**. This CAAP provides a Transition Slope Plan with clear figures summarising by how much approach and landing areas should be kept clear of obstacles to ensure the safe operation of aircraft to and from landing areas like the airstrip at Hawkwood Farm.

6. Physical - Stockyard Hill Wind Farm Development v Hawkwood Farm

- 6.1 Whilst the main thrust of this report is associated with the turbulent effects of wind turbines it is also important to consider any issues associated with the physical nature and positioning of the wind turbines regarding the areas of concern outlined by Philip Hawker.
1. Aerially and ground dispersed crop treatments used for Hawkwood Farm’s agricultural land.
 - a. The positioning of turbines J 3, J 4 J 5 & J 6 could physically interfere with aerial crop treatment activities if there is a need to manoeuvre to the North West of Hawkwood Farm as part of aerial application activities. **Attachment E**.
 2. Firefighting operations for the protection of Hawkwood Farm.
 - a. The positioning of turbines J 1 - J 6, K 1 - K 3 could physically interfere with aerial firefighting activities for the protection of Hawkwood Farm. **Attachment F**.
 3. Safe operation of flights to and from The Beaufort Authorised Landing Area (ALA) YBFT.
 - a. The current position of turbines J 5 & J 6 should not interfere with safe operation of flights to and from The Beaufort Authorised Landing Area (ALA) YBFT in good weather conditions however, they could become more of a concern in low visibility conditions. **Attachment G**.

7. Conclusions

7.1 Turbulence

1. It is evident from the research undertaken by University of Liverpool on behalf of the UK civil aviation regulator, the CAA, that turbulence occurs downwind of wind turbines and that the turbulence is different in nature from that of the ambient airflow. Additionally, this research identified that this turbulence had an adverse effect on light aircraft that flew through it. Therefore, turbulence that occurs

downwind of a wind turbine, which affects any form of aviation asset, must be given serious consideration when identifying sites for wind farm developments.

2. Moreover, as outlined in Para 4 of this report it is clear from the assessment that I have made that turbulence created by certain wind turbines within the Stockyard Hill Wind Farm Development will be in evidence and is likely to affect, to various degrees, the following:
 - a. Aerially and ground dispersed crop treatments applied to Hawkwood Farm's agricultural land.
 - b. Firefighting operations for the protection of Hawkwood Farm.
 - c. Safe operation of flights to and from The Beaufort Authorised Landing Area (ALA) YBFT.

7. 2. Physical

1. It is clearly important to consider physical issues associated with positioning of wind turbines close to populated areas and to small airports or landing strips as locating them close to these assets could adversely affect the safe operation of flights. Moreover, planning authorities, developers and aircraft operators are given sufficient guidance concerning physical issues associated with wind turbines and on how to ensure the safe operation of small airports or airstrips like Hawkwood farm.

8. Recommendations

8.1 Turbulence

1. To mitigate aviation safety concerns associated with the adverse turbulent effect of certain Stockyard Hill Wind Farm Development wind turbines on the safe operation of aircraft applying crop treatments to Hawkwood Farm's agricultural land consider the following:
 - a. Remove, reposition or restrict the operation of turbines J 3, J 4, J 5 & J 6 for winds from direction 270 degrees through to 350 degrees.
2. To mitigate aviation safety concerns associated with the adverse turbulence effect of certain Stockyard Hill Wind Farm Development wind turbines on safe aviation firefighting operations for the protection of Hawkwood Farm consider the following:
 - a. Remove turbines J 1 - J 6, K1 - K3.
3. To mitigate aviation safety concerns associated with the adverse turbulent effect of certain Stockyard Hill Wind Farm Development wind turbines on Hawkwood Farms owner's ability to safely operate flights to and from The Beaufort Authorised Landing Area (ALA) YBFT consider the following:
 - a. Remove, reposition or restrict the operation of turbines J 3, J 4, J 5 & J 6 for winds from direction 270 degrees through to 300 degrees.
4. Consider highlighting wind turbine turbulence as a national issue so that its effect on the safety of aviation operations is properly researched and clearly understood by both aviation and wind industry representatives alike.

8.2 Physical

1. To mitigate aviation safety concerns associated with the adverse physical effect of certain Stockyard Hill Wind Farm Development wind turbines on the safe operation of aircraft applying crop treatments to Hawkwood Farm's agricultural land consider the following:
 - a. Remove or reposition turbines J 5 & J 6.

2. To mitigate aviation safety concerns associated with the adverse physical effect of certain Stockyard Hill Wind Farm Development wind turbines on safe aviation firefighting operations for the protection of Hawkwood Farm consider the following:
 - a. Remove turbines J 1 - J 6, K1 - K3.
3. Phillip Hawker to consider developing an unofficial aerodrome safeguarding map which he would submit to the local planning authority for their awareness regarding any future developments of a similar nature.

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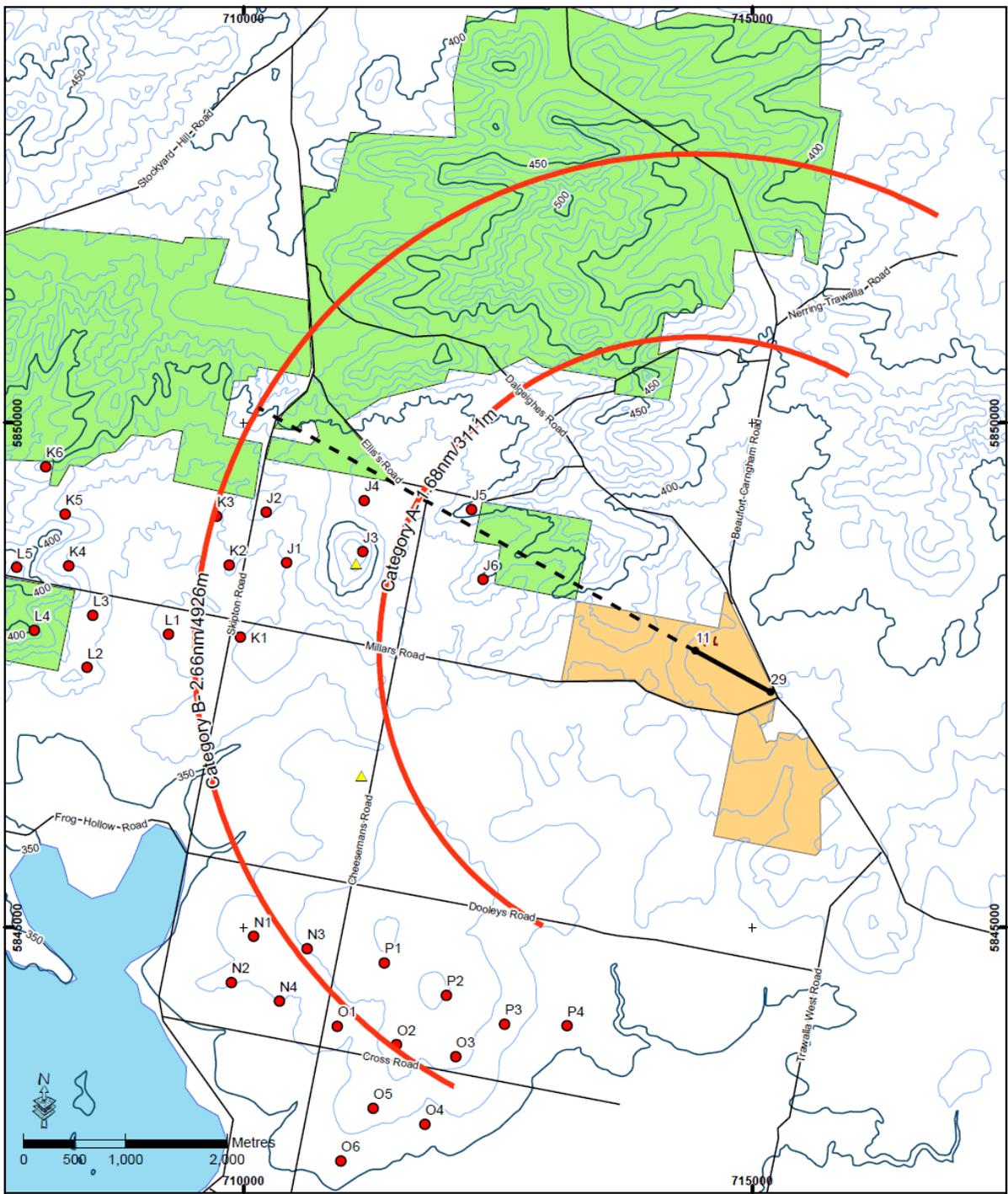
Attachments:

- Attachment A: Hawkwood Farm Map
- Attachment B Hawkwood Farm Map: Turbulence - Aerial and Ground Dispersed Crop Treatments Applied to Hawkwood Farm's Agricultural Land - J5 & J6
- Attachment C Hawkwood Farm Map: Turbulence - Firefighting Operations for the Protection of Hawkwood Farm
- Attachment D Hawkwood Farm Map: Turbulence - Safe Operation of Flights to and From The Beaufort Authorised Landing Area
- Attachment E: Hawkwood Farm Map: Physical - Aerial and Ground Dispersed Crop Treatments Applied to Hawkwood Farm's Agricultural Land - J5 & J6
- Attachment F: Hawkwood Farm Map: Physical - Firefighting Operations for the Protection of Hawkwood Farm
- Attachment G: Hawkwood Farm Map Physical - Safe Operation of Flights to and From The Beaufort Authorised Landing Area

References:

- Reference 1: Department for Energy & Climate Change – The Aviation Plan: 2015 Update In Respect of the Interaction of Wind Turbines and Aviation Interests
- Reference 2: University of Liverpool, School of Engineering, Wind Turbine Wake Encounter Study – 27 March 2015
- Reference 3: Safety & Airspace Regulation Group - CAA Policy and Guidelines on Wind Turbines CAP 764 - February 2016
- Reference 4: Safety & Airspace Regulation Group - CAA Policy and Guidelines on Wind Turbines CAP 764 - February 2016 - Page 34 - Figure 2: The Cylindrical Region Downwind the Rotor Should Be Avoided
- Reference 5: Safety & Airspace Regulation Group - CAA Policy and Guidelines on Wind Turbines CAP 764 - February 2016 – Page 31 – Para 2.53
- Reference 6: Civil Aviation Regulation - 1988
- Reference 7: UK CAP 738 'Safeguarding of Aerodromes'
- Reference 8: UK CAP 793 Safe Operating Procedures at Unlicensed Aerodromes
- Reference 9: Factsheet: National Airports Safeguarding Framework
- Reference 10: Civil Aviation Advisory Publication 92 – (1) July 1992 – Guidance For Aeroplane Landing Area

Hawkwood Farm Map



Legend

Hawkwood Farm	Contours
Vegetation	Major: 50m
Lake	Minor: 10m
Buildings	Wind Turbines
Roads	Permanent Met Mast
Extended Centreline	
Airstrip	

Hawkwood

Farm Map

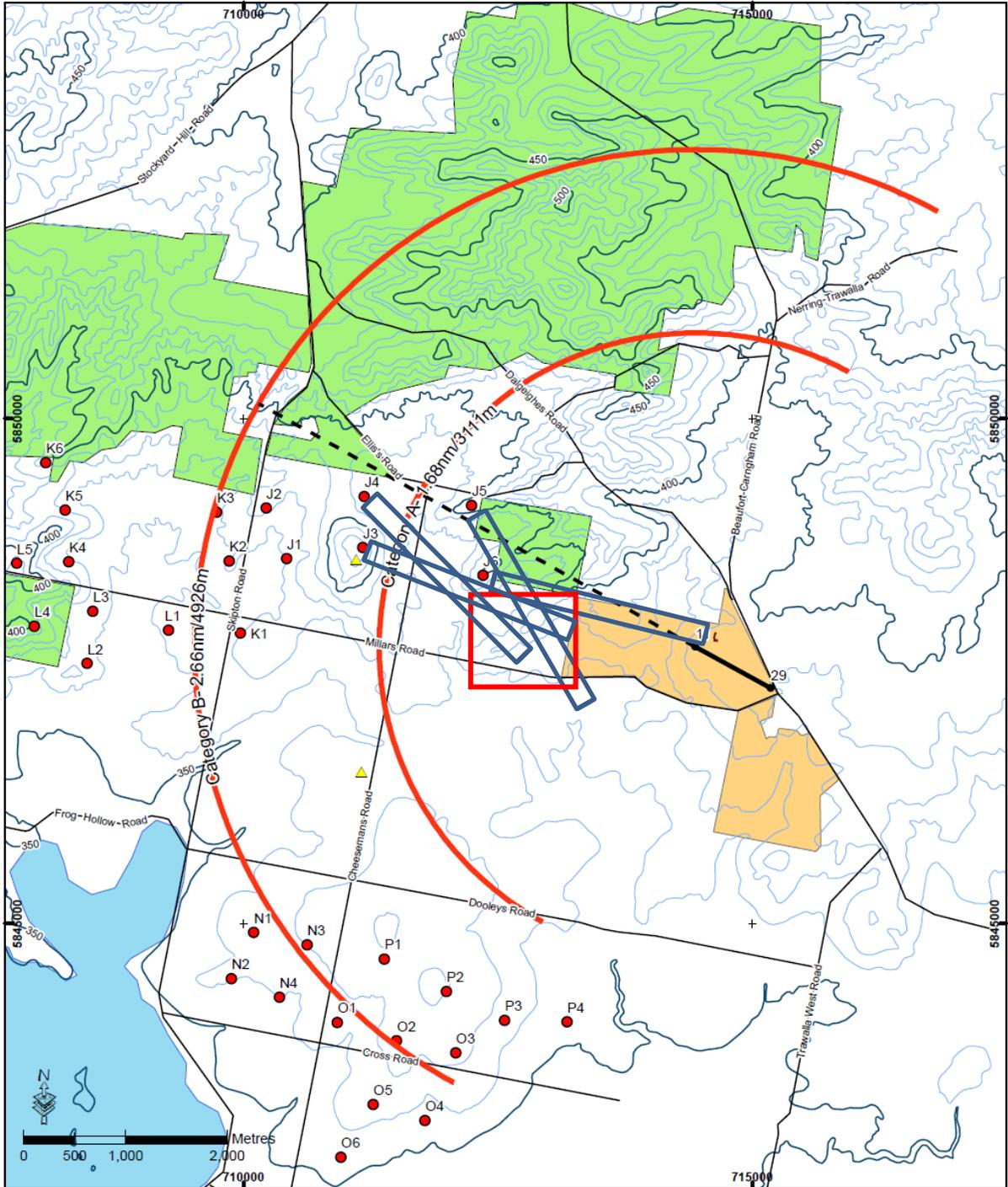
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Hawkwood Farm Map - Turbulence - Aerially and Ground Dispersed Crop Treatments Applied to Hawkwood Farm's Agricultural Land

Turbines J3, J4, J5 & J6



Legend

Hawkwood Farm	Contours
Vegetation	Major: 50m
Lake	Minor: 10m
Buildings	Wind Turbines
Roads	Permanent Met Mast
Extended Centreline	
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Hawkwood

Farm Map

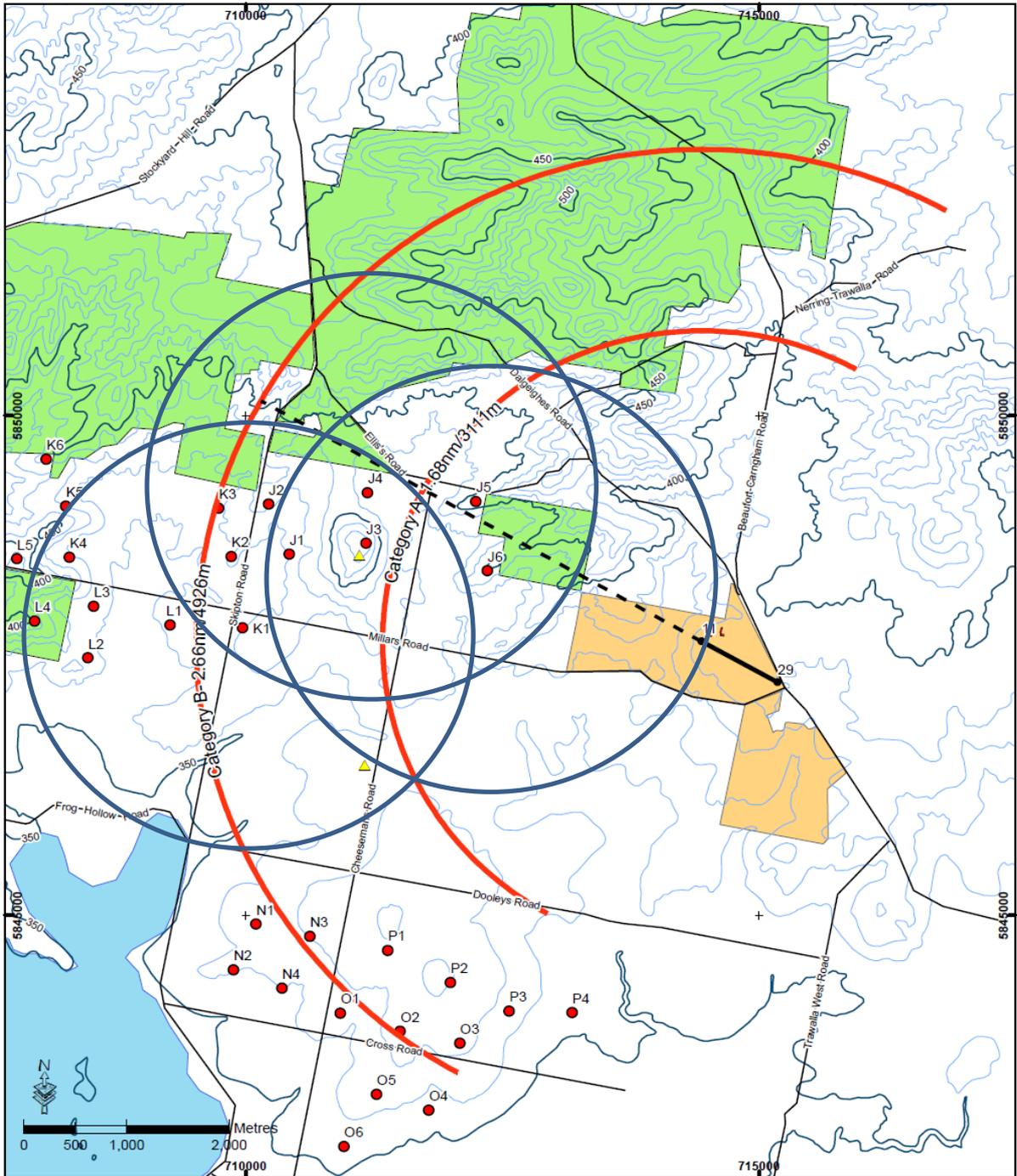
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Hawwood Farm Map - Turbulence – Fire Fighting Operations for the Protection of Hawkwood Farm

Circles of diameter 4544m centred on turbine K1, turbine J4 & turbine J6



Legend

Hawkwood Farm	Contours
Vegetation	Major: 50m
Lake	Minor: 10m
Buildings	Wind Turbines
Roads	Permanent Met Mast
Extended Centreline	
Airstrip	

Hawwood
Farm Map

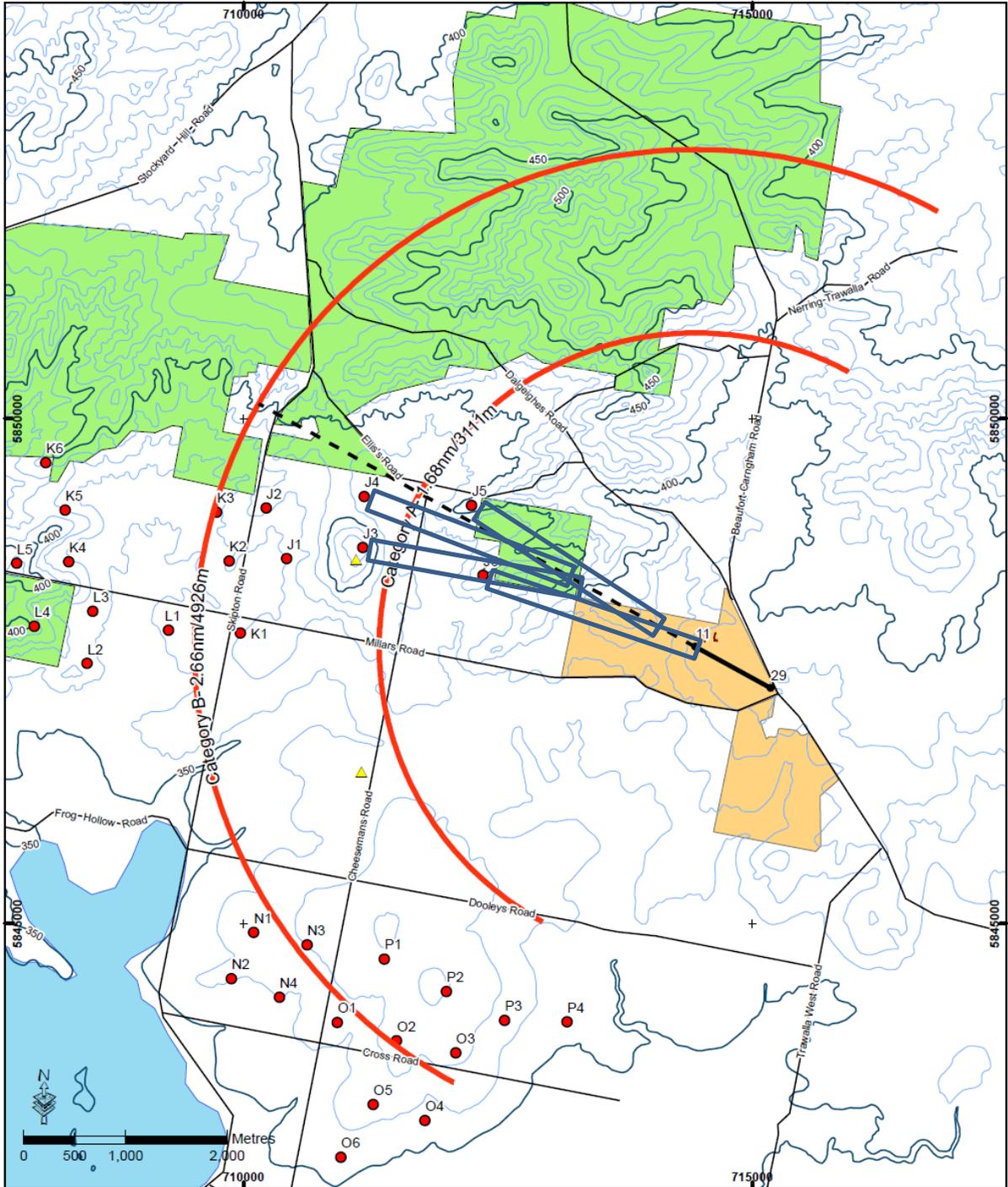
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Hawkwood Farm Map - Turbulence - Safe Operation of Flights To and From The Beaufort Authorised Landing Area (ALA) YBFT.

Turbines J3, J4, J5 & J6



Legend

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Hawkwood

Farm Map

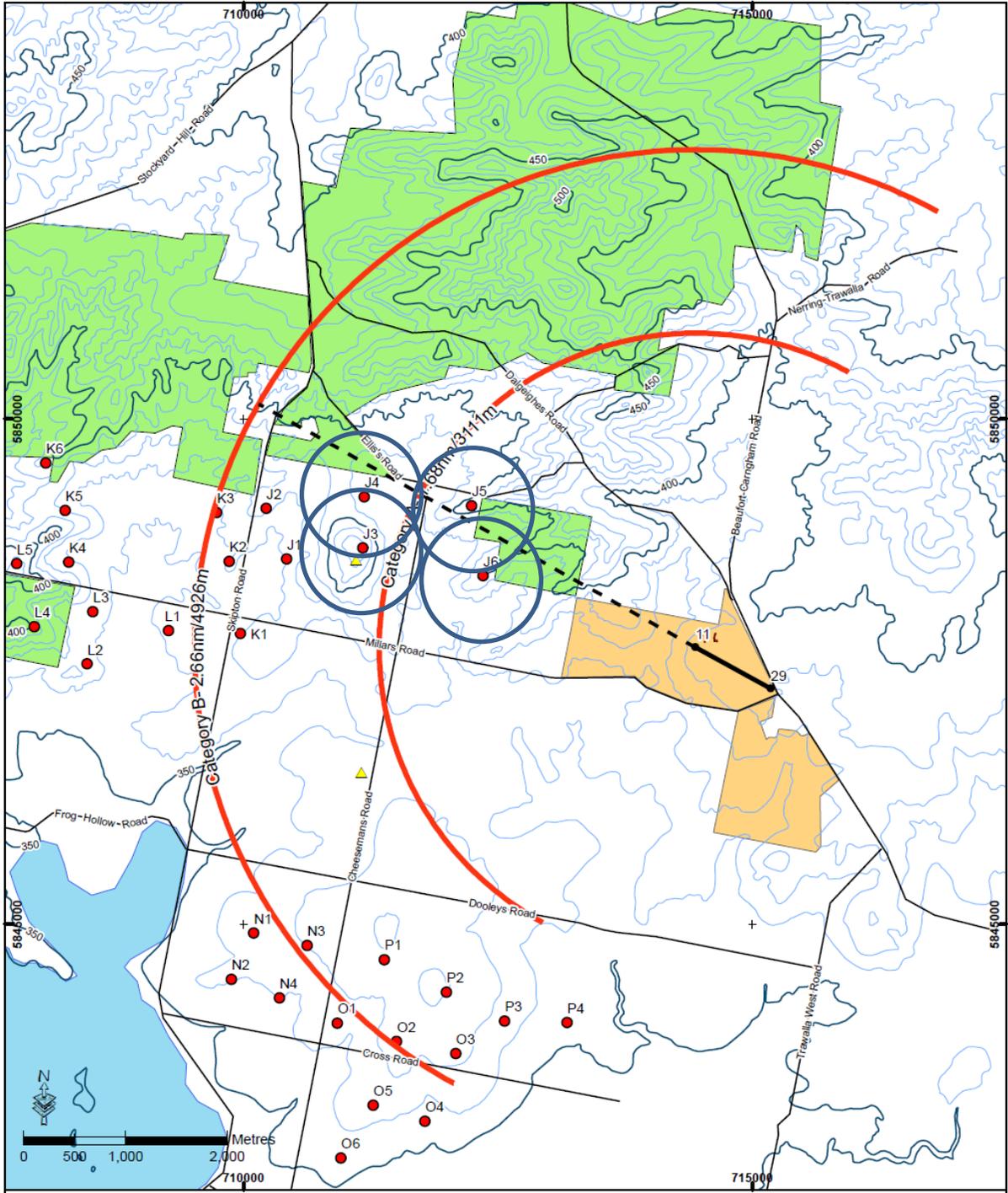
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Hawwood Farm Map - Aerially and Ground Dispersed Crop Treatments Used for Hawwood Farm's Agricultural Land

A circle of radius 600m has been used to identify the area in which aircraft, other than helicopters, are low flying below 1090 ft. agl (500ft + Turbine height 590ft) near the various wind turbines highlighted



Legend

Hawwood Farm	Contours
Vegetation	Major: 50m
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Airstrip	

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Hawwood

Farm Map

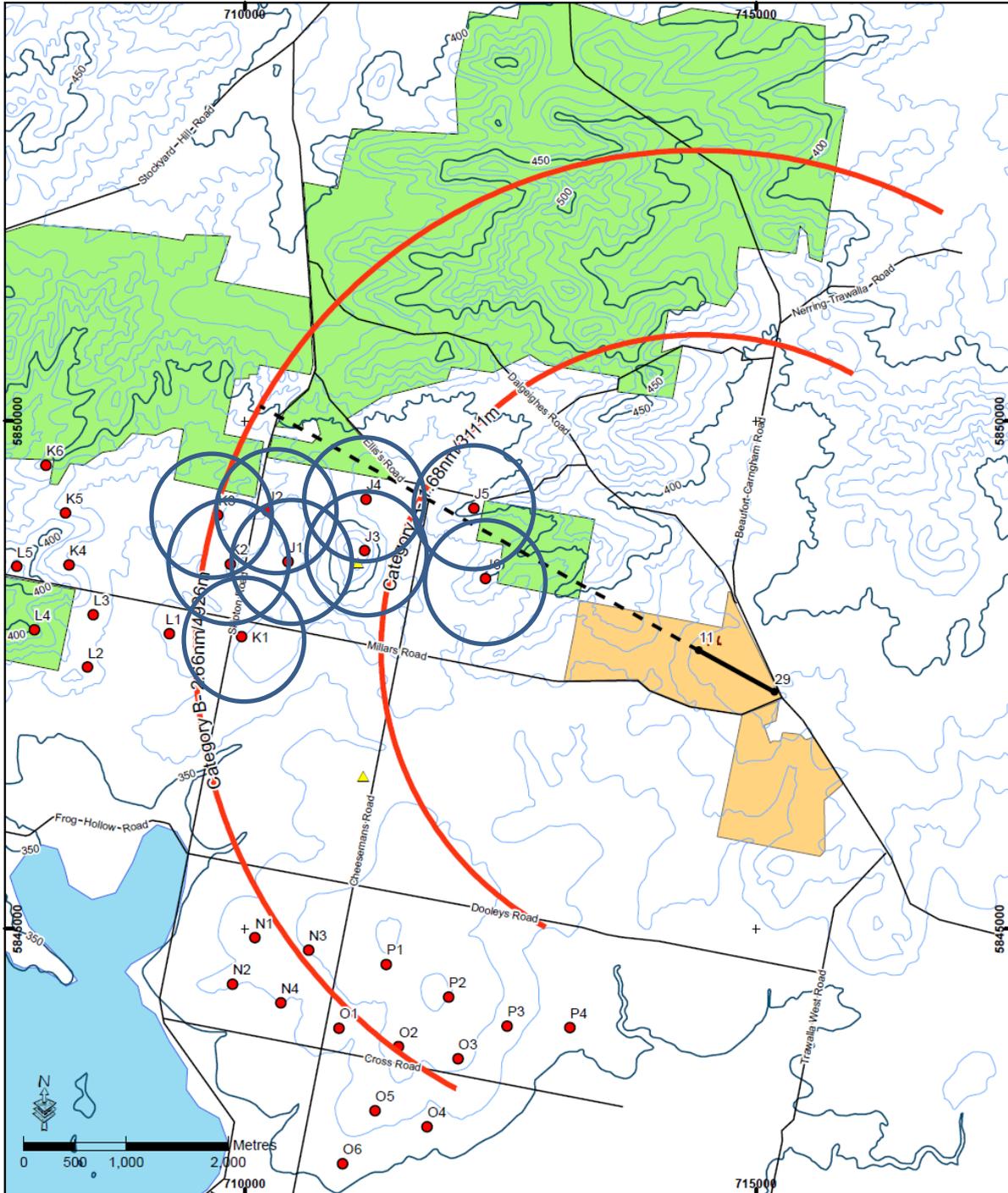
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Hawkwood Farm Map – Fire Fighting Operations for the Protection of Hawkwood Farm.

A circle of radius 600m has been used to identify the area in which aircraft, other than helicopters, are low flying below 1090 ft.agl (500ft + Largest Turbine height 590ft) near the various wind turbines highlighted



Legend

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Hawkwood Farm Map - Physical - Safe Operation of Flights To and From The Beaufort Authorised Landing Area (ALA) YBFT.

Rectangle is a 900m x 150/180 m Landing and take-off area to avoid placing obstacles within.
 Reference Civil Aviation Advisory Publication 92 – (1) July 1992 – Guidance For Aeroplane Landing Area

