RE Future

Brewster Wind Farm

Application for Planning Permit

Appendix H – Electromagnetic Interference Assessment

August 2024

Version History

Version	Author	Reviewer	Date	Description
1	VM	SS	08/03/21	First draft
2	VM	SS	15/03/21	Updated draft
3	VM	SS	01/06/21	Updated draft
4	VM	SS	31/07/21	Updated draft
5	VM	SS	30/10/21	Updated draft
6	VM	SS	04/06/24	Final

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Contents

1 Introduction

The Pyrenees Planning Scheme stipulates that wind farm planning permit applications must address the potential impact of the proposal in terms of electromagnetic interference, at both Clause 52.32 and in the *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria 2019* (Guidelines). In particular, the Guidelines specify that the potential for proposed wind farms to cause electromagnetic interference (EMI) should be minimised, and preferably eliminated, while siting should avoid 'line of sight' alignment between transmitter and receiver as critical services rely upon the delivery of information via electromagnetic waves, or radio signals.

Critical services depend upon the delivery of information via electromagnetic waves, or radio signals. Electromagnetic interference occurs when the transmission of these radio signals is impaired by obstruction, reflection or spurious emissions. In principle wind farms have the potential to cause electromagnetic interference via the following two mechanisms:

- Reflection: Reflection occurs when electromagnetic waves are reflected off the physical surfaces of a wind turbine or turbines. Where there is a receiver nearby a reflected signal it may receive two signals—i.e. the original and reflected signal—leading to a degradation of signal reception at that receiver location; and
- Emission: Emission occurs when wind turbines or the electrical plant associated with them emit electromagnetic waves. Where there is a receiver nearby a powerful source of emissions two signals may be received—i.e. the original signal and emitted noise—leading to a degradation of signal reception at that receiver location.[1]

In practice only one of these mechanisms has been shown to cause electromagnetic interference, namely reflection.[2] Because modern wind turbines and their associated infrastructure are required to meet a stringent electrical engineering standard, they emit very small amounts of electromagnetic radiation. This means that wind farms do not have the potential to cause EMI due to emission. However, due to their large size and location on exposed hilltops, there is the potential for wind farms to be located in proximity to transmitters or receivers, or line of site between a transmitter and a receiver, and thereby cause EMI by reflecting electromagnetic waves.

The services that are theoretically susceptible to EMI in this way are:

- Television broadcasting;
- Radio broadcasting;
- Mobile phone services;
- Navigational systems (VOR, DVOR, ILS, LORANC, and radar); and
- Microwave links.[3]

[1] Hall, S. 'The Assessment and Avoidance of Electromagnetic Interference Due to Wind Farms,' Wind Engineering, Vol. 16, No. 6, 1992; Sengupta D. & Senior T., 'Electromagnetic Interference from Wind Turbines,' in Spera, D., (ed.) *Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering*, New York: ASME Press, 1994.
[2] Ibid.
[3] Ibid.

In practice only two of these services have proven to be affected by wind farm developments, namely television broadcasting and microwave links.[4] While radio broadcasting (AM and FM) is affected, it is only affected within a few tens of metres of a wind turbine, meaning the effect of wind turbine developments of radio broadcasting is negligible. Mobile phone services are designed to work in and around buildings and therefore already withstand any interference that would be posed by a wind farm development. Navigational systems are susceptible to interference from wind turbines; they are generally located in areas where wind farms are not—such as airports and major cities—and as such are rarely affected by wind farm developments. Nevertheless, the potential impact of the wind farm on aeronautical navigational systems is assessed in the Brewster Wind Farm Aeronautical Impact Assessment, which forms part of the planning application documentation for this proposed wind farm.

This leaves digital television broadcasting and microwave links as the two telecommunications systems most likely to be affected by a wind farm development. These two kinds of EMI are discussed in turn below.

2 Television Broadcasting

Television broadcasting systems consist of a transmitter (or a series of transmitters) which broadcast electromagnetic waves in the UHF band. These signals are sent to a large area in all directions.

There are two ways in which a wind farm can cause interference to television broadcasting, namely large scale and small scale interference. Small scale interference occurs when a wind farm interferes with television reception in its immediate vicinity by degrading the signal at its point of reception—i.e. a house. Since the switch to digital television the risk of wind farms causing small scale interference has effectively been negated as digital television requires a much lower signal strength in order to deliver excellent video, meaning that even if a wind farm is causing a degradation of television signal, that signal will generally be strong enough for a digital receiver to produce excellent video. It is for this reason that, prior to the switch over, digital television was used as an amelioration option for dwellings that were affected by wind farm developments. Accordingly, except in rare cases where reception is marginal in the first instance, wind farms no longer pose a risk of causing small scale interference to television broadcasting.

In the case of the Brewster wind farm, the area surrounding the wind farm is well served by two digital television broadcast stations, Ballarat East located 32.7 km east-south-east of WTG 3, and Lookout Hill 28.9 km north-west of WTG 4. Though it is highly unlikely that the wind farm will cause interference to digital television reception at nearby residences, should interference occur at any dwelling, redirecting the antenna in question toward the

[4] Sengupta et. al., 'Electromagnetic Interference from Wind Turbines.'

alternative broadcast site would remedy this interference. The location of digital television broadcast stations to the north-west and east-south-east of the wind farm is such that this amelioration option is available to all dwellings. Figure 1 shows the location of television broadcast sites in the vicinity of the wind farm.

Large scale interference occurs when a wind farm development interacts with a broadcast site and therefore interferes with the broadcast signal at its point of transmission, thereby affecting the entire coverage area associated with it. Large scale interference can be avoided by ensuring that wind turbines are not located in the near vicinity of broadcast stations. It is generally recommended that wind farms should be located at least 6 km from primary television transmitters, and 1 km relay transmitters.[5] According to official transmitter data from the Australian Media and Communications Authority (ACMA) the nearest television broadcast site to the proposed wind farm is located at a distance of 28.9 km —see Figure 1 below.[6] The proposed wind farm will therefore not cause large scale interference to television broadcasting.

[5] Hall, S. 'The Assessment and Avoidance of Electromagnetic Interference Due to Wind Farms.'
[6] http://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Apparatus-licences/list-of-licensed-broadcasting-transmitters. Accessed 19/05/2024.

Brewster Wind Farm

Television Broadcast Sites in the Vicinity of the Wind Farm

Legend

- DTV Transmitter
- Subject Site

Drawn: VM	Scale when printed at A3: 1:200,000
Checked: SS	Date: 19-05-2024
Approved: SS	Figure No: 1

0 5 10 km

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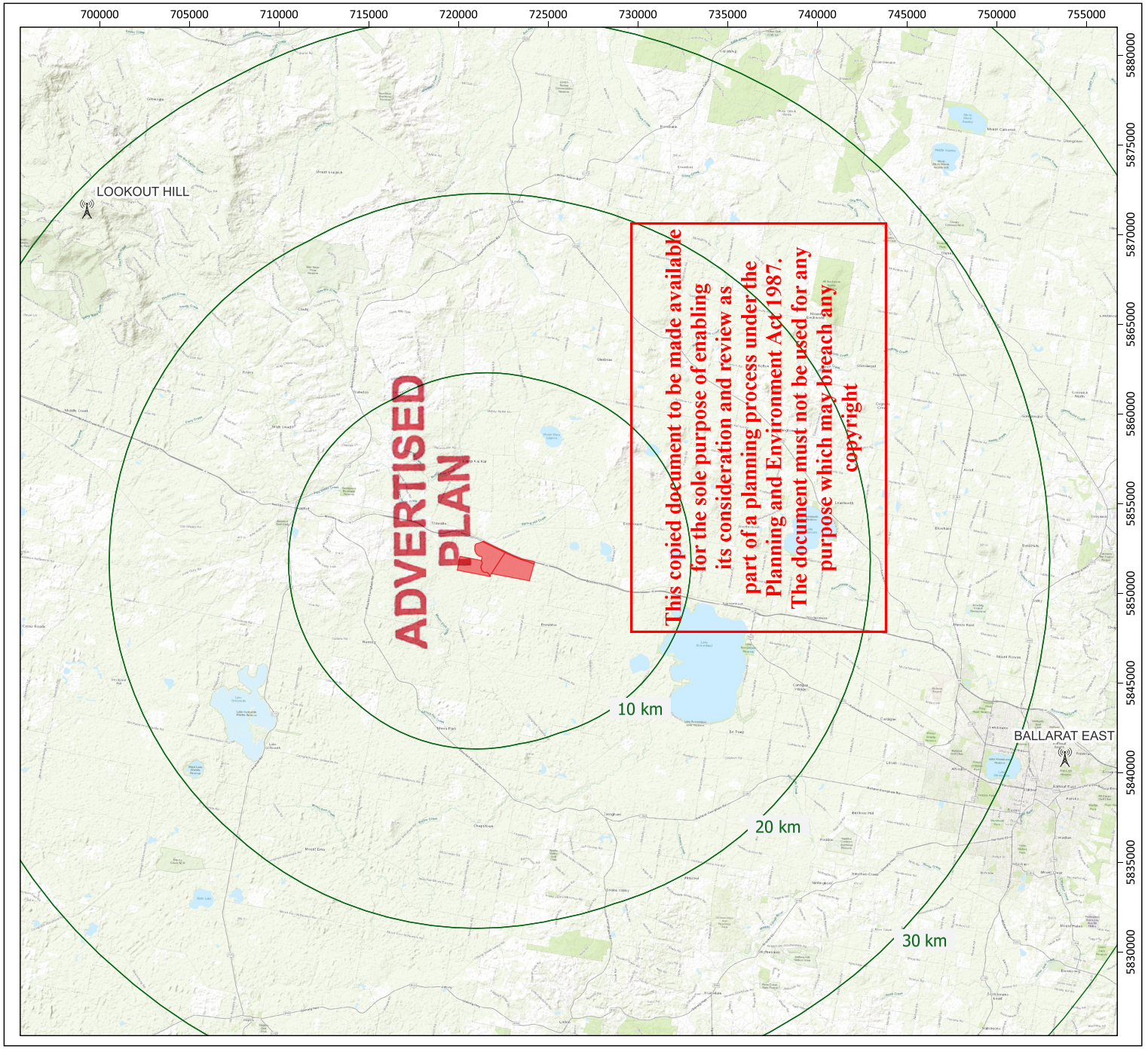


3 Microwave Links

Unlike television broadcasting, which emanates from a single point to a large area, microwave links transfer information between single points, or from point to point. These systems operate in the super high frequency range, sending and receiving highly focused signals between transmitters and receivers.

The path of these signals is effectively identical to the line of sight between a transmitter and a receiver; however it is not limited to a straight line. Rather the path of a microwave link covers an elliptical area surrounding the central path of the beam known as the Fresnel Zone. The Fresnel Zone consists of a series of concentric ellipses of increasing radius from the centre point of the beam, usually termed the first, second and third Fresnel Zones. The radius of these Fresnel Zones is a function of the distance between the transmitter and the receiver, and the wavelength of the signal, as per the simple formula shown below.

$$R_n = \sqrt{((n\lambda D_1 D_2)/(D_1 + D_2))}$$

Where:

R_n = radius of the nth Fresnel Zone

n = Fresnel Zone number

λ = wavelength

D_1 = distance between transmitter and point of interest (wind farm)

D_2 = distance between receiver and point of interest (wind farm)

A graphical representation of the Fresnel Zone around a microwave link is shown below.

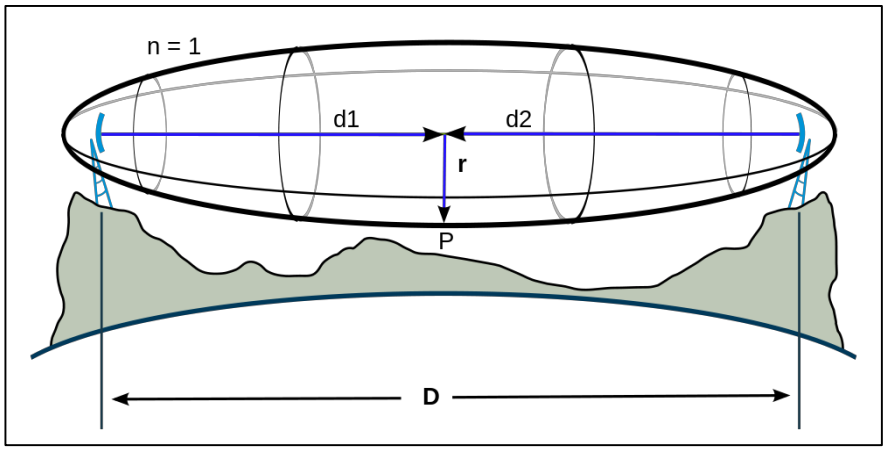


Figure 2: Geometry of a Fresnel Zone Around a Microwave Link

There are two ways in which a wind farm development can cause interference to a microwave link, namely near field interference and path obstruction.[7] Path obstruction occurs when a physical object is sited in the path of a microwave link, otherwise known as the Fresnel Zone. In order to avoid causing interference via path obstruction it is generally recommended that wind turbines be located outside of the second Fresnel Zone of a microwave link.[8] The nearest microwave links to the wind farm have been identified using official data from ACMA.[9] These links are shown in Figure 3 and their respective Fresnel Zone radii listed in Table 1.

Table 1: Fresnel Zone Radii of Nearest Microwave Link

Microwave link	Length (km)	Min Frequency (Ghz)	Maximum Radius (m)	Min setback required (m)*	Min setback to a WTG (m)
Mt Callender – Beaufort	25.2	7.8663	21.9	157.9	343.5
Ballarat – Beaufort	51.2	0.4049	115.7	251.7	1173.7

*Based on Vestas V172 (with a blade length of 86 m) and an additional 50 m margin of safety. Distance measured from the centre of the WTG tower.

3.1 Microwave Link Path Obstruction Analysis

3.1.1 Mt Callender – Beaufort link

ACMA data specifies that this link has a minimum frequency of 7.866 GHz, and a calculated maximum second Fresnel Zone radius of 21.9 m at the midpoint along its 25.2 km length. At its nearest point this link passes to the north of the wind farm adjacent to wind turbine two (T2) at distance of 343.5 m when 10.1 km along its path. Given this link has a maximum second Fresnel Zone radius of 21.9 m the proposed wind farm does not pose a risk of causing interference to this microwave link via path obstruction.

3.1.2 Ballarat – Beaufort link

ACMA data specifies that this link has a minimum frequency of 404.875 MHz, and a calculated maximum second Fresnel Zone radius of 137.7 at the midpoint along its 51.2 km length. At its nearest point this link passes to the south of the windfarm adjacent to wind turbine six (T6) at distance of 1173.7 m when 40.2 km along its path respectively. Given this link has a maximum second Fresnel Zone radius of 137.7 m the proposed wind farm does not pose a risk of causing interference to this microwave link via path obstruction.

[7] Hall, S. 'The Assessment and Avoidance of Electromagnetic Interference Due to Wind Farms;' Sengupta et. al., 'Electromagnetic Interference from Wind Turbines.'
[8] Ibid.
[9] http://web.acma.gov.au/pls/radcom/register_search.main_page. Accessed 19/05/2024.

The near field is a region surrounding every transmitter and receiver within which they are highly susceptible to interference. Different telecommunications systems have different sensitivities to near field interference. In the case of microwave links the transmitters and receivers used for relaying signals are highly sensitive, meaning the area within which they are susceptible to near field interference is quite large. The extent of the near field is a function of the diameter of the antenna and wavelength of the signal, as per the equation shown below.

$$D_f = {}^{2D^2}/_{\lambda}$$

Where:
D_f = linear extent of the near field zone
D = diameter of antenna
λ = wavelength

However, a conservative recommendation is that near field interference can be avoided by ensuring the turbines are located at least 1 km from a transmitter or receiver. According to official data from ACMA the nearest transmitter or receiver to the wind farm site is located at a distance of 5.5 km from WTG 3.[10] Therefore the proposed wind farm will not cause interference via near field interference.

[10] http://web.acma.gov.au/pls/radcom/register_search.main_page. Accessed 19/05/2024.

Brewster Wind Farm

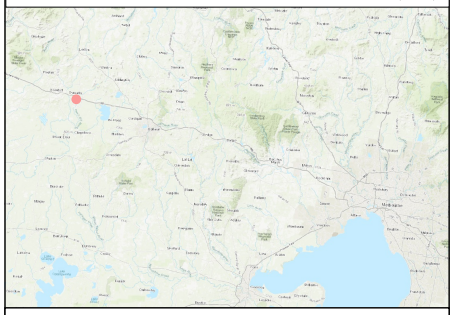
Microwave Links in the Vicinity of the Wind Farm

Legend

- Wind turbine
- Microwave links
- Highway
- Rail line

Drawn VM	Scale when printed at A3 1:18,000
Checked SS	Date 04-06-2024
Approved SS	Figure No: 3

0 0.5 1 km



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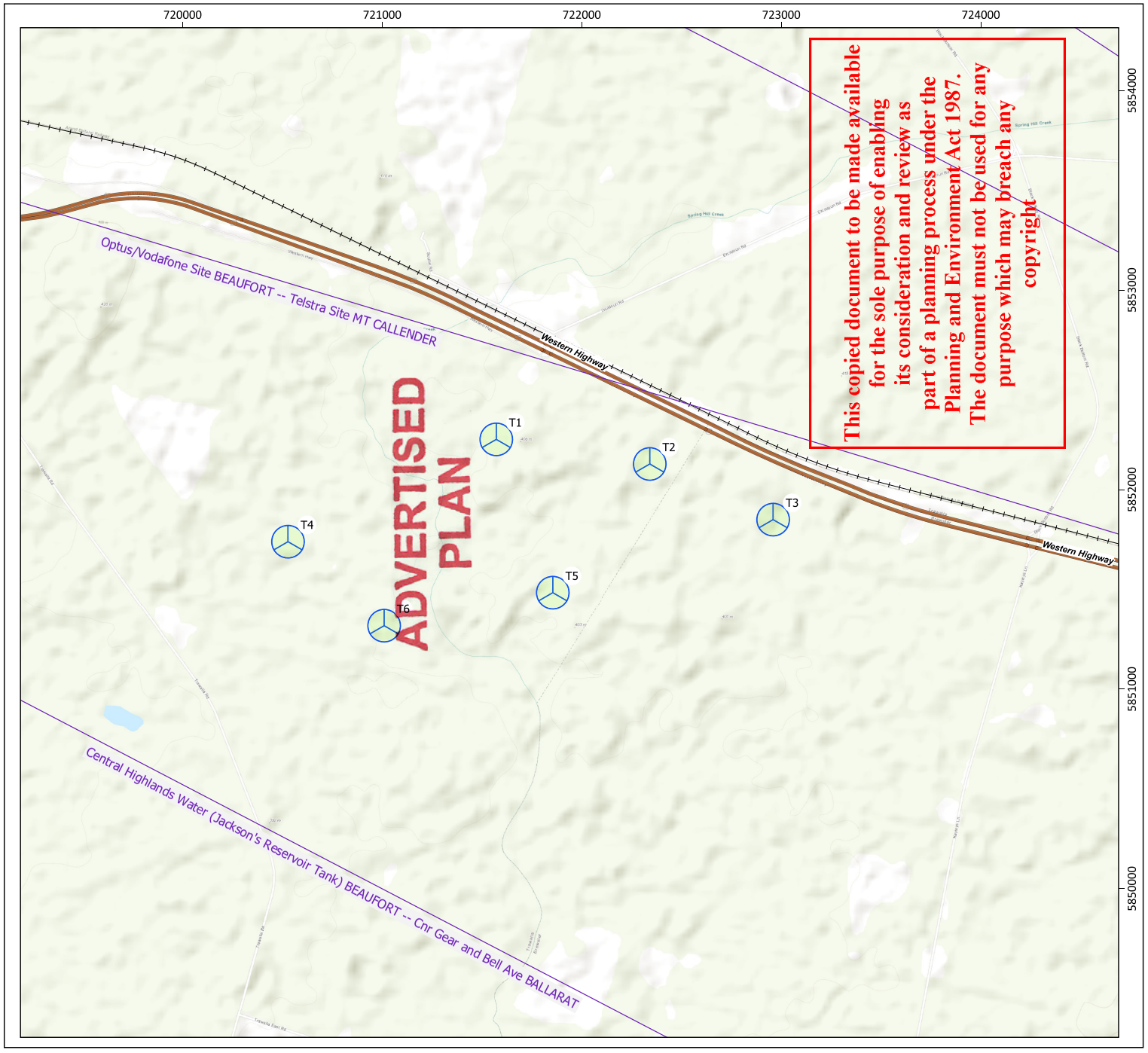

4 Conclusion

The potential impact of the proposed wind farm on television broadcasting and point-to-point radio links has been considered in this report.

The switchover to digital television has effectively eliminated wind farms as the cause of interference to individual television reception, however large-scale interference to television broadcasting may occur where located too close to a broadcast site. According to official data from the Australian Communications and Media Authority the nearest digital television broadcast site is 28.9 km from the nearest wind turbine (WTG) of the proposed Brewster wind farm. At this distance, the wind farm will not be capable of causing large scale interference to television broadcasting—see Figure 1.

In the case of microwave links, wind farms have the potential to cause EMI via two mechanisms. Near field interference can be caused by wind farms if they are located too close to a transmitter or receiver, and path obstruction can occur when they are located within the second Fresnel Zone of a radio link. However, according to official data from ACMA the nearest microwave transmitter or receiver is 5.5 km from the Brewster site. In addition, the wind farm is located well outside the second Fresnel Zone of the nearest microwave link, which has a maximum second Fresnel zone radius of 21.9 m and is located 343.5 m from the nearest turbine—see Figure 3.

Given the above distances, the Brewster wind farm will not cause interference to either television broadcasting or microwave link activity.

References

Australian Communications and Media Authority (ACMA). Broadcast Transmitter Data, http://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Apparatus-licences/list-of-licensed-broadcasting-transmitters, accessed 19/05/2024.

Australian Communications and Media Authority (ACMA). Register of Radiocommunications Licences, http://web.acma.gov.au/pls/radcom/register_search.main_page, accessed 19/05/2024.

Hall, S. 'The Assessment and Avoidance of Electromagnetic Interference Due to Wind Farms,' Wind Engineering, Vol. 16, No. 6, 1992.

Sengupta D. & Senior T., 'Electromagnetic Interference from Wind Turbines,' in Spera, D., (ed.) *Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering*, New York: ASME Press, 1994.