

Burrendong Wind Farm Amendment Report

APPENDIX K

Hazard and Risk - Revised

Telecommunications Assessment





Client: Eco Logical Australia

Project: Burrendong Wind Farm

Report: Telecommunications Impact Assessment Report

Document Number: 20092-E-RPT-0004

Revision: 4 (Final)



Revision history

Table 1: Revision history

Revision	Date	Description	Prepared by	Reviewed by	Approved by
0	07/09/2021	Issued for client review	Phillip Chau Jingwen Ding Jerome Rowcroft	Roger Brown	Roger Brown
1	04/05/2022	Minor nomenclature update.	Amber Truong	Jerome Rowcroft	Roger Brown
2	31/08/2023	Updated turbine layout	Ramez Barakat	Eric Bendtsen	Alex Low
3	22/03/2024	Update antenna heights	Heshna Uppadoo	Eric Bendtsen	Timothy Cervenjak
4	22/10/2024	Final Issue	Heshna Uppadoo	Ramez Barakat	Craig Johnston

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Executive Summary

Eco Logical Australia engaged Middleton Group Engineering to undertake a Telecommunications Impact Assessment for the updated Wind Turbine Generator (WTG) layout at Burrendong Wind Farm (the Project). The Project consists of up to 70 WTGs with tip height of up to 250 m and rotor diameter up to 180 m.

Middleton Group first completed a telecommunications assessment on the Project in 2021 and produced revision 1 of this report. Since then, Burrendong Wind Farm Pty Ltd (the Proponent) has revised the WTG layout by changing the location and reducing the number of WTGs in 2023. This document assesses the revised layout considering an antenna height at the two receivers at Burrendong Dam and Mt Bocoble as part of the Response to Submission.

This study demonstrates that the Project is unlikely to have a material impact on:

- Fixed radiocommunications links;
- Meteorological radar;
- Mobile voice-based communications;
- Wireless and satellite internet services;
- AM, FM and digital radio;
- Digital and satellite television;
- Trigonometry stations; or
- GPS.

The Australian Communication Media Authority (ACMA) database for telecommunication sites was surveyed for point-to-point links within a 150 km radius of the wind farm site. Refer to Item 3 of Table 3 for input source reference.

A single point-to-point link, owned by Water NSW, traverses the site. Since revision 1 of this report (04/05/2022), one end of the link has been shifted approximately 1 km due south. Detailed assessment of the link was undertaken based on the new turbine locations provided and the location of the transmitter and receiver sourced from ACMA. Water NSW expressed no concerns to the proposed WTG layout in 2021. However, with the revised layout, Water NSW expressed that the antenna's heights have not been considered in the 3D modelling. Hence, the 2D modelling phase would be the same. No other point-to-point links have been identified passing through the Project.

The nearest weather radar to the Project is the Bureau of Meteorology (BoM) radar at Yeoval, nominally 45 km from the Project. A line-of-sight analysis has been conducted, demonstrating that there is no line of sight between the Yeoval radar and any of the WTGs. Nonetheless, the BoM has expressed some concern about the impact of the facility on the Yeoval radar. As such, the Proponent and BoM will be entering into an agreement on the operation of the Project that satisfies BoM's operational requirements.

The assessment demonstrates that the Project has been designed, located and sited to avoid, or minimise electromagnetic interference to pre-existing television, radar and radio transmission and reception.

Stakeholder correspondence has been collated in Appendix A and no interference is expected.

1 Abbreviations / Definitions

Table 2: Abbreviations

Abbreviation	Explanation
ACMA	Australian Communications and Media Authority
AM	Amplitude Modulation
BoM	Bureau of Meteorology
C/I	Carrier-to-interference
D_a	diameter of antenna physical aperture (m)
D_{nf}	near-field clearance distance
DTV	Digital Television
DPE	Department of Planning and Environment
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EMI	Electro-Magnetic Interference
f	frequency (GHz)
FM	Frequency Modulated
F_n	n th Fresnel Zone; also, F_1 , F_2 , etc.
GHz	Giga-Hertz – 1 billion Hertz
GIS	Geographic Information System
GNSS	Global Navigation Satellite System Networks
LoS	Line of Sight
MGE	Middleton Group Engineering
MHz	Mega-Hertz – 1 million Hertz
the Project	Burrendong Wind Farm
UHF	Ultra-High Frequency
WMO	World Meteorological Organization
WTG	Wind Turbine Generator

2 Normative References

- [1] D. Bacon, "Fixed-link wind-turbine exclusion zone method," Radiocommunications Agency UK, 2002.
- [2] G. Durgin, "The Practical Behavior of Various Edge-Diffraction Formulas," *IEEE Antennas and Propagation Magazine*, vol. 51, no. 3, pp. 24-35, 2009.
- [3] Commission for Instruments and Methods of Observation, "WMO Guidance Paper on Weather Radar/Wind Turbine Siting," World Meteorological Organisation, Helsinki, 2010.
- [4] EUMETNET, "Statement of the OPERA group on the cohabitation between weather radars and wind turbines," 2009. [Online]. Available: https://www.eumetnet.eu/wp-content/uploads/2017/01/OPERA_2010_14_Statement_on_weather_radars_and_wind_turbines.pdf.

3 Background

The Burrendong Wind Farm (the Project), developed by Burrendong Wind Farm Pty Ltd (the Proponent) is located approximately 7 km south of Yarrabin and 8 km east of Yarragal in New South Wales. The Project WTG layout has had several iterations. This assessed layout consists of a total of 70 WTGs.

Middleton Group Engineering (MGE) has been engaged by Eco Logical Australia (ELA) to undertake a Telecommunications Impact Assessment desktop study with the updated WTG layout suitable for inclusion in an Environmental Impact Statement (EIS) as part of the Response to Submission for submission to the NSW Department of Planning and Environment (DPE).

4 Scope

This Telecommunications Impact Assessment is a desktop study mapping the updated WTG locations along with telecommunication services and evaluating the impact of the WTGs on these services.

The study is confined to the analysis of publicly available information and consultation with key stakeholders.

The impact of the Project has been assessed with respect to the following services:

- Fixed radiocommunications links;
- Meteorological radar;
- Mobile voice-based communications;
- Wireless and satellite internet services;
- AM, FM and digital radio;
- Digital and satellite television;
- Trigonometrical stations; and
- GPS.

WTG Electro-Magnetic Compatibility has not been assessed in this report. Any electrical component installed in Australia must comply with the *Radiocommunications Act (1992)* and associated notices. All installations on the Project will comply with the Act, including affixation of relevant compliance markers to the equipment. The original equipment manufacturers must guarantee compliance.

5 Inputs

This assessment is based on the inputs specified in Table 3.

Table 3: Study inputs.

ID	Input	Source	Format	Date Provided/Accessed
1	WTG coordinates (updated April 2023)	Eco Logical Australia	.shp	2023-04-19
2	WTG dimensions	Eco Logical Australia	Email	2021-03-12
3	Point to point microwave links	ACMA Website	.kml	2023-04-27
4	Mobile voice-based communication, and internet services	RFNSA Website	Website: Lats & Longs	2023-04-27
5	AM, FM, Digital Radio Broadcasters Digital TV	ACMA Website	.xlsx .kmz	2023-04-27
6	Meteorological Radar	BoM	Website: Lats & Longs	2023-04-27
7	Trigonometrical Station and GPS	Geoscience Australia	Website: Lats & Longs	2023-04-27
8	Survey marks	NSW Spatial Services	ESRI ArcGIS Feature Server	2023-04-27

6 Assumptions

This study has been developed on the following basis:

- The study is desktop only. No site visit or on-site ground-truthing has been conducted.
- Information, including the spatial location of items, antenna heights, emission frequencies and the like, as sourced from ACMA are correct. While MGE checked information against satellite imagery, MGE has developed the report on the basis that information supplied by/through ACMA is correct.
- Locations of dwellings have not been provided by ELA. Dwellings have not been mapped for this study and is assumed not to be within 1 km of the Project.
- WTGs have a tip height of 250 m and a rotor diameter of up to 180 m.

7 Impact Assessment

7.1 Point to Point Links

WTGs have the potential to impact on point-to-point communication links through three mechanisms [1]:

1. Near field effects;
2. Reflection or scattering effects; and
3. Diffraction.

As seen in Figure 1 and Figure 2, one communication link passes within a 2 km buffer of the WTGs. This link is the same link from revision 1 of this assessment, dated in 2022. However, the link path has shifted approximately 1 km south and decreased in length by 300 m, from 65.9 km to 65.6 km. The transmitter, site ID 250574 (Burrendong Dam) has moved locations, approximately 1.6 km south which resulted in the link shifting south and changing its bearing. The receiver, site ID 35200 (Mt Bocoble) has remained in its original position.

Since the link's frequency remained the same, the slight change in length will have no significant impact on the magnitude of the 2nd Fresnel maximum zone. Detailed information of this link is outlined in Table 4.

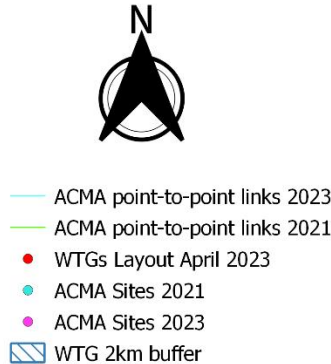
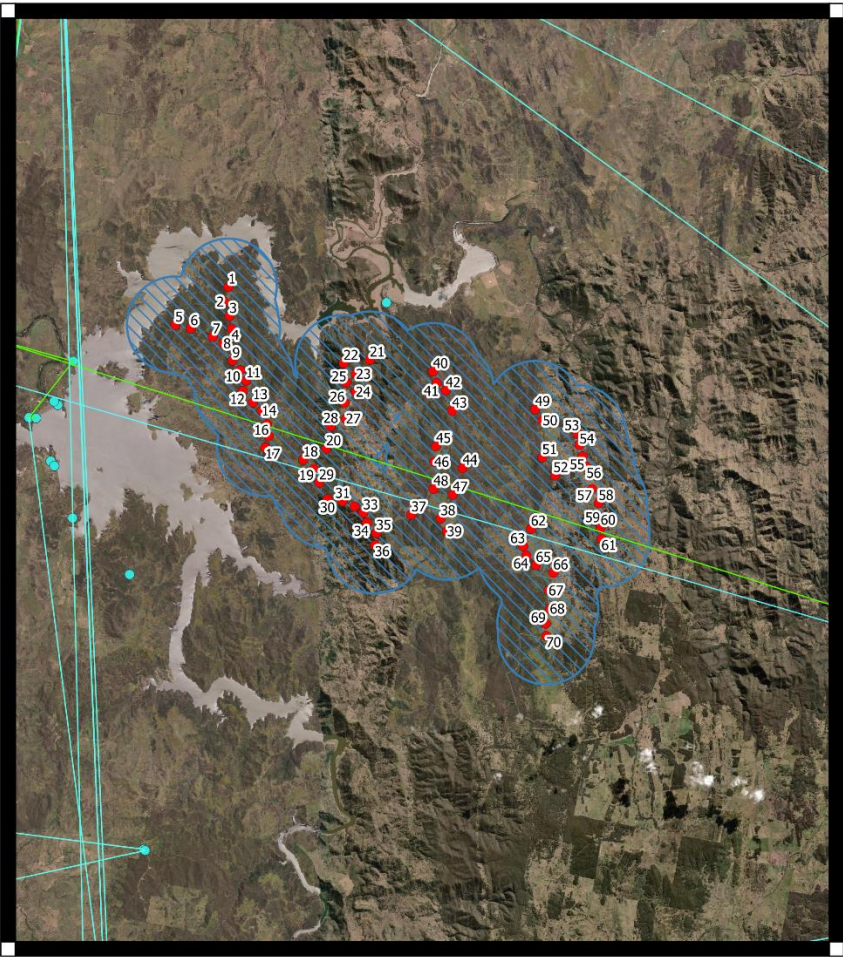
Since revision 1 of this report (04/05/2022), there are no new ACMA communication sites located within 2 km of the proposed WTGs.

Near-field and reflection/scattering impacts are considered in Section 7.1.1 and Section 7.1.2. Section 7.1.3 provides an analysis of diffraction effects.

Table 4: List of point-to-point links that pass across the site.

#	BSL/ Licence No	Site 1	Site 2	Length (km)	Frequency (min)	Owner
1	496812/2	250574: Dept Land & Water Cons Site Mt Edwards near; BURRENDONG DAM	35200: Communal Site Mt Bocoble; BOCOBLE	65.6	451.325 MHz	WATER NSW

Figure 1 below shows both the previous and updated ACMA links and sites. The link which traverses the Project has shifted south. The frequency (451 MHz) and owner (Water NSW) of the link remain unchanged. No new sites were found within the site boundary.



Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 1: The Project WTGs and 2 km buffer; ACMA communications sites.

Figure 2 below shows the updated link crossing the Project with an overview of nearby WTGs.

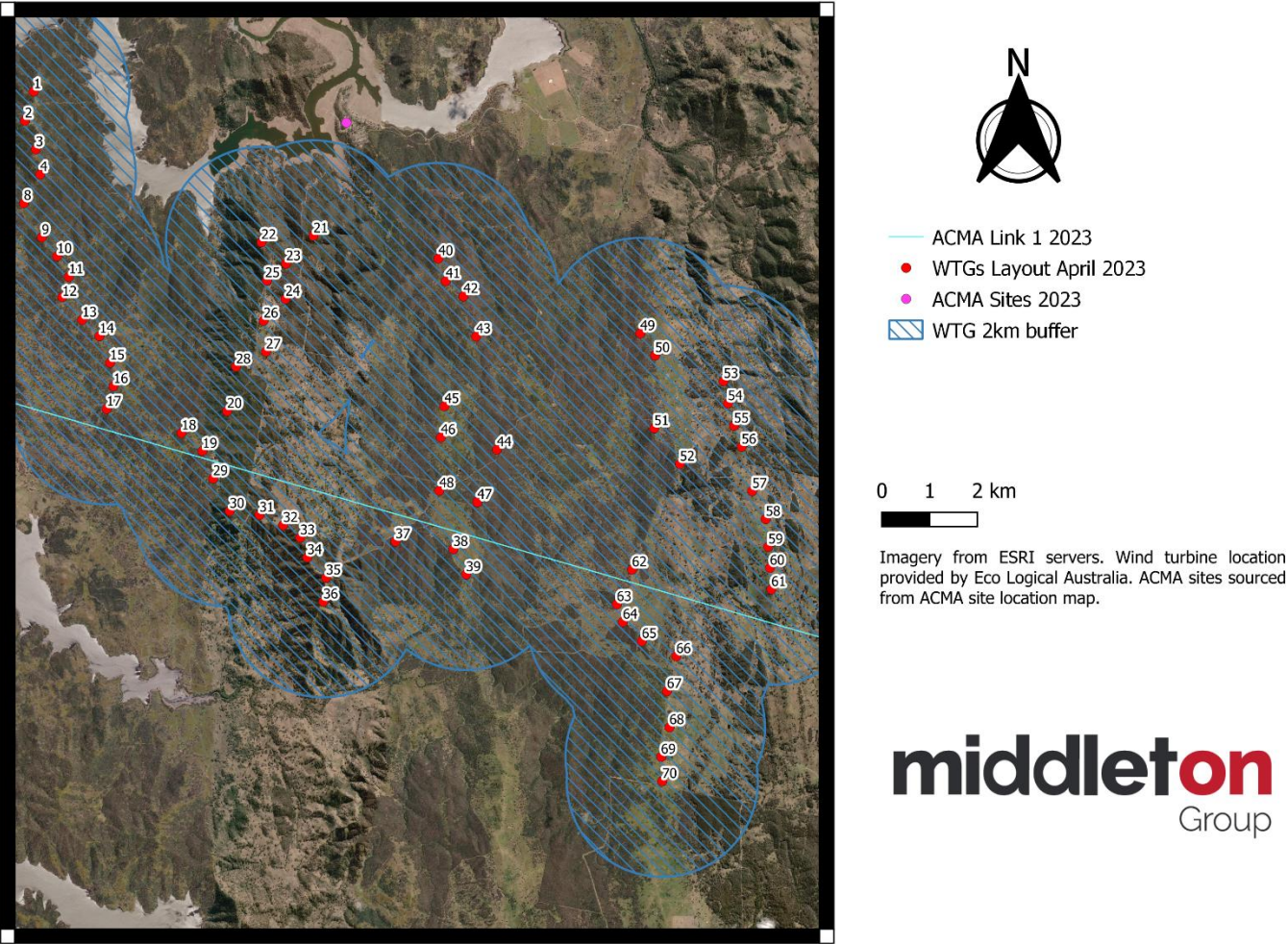


Figure 2: ACMA communication site location and link (ID 1) within 2 km boundary of the WTGs.

7.1.1 Near-field effects

Near-field effects occur in the vicinity of the transmitter and receiver, typically being impacted by objects with inductive fields up to several hundred metres from the transmitter/receiver – though the precise impact is difficult to calculate.

No ACMA communication sites were found within a 2 km boundary of the updated WTGs. Therefore, no material near-field effects due to the Project are anticipated.

7.1.2 Reflection/ scattering effects

Reflection and scattering relate to the interference by an object that reflects the signal from the transmitter to the receiver. This process creates a longer path between the transmitter and receiver, which can cause undesirable temporal modulation. However, where the carrier to interference ratio, that is the ratio of the strength of the intended signal to the interference signal is sufficiently high, the performance will be unaffected. This threshold varies from site to site. Generally, impacts on signal will be negligible beyond 2 km from a transmitter/receiver.

Lack of information regarding C/I ratios, in conjunction with limited information regarding the radar surface area of the proposed WTGs means that it is impossible to accurately assess potential impacts associated with reflection and scattering. There is no single criterion for potential impact due to scattering.

As there are no WTGs located within 2 km of any telecommunication site, no impacts associated with reflection and scattering are anticipated.

7.1.3 Diffraction effects

Diffraction is where an object modifies a wave by obstructing its path of travel. Fresnel zones define envelopes of influence along the length of the ray line, whereby a rotating wind turbine could adversely impact the signal.

The radius of the n -th Fresnel Zone, F_n , of a point-to-point link of length D , at a distance d_1 from the transmitter (or receiver) is given by the following equation:

$$F_n = \sqrt{\frac{n\lambda d_1(D - d_1)}{D}}$$

The wavelength of the transmittal signal, λ , is calculated as c/f , where c is the speed of light in air and f is the frequency of the transmittal signal.

Obstacles within the 1st Fresnel Zone will adversely impact the signal, whereas, beyond the 1st Fresnel Zone the impact is reduced. More specifically, for odd values of n the Fresnel Zone is a region of constructive interference, whereas for even values of n the Fresnel Zone is a region of destructive interference [2].

In calculating the paths of the links and the relative impact of obstacles, it is important to account for the curvature of the earth and the height of any antennae, as available.

Some sources recommend a clearance threshold of 60% of the 1st Fresnel Zone Radius – in particular for ground clearance and the like [1]; this advice typically relates to 400 MHz links. For higher frequency links, for example those operating at frequencies greater than 1 GHz, a more conservative approach is recommended, that is, maintaining clearance of the maximum extent of the 1st Fresnel Zone, or, as recommended by Bacon [1], clearance of the maximum extent of the 2nd Fresnel Zone.

Link ID 1 has a frequency of 451.3 MHz and thus, a threshold of 60% of the maximum 1st Fresnel Zone is the appropriate separation threshold. This corresponds to a buffer of 62.7 m, as summarised in Table 5.

Link 1: Dept Land & Water Cons Site Mt Edwards near BURRENDONG DAM – Communal Site Mt Bocoble BOCOBLE

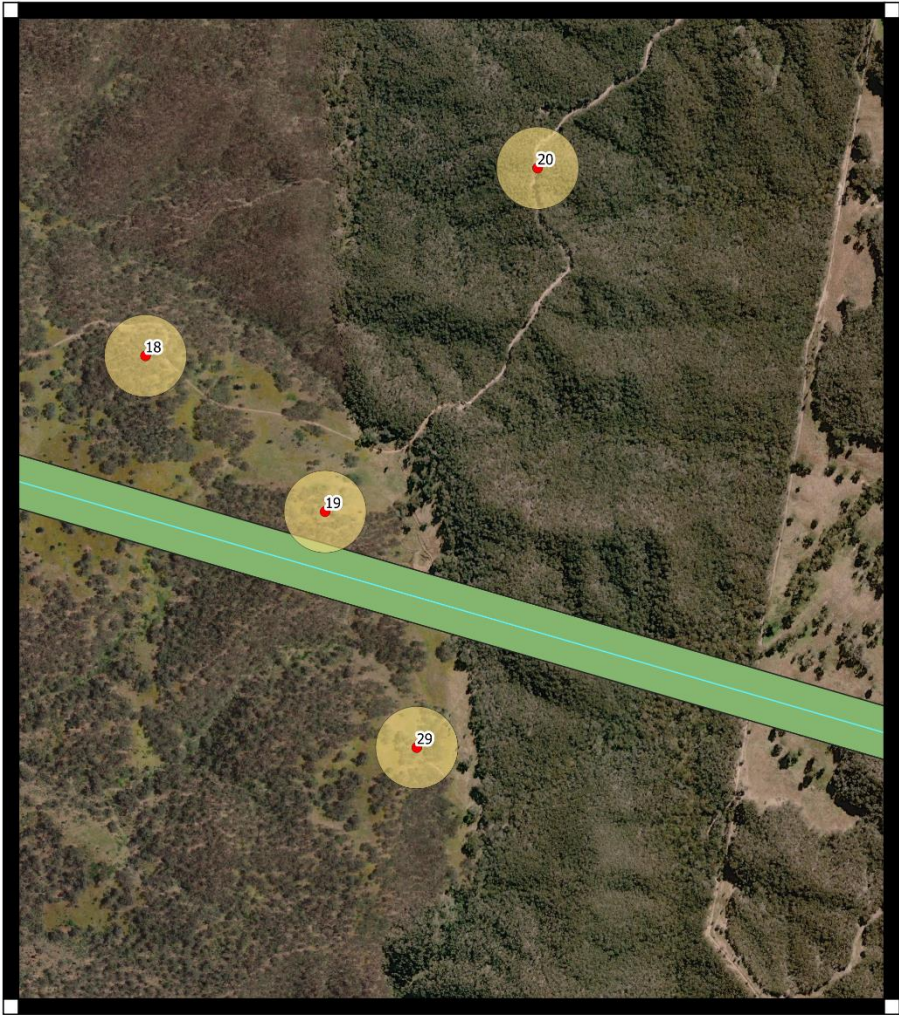
Link 1 is a 451.3 MHz, 65.6 km link between Dept Land & Water Cons Site Mt Edwards near BURRENDONG DAM (Site ID 250574) and Communal Site Mt Bocoble BOCOBLE (Site ID 35200). It is owned by Water NSW. The link is near two WTGs, number 19 and 62.

From a bird's eye view, seen in Figure 3, the rotor extent of WTG 19 appears to impinge on 0.6 of the Maximum 1st Fresnel Zone (F1Max) by 25 m. Further analysis was conducted and presented below to investigate the impact of the WTG to the link. Figure 5 and Figure 6 provide topographical and line of sight perspectives of Link 1 and WTG 19. From this analysis, Middleton Group conclude that WTG 19 causes no line-of-sight interference on link 1 and therefore no impact is expected from WTG 19 on the link.

As shown in Figure 4, WTGs 62 is outside of 0.6 of the Maximum 1st Fresnel Zone. Therefore, it is unlikely that the WTG will cause impact on the link.


Table 5: Information on point-to-point link

BSL/ Licence No	Length/ Km	Minimum Freq (MHz)	Nearest WTGs	Distance to WTG/km		Offset from line-of- sight to WTG/ m		0.6 x F1 Max/ m
				WTG 19	WTG 62	WTG 19	WTG 62	
496812/2	65.6	451.3	19 & 62	15	24	137	261	62.7



 WTGs Layout April 2023

 ACMA Link 1 2023

 ACMA Link 1 0.6 x Max 1st Fresnel Zone

0 100 200 m



Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 3: WTG 19 envelope based on 180 m rotor diameter, relative to 0.6 multiplied by maximum 1st Fresnel Zone extent of Link 1.



WTGs Layout April 2023



ACMA Link 1 2023



ACMA Link 1 0.6 x Max 1st Fresnel Zone

0 100 200 m



Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 4: WTG 62 envelope based on 180 m rotor diameter, relative to 0.6 multiplied by maximum 1st Fresnel Zone extent of Link 1.

Figure 5 is a plot of Link 1, which includes the line of sight and its topography relative to the location of WTG 19. Propagation of the signal between transmitter and receiver relies on knife-edge diffraction at the point where Link 1 intersects with the terrain. This point is likely at the point approximately 15 km from the transmitter of the ACMA link (Dept Land & Water Cons Site Mt Edwards near BURRENDONG DAM) – where the WTG is located. At the knife-edge, the signal will diffract over the topography and propagate towards the receiver – and may rely on further knife-edge diffraction to ultimately reach the receiver.

The transmitter, Burrendong dam (ID: 250574) has an antenna height of 25 m and the receiver, Mt Bocoble (ID: 35200) has a height of 35 m.

The expected wave-front associated with the knife-edge diffraction will be emanating from the base of the topography – corresponding to the base of the proposed WTGs.

When the expected wave-front is plotted in Figure 6, the extent of expected interference from WTG 19 indicates that the $0.6 \times F_{1Max}$ threshold will not be exceeded.

WTGs along the propagation path can cause an increase in interference due to the combination of diffraction effects caused by the local environment and the WTG, as well as potential reflection/scattering. Notwithstanding the above, it is expected that the current siting may not cause any material impact to the link.

Consultation with the owner of this link, Water NSW is included in Appendix A. Water NSW responded to our initial engagement in 2021 and at the time confirmed that the wind farm will not cause any material impact on the link. Since this initial engagement, the WTG layout and link path have changed. Water NSW have expressed that the antenna heights of the two sites have not been considered previously. Water NSW has confirmed that there is no impact on their services accounting for both the updated layout and antenna height.

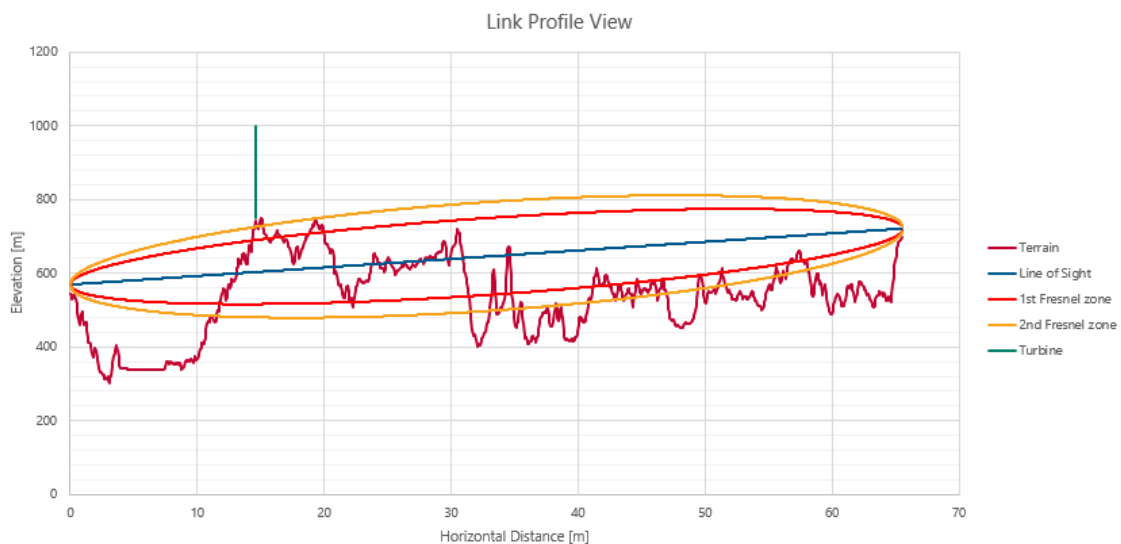


Figure 5: Topography of Link 1's path, Line of Sight, Turbine location and expected link path considering knife edge diffraction

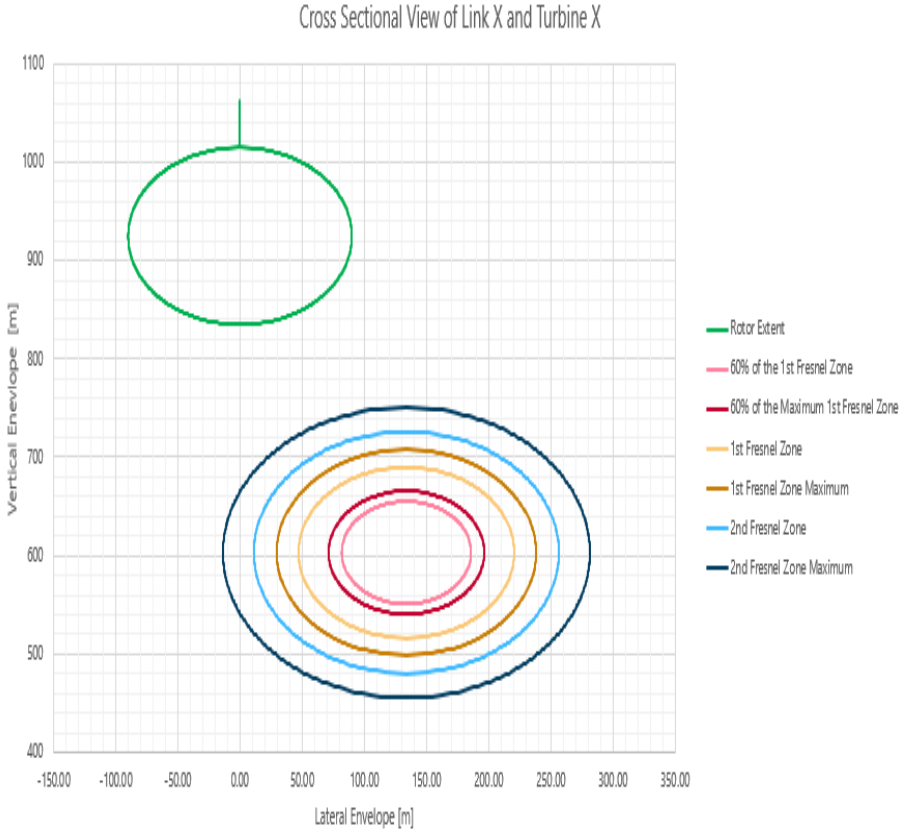


Figure 6: Slice along Link 1's path, showing extent of $F_{z,Max}$ to wind turbine 19.

7.2 Meteorological Radar

Meteorological radars detect rain and thunderstorm events, as well as other phenomena such as flocks of birds, smoke or ash, which cause echoes to be visible. The Bureau of Meteorology's (BoM's) radars typically detect rain between 2.5 km to 3.5 km above the ground within a radius of 200 km. Some wind farms show up on meteorological radars as static echoes.

Details of specific radars and corresponding coverage maps are available online from <http://www.bom.gov.au/australia/radar/index.shtml>.

The World Meteorological Organisation (WMO) recommend that WTGs are sited beyond 5 km from meteorological radars, and preferably beyond 20 km¹ [3], while EUMETNET's OPERA group state that "wind parks should be submitted to an impact study when they concern ranges lower than 30 km for S-Band radars" [4].

The nearest meteorological radar to the Project is the radar at Yeoval. The Yeoval meteorological radar is 45 km west of the nearest WTG. Based on global standards [3, 4], the Project will have a negligible impact on the Yeoval meteorological radar.

A notification email was sent to the BoM where the correspondence has been included in Appendix A: Stakeholder Correspondence and Responses.

MGE has completed further assessment, summarised below:

1. Line of sight analysis has been conducted to determine the potential impact of the Project on the Yeoval radar. A digital terrain model with eight WTG paths to the radar has been analysed, as shown in Figure 7. In addition, the line-of-sight plots for WTGs 1, 05, 11, 28, 39, 44, 58, and 68 to the radar are shown in Figure 8 through Figure 15, respectively. As seen in the line-of-sight plots, there is no direct line of sight from the Yeoval radar to the WTGs analysed due to the obstruction from the elevation profile. As a result, it is highly unlikely that the WTGs will affect the functionality of the BoM radar.
2. The level of attenuation associated with idealised knife-edge diffraction has been calculated (as per ITU-R P.526-15) to be generally more than 50 dB. Therefore, the level of impact on Yeoval radar from the Project will be minimal.

Despite the above reduction in potential impact, weather radars are sensitive and designed to cover large areas, so it is possible that some echoes from the WTGs will be detected. These echoes appear similar to precipitation. BoM has expressed some concern about the impact of the facility on the Yeoval radar. The Proponent accepts the BoM requirement to:

- Keep the BoM informed of any variation in turbine layout and tip height.
- Provide advanced notice of any planned whole of wind farm shutdown events to allow recalibration of radar systems.
- Collaborate with the BoM in the event of any severe weather conditions.

¹ World Meteorological Organisation (WMO) report
Client: Eco Logical Australia
Report: Telecommunications Impact Assessment Report
Revision: 4

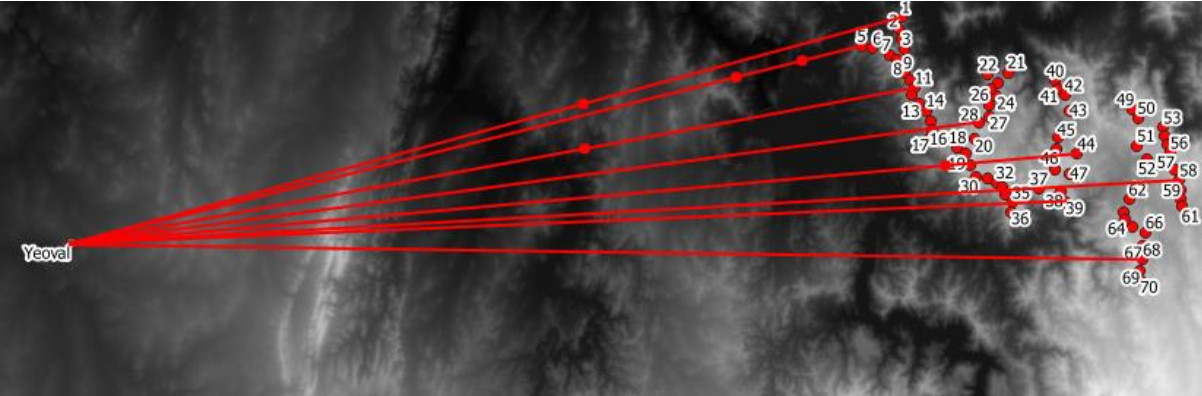


Figure 7: Terrain model with eight WTG paths to Yeoval radar



Figure 8: Line of sight analysis between Yeoval radar and WTG 1

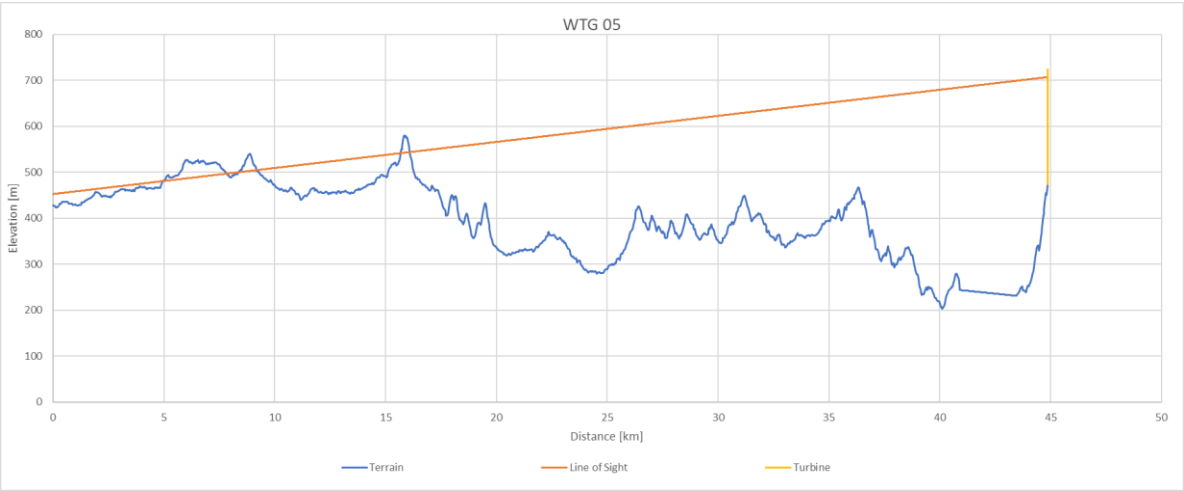


Figure 9: Line of sight analysis between Yeoval radar and WTG 05

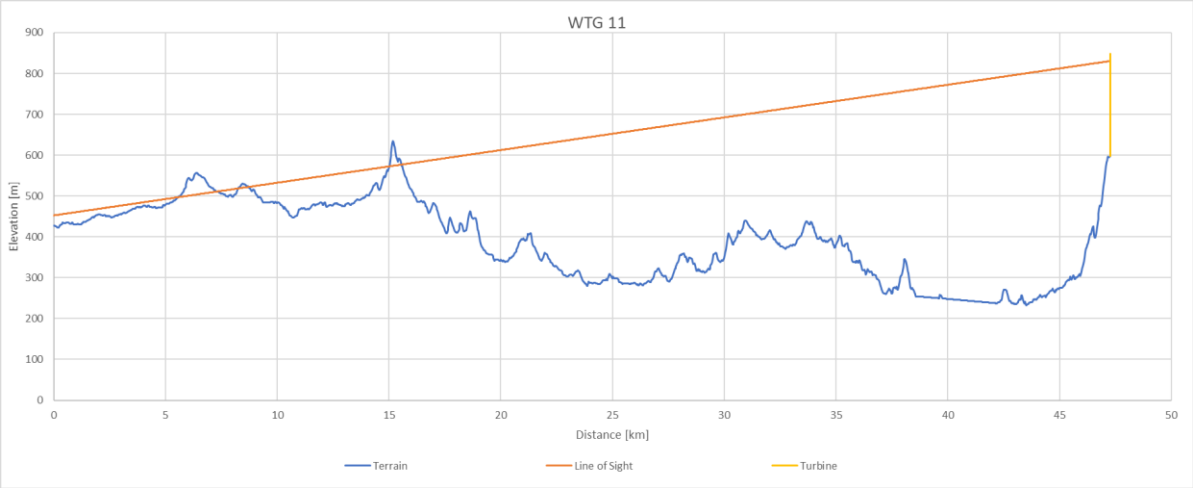


Figure 10: Line of sight analysis between Yeoval radar and WTG 11

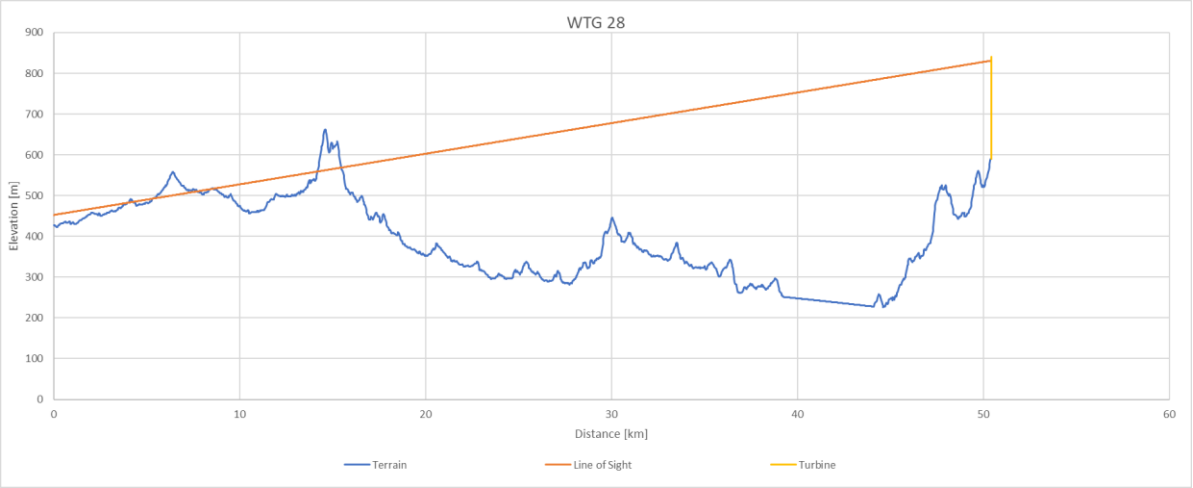


Figure 11: Line of sight analysis between Yeoval radar and WTG 28

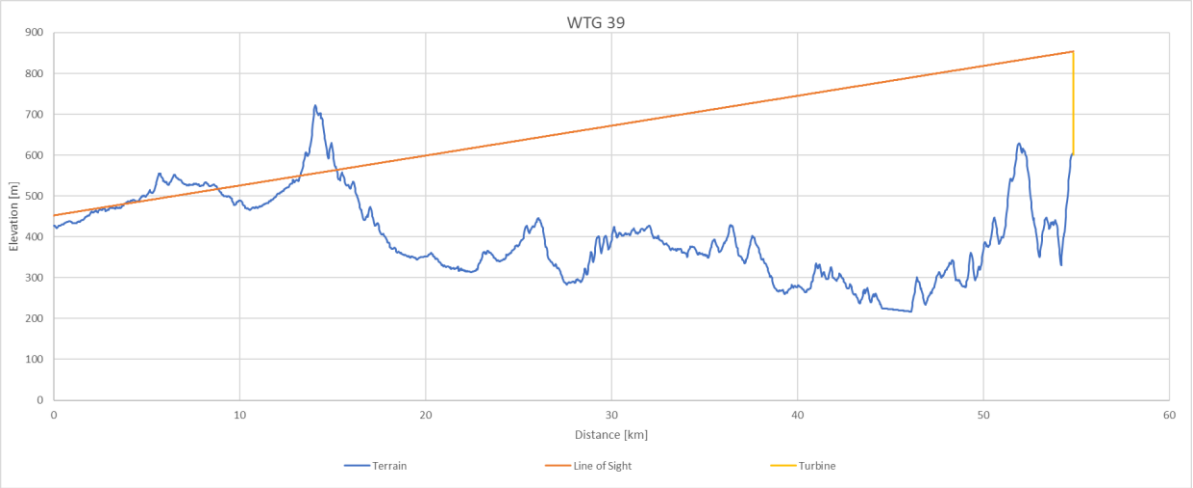


Figure 12: Line of sight analysis between Yeoval radar and WTG 39

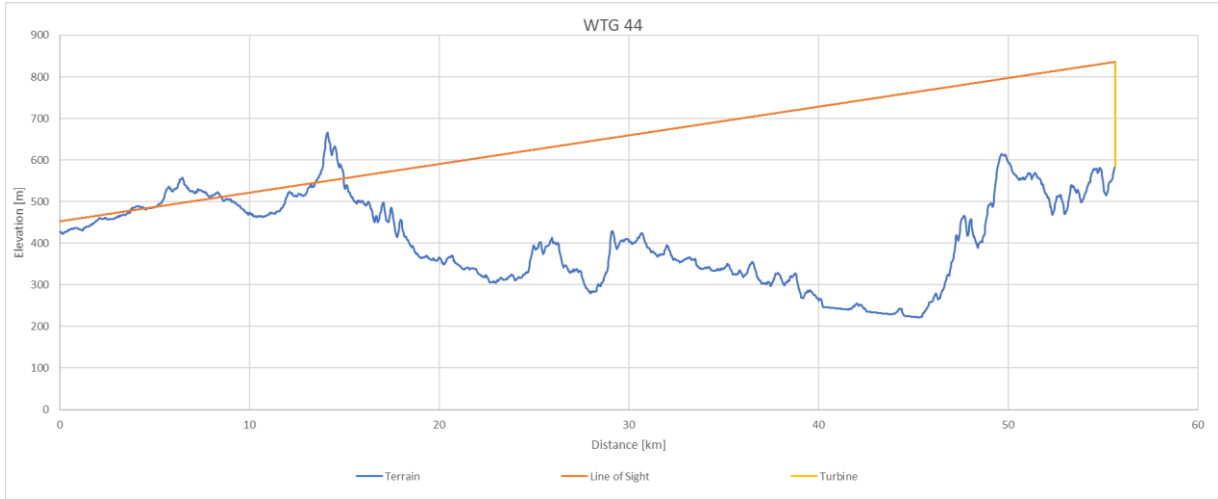


Figure 13: Line of sight analysis between Yeoval radar and WTG 44



Figure 14: Line of sight analysis between Yeoval radar and WTG 58

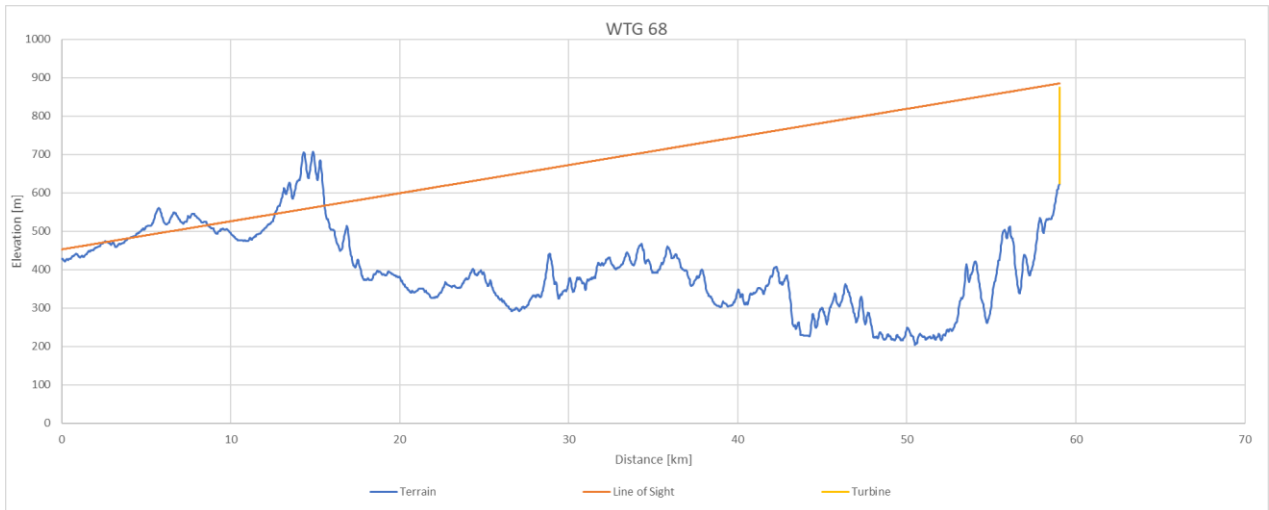
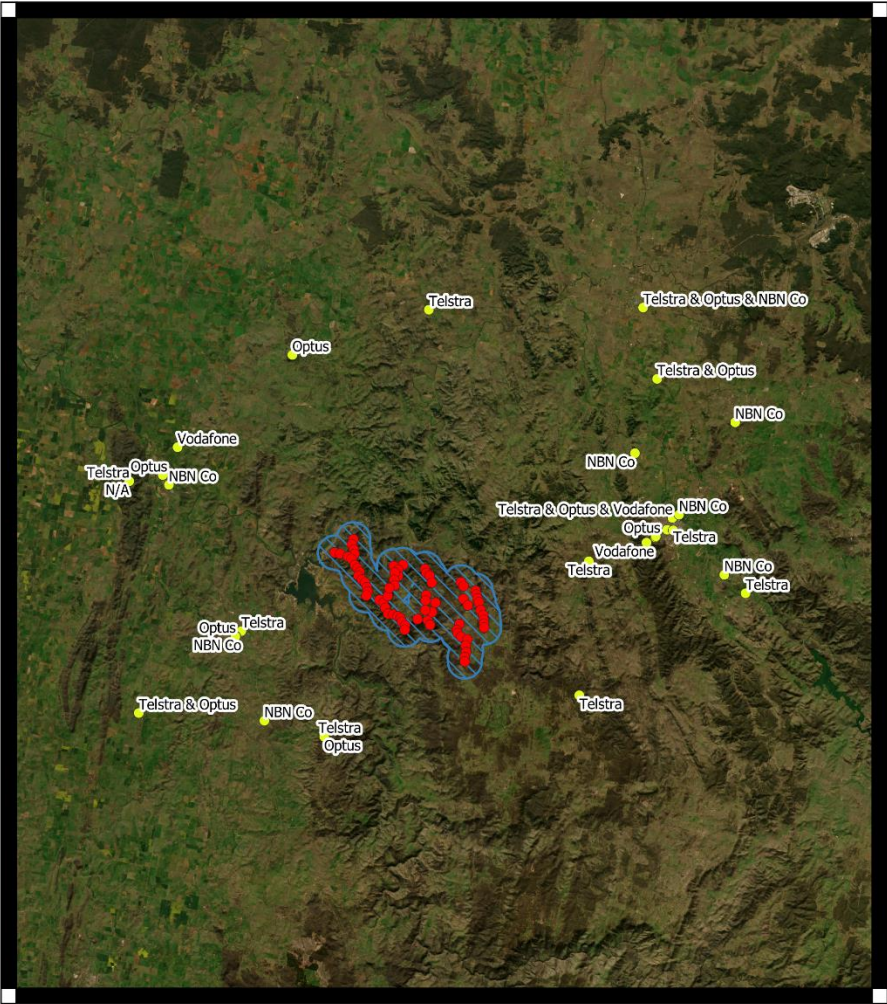


Figure 15: Line of sight analysis between Yeoval radar and WTG 68

7.3 Mobile Voice-based Communications

From Figure 16, all mobile phone base stations are located beyond the 2 km buffer of the Project's WTGs. Previous experience suggests that the signal will not be significantly impacted where the towers are located more than 1 km from WTGs. Therefore, the Project will not cause any significant impact on the operation of mobile phone base stations.

Consultation and engagement with the mobile service providers (Telstra, Optus, Vodafone and NBN Co), with respect to the impact on their mobile telemetry services, was initiated by the Proponent on 28th July 2021 and re-initiated in 2023. NBN Co confirmed in 2021 that the Project will not cause any impact on their mobile telemetry services. Optus and Telstra both confirmed in 2023 that the Project will not cause any impact on their mobile telemetry services. No response was received from Vodafone in the two weeks from the date of the letter, nor has any correspondence been received at the time of writing this report.



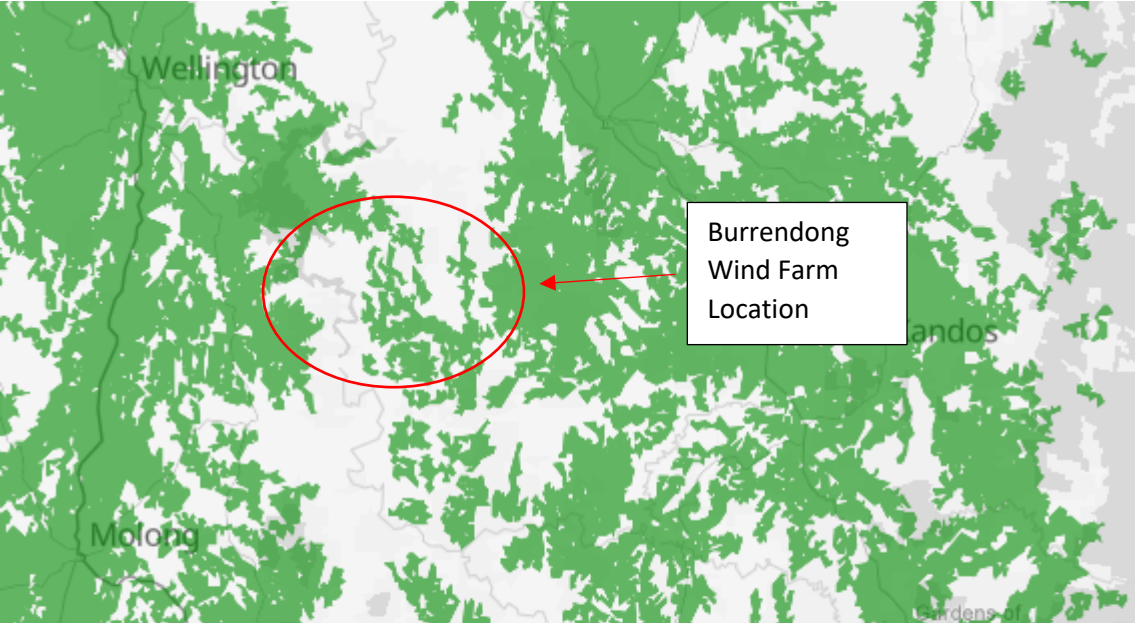
- WTGs Layout April 2023
- Mobile towers 2023
- ▨ WTG 2km buffer

0 10 20 km

Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 16: Proximity of the Project to mobile phone base stations.

As per Figure 17 through Figure 19, there is mobile network coverage from Telstra, Optus and Vodafone within the region. In the immediate vicinity of the WTGs, some reduction in signal may occur. However, this can be mitigated by relocating the mobile phone receiver in the order of tens of metres. Beyond the Project Site, there will not be any significant impact on the signal.



Type of coverage



Figure 17: Telstra mobile network coverage in the Project Site

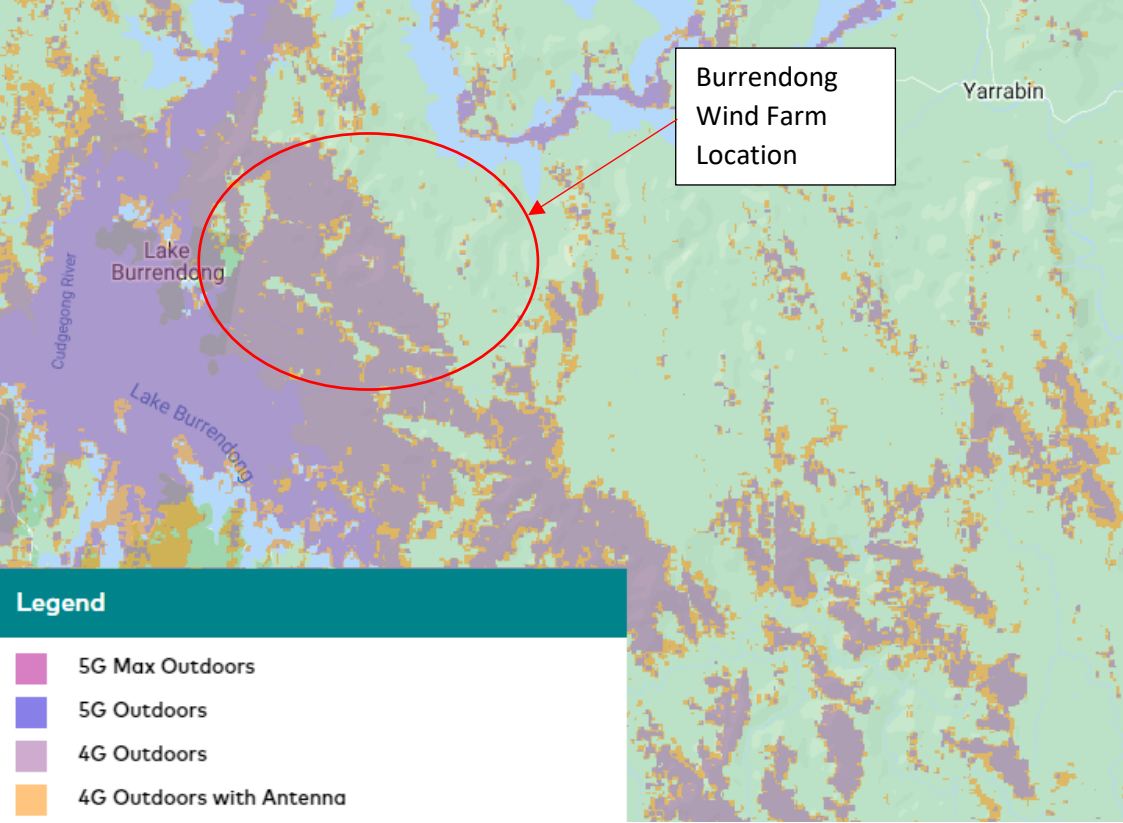


Figure 18: Optus mobile network coverage in the Project Site

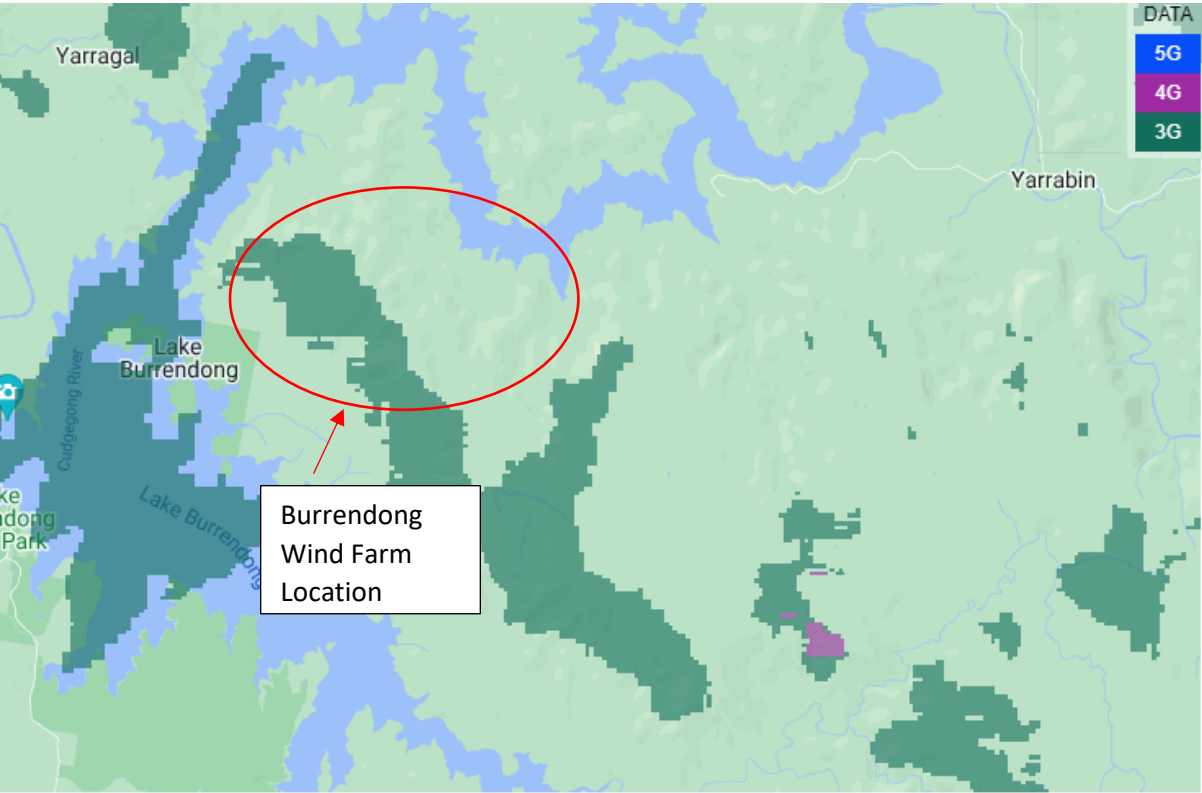


Figure 19: Vodafone mobile network coverage in the Project Site

7.4 Wireless and Satellite Services

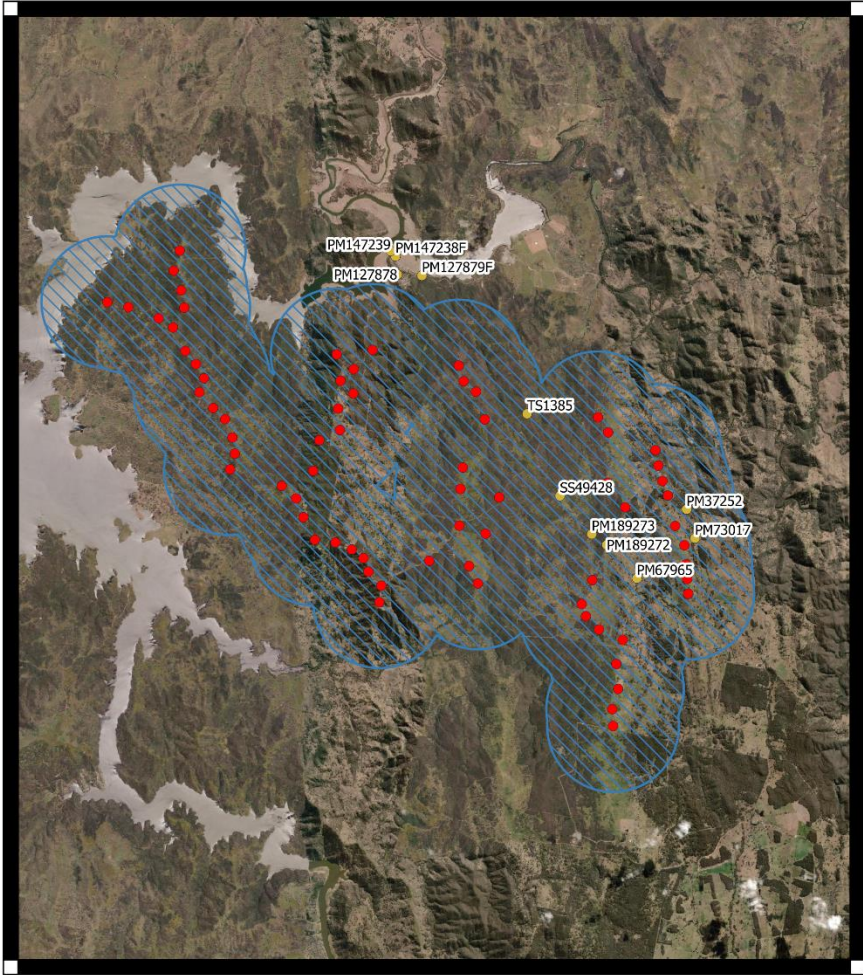
Satellite services will only be impacted where receivers are sited in extremely close proximity to turbines, impeding their view of the sky. These satellites typically provide pay-TV, wireless internet and satellite phone coverage, as well as TV coverage where there is no terrestrial service available.

As no WTGs are located within 800 m from a dwelling, it is highly unlikely that the Project will impact on satellite services.

7.5 Trigonometrical Station and GPS

Trigonometrical stations and survey marks are observation marks used for surveying or distance measuring purposes. GPS antennas and Electronic Distance Measuring (EDM) devices may be installed for some Trigonometrical stations. However, most of the EDM devices will not be affected by the line of sight or visibility.

MGE have mapped survey marks in the vicinity of the Project shown in Figure 20. Five are within 2 km of proposed WTG locations. While the WTGs will not directly impact on survey marks, should any of the wind farm infrastructure interfere with a survey mark, the Proponent should engage a registered surveyor to assist with their removal or relocation prior to construction.



- WTGs Layout April 2023
- Survey Marks
- ▨ WTG 2km buffer

0 2.5 5 km

Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

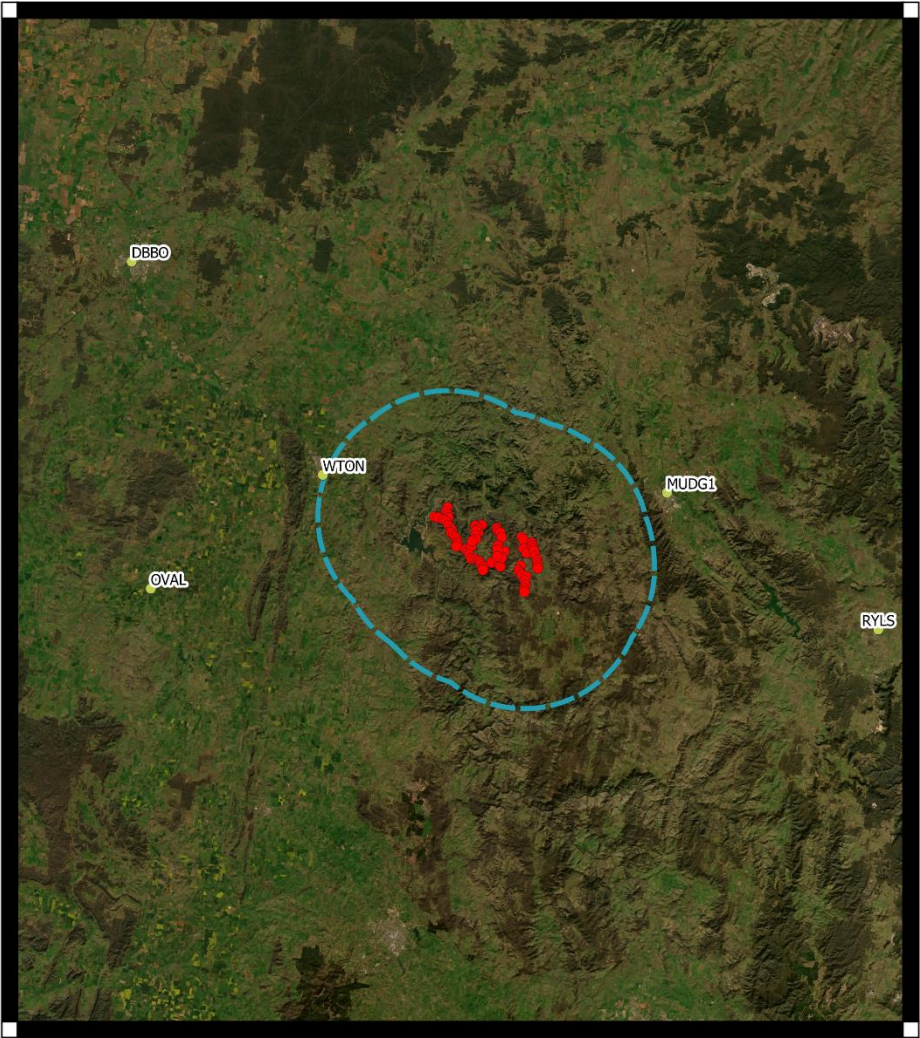
Figure 20: Survey marks with proximity to 2 km boundary of the WTGs

For sight navigational purposes, line of sight between markers may be obstructed, however, moving laterally one to two metres will typically alleviate the line-of-sight blockage. In addition, the presence of WTGs will typically assist with sight navigation, providing fixed reference points.

Global Navigation Satellite System (GNSS) networks are operated and maintained across the Australian region and the South Pacific. This includes the Australian Regional GNSS Network (ARGN), the South Pacific Regional GNSS Network (SPRGN) and the AuScope Network. GNSS networks provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Data from the GNSS Network also contributes to the International GNSS Service (IGS).

Based on the GNSS network map in the Geoscience Australia, the EMI impact of the Project to the GNSS stations has been analysed. Figure 21 demonstrates that all stations except the GNSS Station WTON, are outside of the Project's 20 km buffer. WTON is 20.5 km away from the closest WTG with a slight shift outside the 20 km buffer. The second nearest station (MUDG1) is 25 km away from the closest WTG.

Geoscience Australia confirmed in 2023 that the Project will not cause any impact on their GNSS services.



- WTGs Layout 04_23
- GNSS locations
- WTGs 20km buffer

0 10 20 km



Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 21 GNSS stations location and 20 km WTG buffer

7.6 Broadcast and Digital Radio and Television

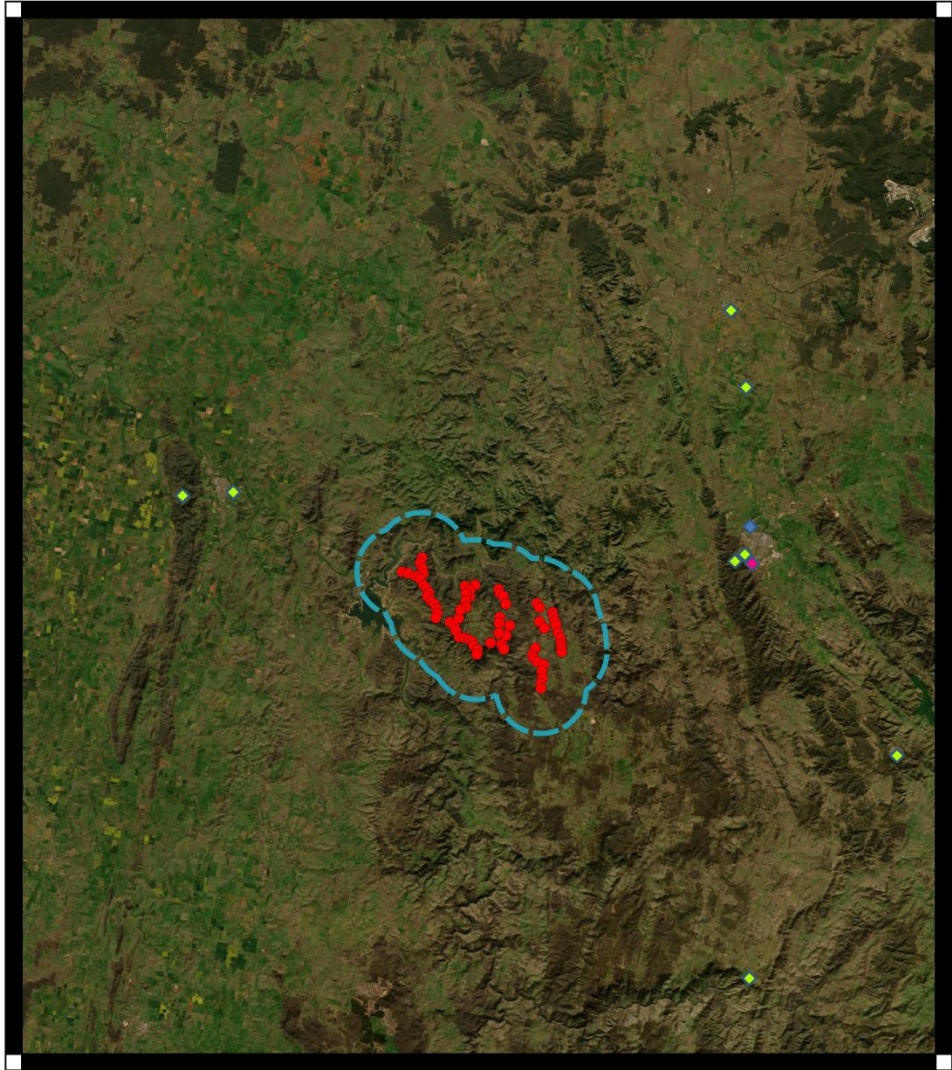
Amplitude Modulation (AM) signals are long wave signals. Operating WTGs can influence the radiating patterns, with the potential to result in reduced signal quality and strength, as well as causing interference at neighbouring frequencies. A 2 km radius consultation zone exists around AM transmitters. The field of influence from the receiver's perspective is in the order of tens of metres.

Frequency Modulation (FM) signals tend to be more robust around obstructions such as buildings and wind farms. At the edge of their transmission range, where the signal to noise ratio is already quite low, WTGs can have an adverse influence on the signal. A 1 km radius consultation zone exists around FM radio transmitters.

Digital signals tend to be more robust than analogue signals. A 2 km radius is generally desirable around transmitters – for both digital radio and Digital Television (DTV). Digital signals are more robust against ghosting, though WTG rotor pass can cause signal frequency variation.

As can be seen in Figure 22 no AM, FM or DTV transmitters are located within 5 km of a WTG. No digital radio transmitters were identified in the vicinity of the Project Site.

If issues are encountered with television reception, this is most readily mitigated by readjusting the receptor, to capture signal from an alternative transmitter.



- WTGs Layout April 2023
- WTGs 5km buffer
- ◆ AM
- ◆ FM
- ◆ DTV

0 10 20 km

Imagery from ESRI servers. Wind turbine location provided by Eco Logical Australia. ACMA sites sourced from ACMA site location map.

Figure 22: Location of broadcasters relative to the Project.

Client: Eco Logical Australia
Report: Telecommunications Impact Assessment Report
Revision: 4

Document Number: 20092-E-RPT-004

Project: Burrendong Wind Farm

Page 32 of 41

8 Stakeholder Engagement

Consultation with stakeholders has been prepared. A list of key stakeholders is presented in Table 6. Correspondences are provided in Appendix A: Stakeholder Correspondence and Responses.

A summary of the engagement is listed below:

- Water NSW confirmed in 2021 that the wind farm will not cause any material impact on the link. A notification email and multiple follow-up emails were sent to Water NSW informing of the 2023 to amendment of the Project layout and altered telecommunication link path. Water NSW provided confirmation that the updated layout has been received however have not provided comment at the time of issuing this report.
- BoM has expressed some concern about the impact of the facility on the Yeoval radar. The Proponent and BoM will enter into an agreement on the operation of the wind farm that satisfies BoM's operational requirements.
- Engagement with NBN Co highlighted that there may an issue if the RF emission of the turbines is within the NBN co bands. However, all installations on the Project will comply with the *Radiocommunications Act (1992)* and associated notices, including affixation of relevant compliance markers to the equipment. Therefore, the likelihood of any interference on NBN Co's telecommunication system is very low;
- Engagement Optus finds no concerns with the proposed WTG layout.
- Engagement Telstra finds no concerns with the proposed WTG layout. Telstra requests that and Low Frequency Induction and Earth Potential Rise study is conducted to assess impact on any Telstra plant. This will be addressed during detailed design as specific design details are developed.
- Engagement Geoscience Australia finds no concerns with the proposed WTG layout.

Table 6: List of stakeholder engagement.

Stakeholder	Email address	Telecommunication Service	Responses
Water NSW	Customer.Helpdesk@waterNSW.com.au	UHF Link (License No: 496812/2)	Responded: No impact for the wind farm with updated layout
Bureau of Meteorology	weatherquestions@bom.gov.au	Meteorological radar	Responded: Potential impact on Yeoval radar; the Proponent and BoM will enter into an agreement.
Telstra	Basestation.Enquiries@team.telstra.com	Mobile service operation	Responded: No impact to telecommunications. LFI & EPR assessment requested, to be addressed at later stage
Optus	emeenquiries@optus.com.au	Mobile service operation	Responded: No impact
Vodafone	smc.vha@nokia.com	Mobile service operation	No response
NBN Co	noc.sydney@ericsson.com; nocrestore@nbnco.com.au; nocshiftmanager@nbnco.com.au	Mobile service operation	Responded: No impact
Geoscience Australia		GNSS Stations	Responded: No impact

9 Conclusions

The potential electromagnetic interference impact of the updated wind turbine layout has been assessed in this report. The link passing through the Project has shifted south with no change in frequency nor ownership, however a slight decrease in distance. The results and key outcomes of the assessment are outlined below:

1. The investigation showed that the wind farm is unlikely to have any material impact on the following services:
 - a. Fixed radiocommunications links;
 - b. Meteorological radar;
 - c. Mobile voice-based communications;
 - d. Wireless and satellite internet services;
 - e. Broadcast and digital radio;
 - f. Broadcast, digital and satellite television;
 - g. Trigonometry stations; and
 - h. GPS;
2. There are no ACMA communication sites found within the 2 km buffer of the WTGs. Therefore, no detailed assessment of near-field effects due to WTGs is required;
3. There are no WTGs located within 2 km of any telecommunication site;
4. Assessment has shown that WTG 19 impinges on Link 1's $0.6F_{1,Max}$ buffer from a plan view, however, detailed line of sight analysis shows no significant impact from the WTG is expected to occur to the link. Water NSW confirmed in 2021 that the Project will not cause any material impact on the link. Water NSW have not commented on the revised project layout and Link 1 path.
5. WTG 62 comes to close proximity to the link 1's $0.6 F_{1,Max}$. However, a sufficient distance is observed between the WTG and the Fresnel zone so an impact is highly unlikely.
6. BoM indicated that there is potential impact on the Yeoval. The Proponent and BoM will enter into an agreement on the operation of the Project that satisfies BoM's operational requirements; and
7. No mobile phone base stations were located within the 2 km buffer of the WTGs. Therefore, the Project will not cause any significant impact on the operation of mobile phone base stations.

The assessment has shown that the Project has been designed, located, and sited to avoid, or minimise electromagnetic interference to the pre-existing television, radar and radio transmission and reception.

The Proponent is recommended to seek Water NSW acknowledgement of the revised link path and WTG layout.

Appendix A Stakeholder Correspondence and Responses

Appendix A.1 Water NSW

[Redacted]

From: [Redacted]
Sent: Tuesday, 2 April 2024 2:09 PM
To: [Redacted]
Cc: [Redacted]
Subject: RE: Burrendong Wind farm TIS - Ref: D2023/163253

Good afternoon,

I have now received advice from our Digital Team – they are satisfied with the revised analysis and consider the wind turbines will have minimal impact on WaterNSW’s radio link.

Kind regards,

[Redacted]
[Redacted]

Please note: I am working remotely. Please contact me by email.



[Redacted]

The information contained in this electronic mail message is privileged and confidential, and is intended only for use of the addressee. If you are not the intended recipient, you're hereby notified that any disclosure, reproduction, distribution or other use of this communication is strictly prohibited. If you have received this communication in error, please notify the sender by reply transmission and delete the message without copying or disclosing it.

[Redacted]

Sent: Thursday, March 28, 2024 11:45 AM

[Redacted]

[Redacted]

Subject: RE: Burrendong Wind farm TIS - Ref: D2023/163253

[Redacted]

Thank you for your email and response to WaterNSW’s comments. Your information has been forwarded to WaterNSW’s Digital Network Team for review. I will respond to you as soon as their advice has been received.

Kind regards,

[Redacted]
[Redacted]

Please note: I am working remotely. Please contact me by email.



[REDACTED]

The information contained in this electronic mail message is privileged and confidential, and is intended only for use of the addressee. If you are not the intended recipient, you're hereby notified that any disclosure, reproduction, distribution or other use of this communication is strictly prohibited. If you have received this communication in error, please notify the sender by reply transmission and delete the message without copying or disclosing it.

[REDACTED]

Sent: Thursday, March 28, 2024 10:12 AM

[REDACTED]

Cc: Environmental Assessments <Environmental.Assessments@waterNSW.com.au>

Subject: [EXTERNAL] Burrendong Wind farm TIS - Ref: D2023/163253

[REDACTED]

We are conducting a third revision consultation for the Burrendong Wind Farm near Yarragal in New South Wales, in particular, focussing on the telecommunication impact analysis of the WaterNSW ACMA link. From the last revision, the antenna heights of the two sites: Burrendong Dam (ID 250574) and Mt Bocoble (ID 35200) were considered as 0 m. See attached email from this initial consultation for your record keeping.

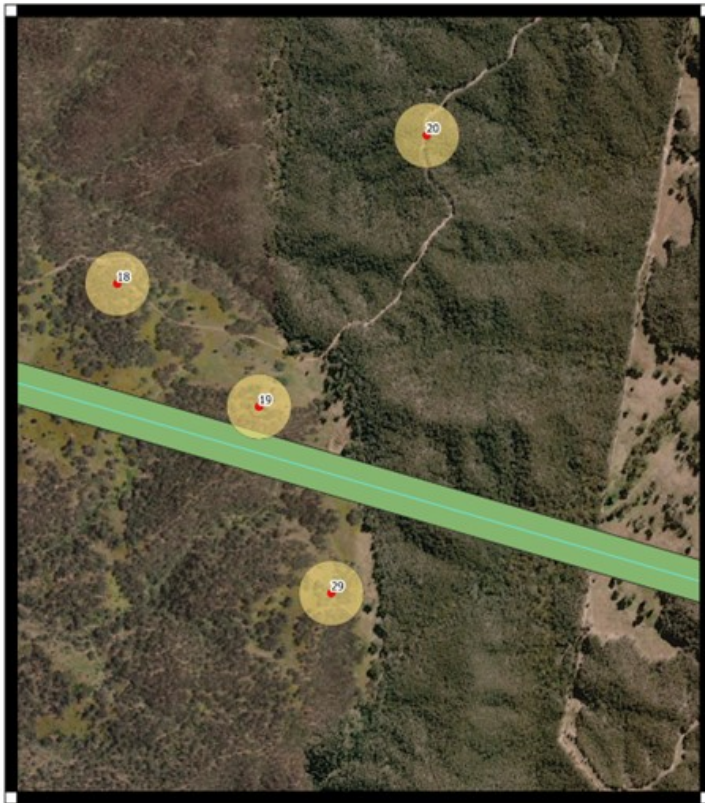
We note that antenna heights at the sites are as follows:
Burrendong Dam (ID 250574): 25 m
Mt Bocoble (ID 35200): 35 m

Based on our analysis, two of our proposed wind turbines are near this link. One WTG appears to impinge on the link from a bird eye's view, however after a line of sight and topography analysis, the WTG is found to be positioned well above the 1st Fresnel zone of the link. This can be seen in the images below.

While the analysis is very similar to our earlier engagement, we nonetheless wish to inform Water NSW of our updated analysis.

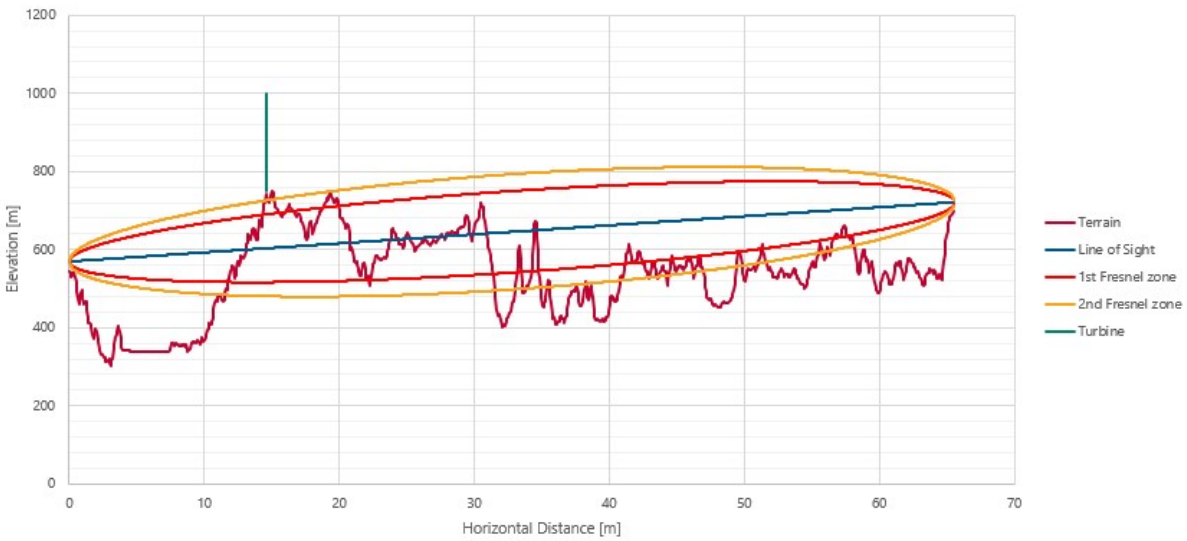
We append the wind turbine co-ordinates as a .csv file inclusive of WTG ID, Eastings, Northings, Co-ordinate Reference System and Elevation above sea level. Note that the rotor diameter of our turbines will be up to 180 m, with hub height of up to 160 m and maximum tip height up to 250 m.

If you have any concerns relating to the development and any potential impacts on your communication links, please get in contact by return email or by calling us on the phone number listed below prior to 20/04/23.

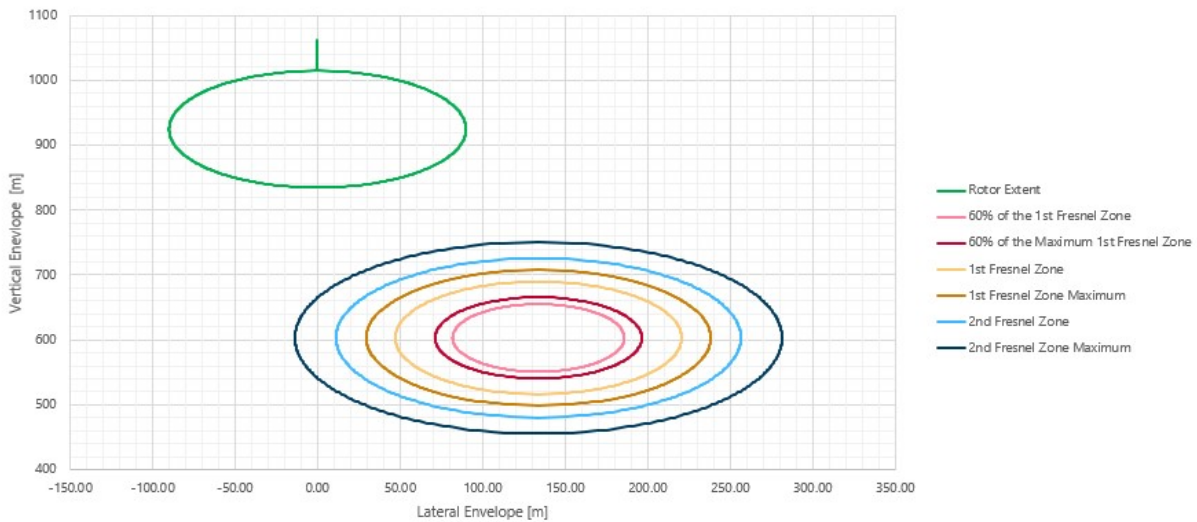


middleton
Group

Link Profile View



Cross Sectional View of Link X and Turbine X



Appendix A.2 Bureau of Meteorology

From: [REDACTED]
Sent: Tuesday, 20 June 2023 1:52 PM
To: [REDACTED]
Cc: [REDACTED]
Subject: RE: BoM - Burrendong Wind Farm - 2023 Revised Layout: Electromagnetic Interference Consultation [SEC=OFFICIAL]

Further on this, we have re-assed the windfarm with updated layout. Our assessment remains same as communicated on Wed 3/08/2022 2:08 PM, the windfarm under normal propagation is in low-risk category.

We previously requested a letter from developers for a voluntary collaboration including following main points:

1. **Informing the BoM of significant variation of turbine layout (i.e. by more than 100m in any lateral direction, or alteration of tip height) between the initial plan and construction.**
2. **Provide advanced notice (one week preferably) to the BoM of any planned whole wind farm shutdown events for more than 12 hours, to allow the recalibration of radar systems.**
3. **Collaborate with the BoM in the event of severe weather conditions to assist in endeavours of community safety.**

Kind Regards,

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]



From: [REDACTED]
Sent: Tuesday, May 30, 2023 8:53 AM
To: [REDACTED]
Cc: [REDACTED]
Subject: RE: BoM - Burrendong Wind Farm - 2023 Revised Layout: Electromagnetic Interference Consultation [SEC=OFFICIAL]

Thanks for the update.
As we have provided you an assessment previously, we will have to run our own investigations to understand the impact on Yeoval radar. We will provide you the feedback on this in couple of weeks' time.

Regards,

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]



From: [REDACTED]
Sent: Friday, May 26, 2023 2:51 PM
To: [REDACTED]
Cc: [REDACTED]
Subject: BoM - Burrendong Wind Farm - 2023 Revised Layout: Electromagnetic Interference Consultation

To whom it may concern,

We are conducting a second revision consultation for the Burrendong Wind Farm near Yarragal in New South Wales, in particular, focussing on Electro-Magnetic Interference. The wind turbine generator (WTG) layout has changed since the last revision, dated in 2021. See attached email from this initial consultation for your record keeping.

The nearest radar (Yeoval) is approximately 45 km from our nearest proposed wind turbine. Based on the WMO guidance document (CBS-CIMO Remote Sensing, Annex II), we do not anticipate that the wind farm will adversely impact the radar operation.

We attach both a Google Earth .kml file of the wind farm layout and a .csv file containing the wind turbine co-ordinates in GDA94 zone 55 and WTG base height above sea level. Note that the rotor diameter of our turbines will be up to 180 m, with hub height of up to 160 m and maximum tip height up to 250 m.

If you have any concerns relating to the development and any potential impacts on your communication links, please get in contact by return email or by calling us on the phone number listed below prior to 9th June 2023.

Regards,

[Redacted]

MEng (Electrical)

[Redacted]

[Redacted]

[Redacted]

Appendix A.3 Optus

From: [REDACTED]
Sent: Tuesday, 30 May 2023 9:27 AM
To: [REDACTED]
Cc: [REDACTED]
Subject: RE: Optus - Burrendong Wind Farm - 2023 Revised Layout Electromagnetic Interference Consultation

Thanks for your enquiry. Our Networks Engineering team have investigated this and concluded the wind turbines will not cause interference:

“Please note that the Burrendong Wind Farm turbine locations will have no impact on the existing Optus microwave links in the area.”

Kind regards,
[REDACTED]

[REDACTED]
[REDACTED]



OPTUS

Follow us



Optus acknowledges the Traditional Owners and Custodians of the lands on which we live, work, and serve. We celebrate the oldest living culture and its unbroken history of storytelling and communication. We pay our respect to Elders – past, present, and future – and we strive together to embrace an optimistic outlook for our future in harmony, across all of Australia and for all of its people.

This email may be confidential. If you received it accidentally, please do not send it to anyone else, delete it and let the sender know straight away.

Sent: Friday, 26 May 2023 2:52 PM
[REDACTED]

Subject: Optus - Burrendong Wind Farm - 2023 Revised Layout Electromagnetic Interference Consultation

[External email] Please be cautious when clicking on any links or attachments.

To whom it may concern,

We are conducting early-stage consultation for the Burrendong Wind Farm near Yarragal in New South Wales, in particular, focussing on Electro-Magnetic Interference. The proposed wind turbine layout consists of 70 turbines.

We note that your nearest mobile base station is approximately 13 km from the nearest wind turbine, and you do not have any point-to-point links crossing the site.

We attach both a Google Earth .kml file of the wind farm layout and a .csv file containing the wind turbine co-ordinates in GDA94 zone 55 for your information. Note that the rotor diameter of our turbines will be up to 180 m, with hub height of up to 160 m and maximum tip height up to 250 m.

If you have any concerns relating to the development and any potential impacts on your operations, please get in contact by return email or by calling us on the phone number listed below prior xx/xx/23.

Kind regards,
[REDACTED]

MEng (Electrical)
[REDACTED]
[REDACTED]



Appendix A.4 NBN Co

[REDACTED]

From: [REDACTED]
Sent: Thursday, 29 July 2021 10:53 AM
To: [REDACTED]
Cc: Burrendong WF - EMI; Network_Capacity_Enquiries
Subject: RE: Burrendong Wind Farm: Electromagnetic Interference Consultation

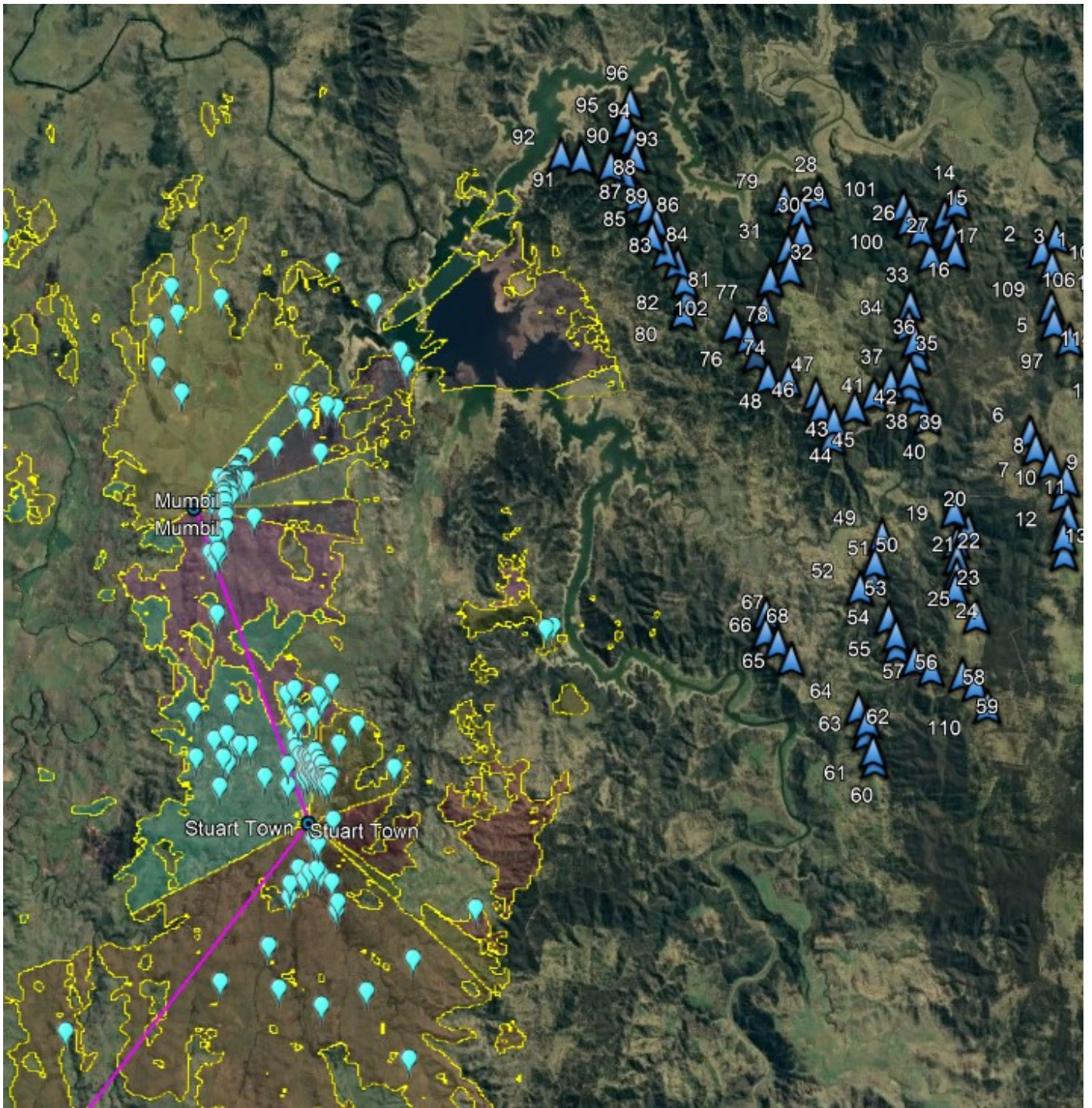
NBN Classification - Commercial

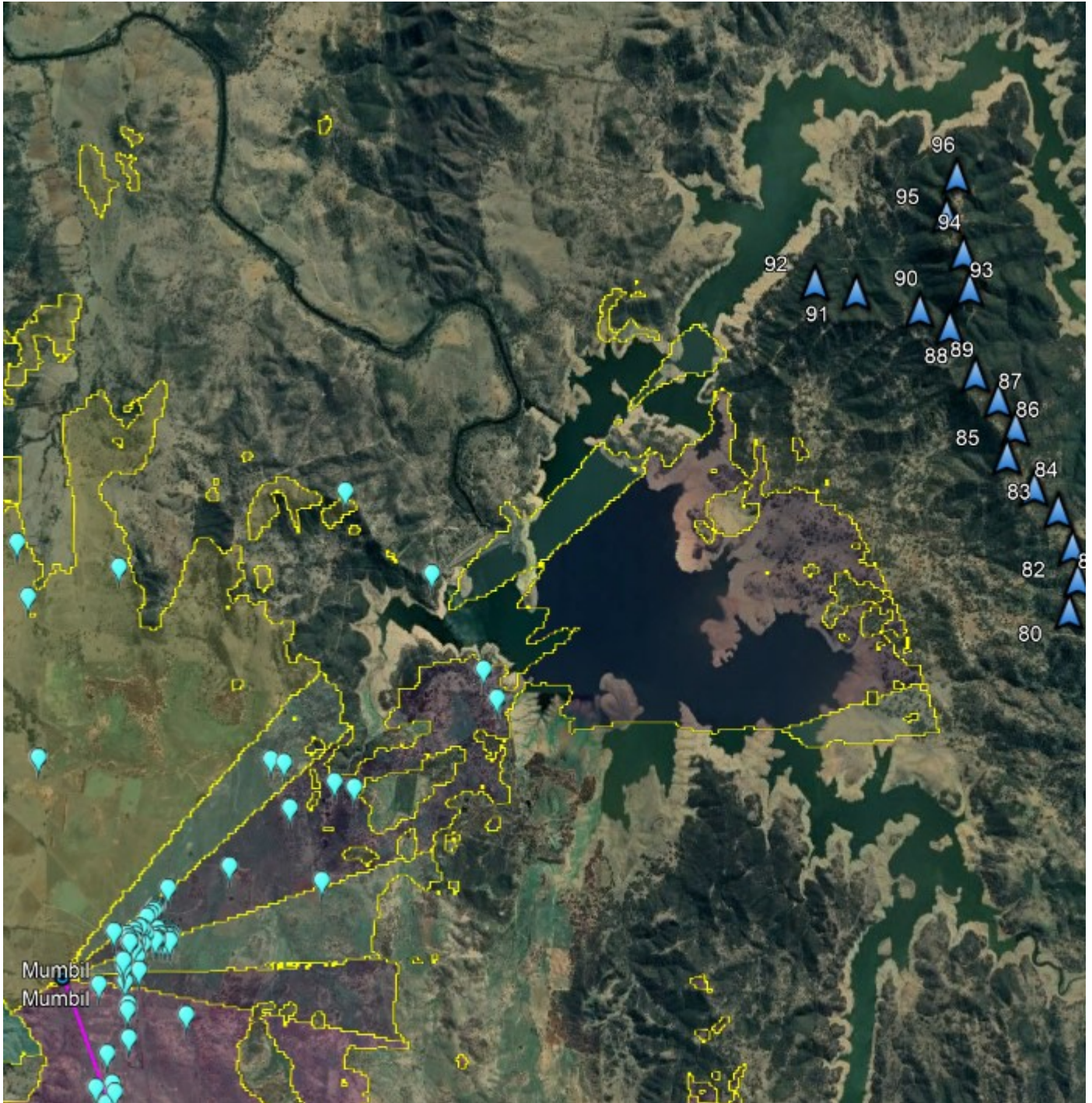
[REDACTED]

Thanks for your email. Please see response from our engineering team below:

Desktop Analysis

I have reviewed the data provided based on the proposed wind farm location ; while some proposed towers are near existing nbn wireless coverage boundaries, the proposed wind tower locations do not pose any risk of introducing a physical obstruction to existing wireless customer RF Profiles or any boresight paths of existing nbn microwave links.





Images show current operational or planned nbn wireless coverage areas relative to wind farm location and turbines. Western side of wind farm nears nbn Wireless Coverage Boundaries.

Legend: blue triangle = wind turbine, yellow = nbn Wireless Coverage Boundary, purple line = nbn microwave link, light blue = active nbn wireless customer installation

Please provide information on any planned RF transmission equipment planned to be installed so a potential interference impact can be assessed. This information should include as a minimum the operating transmission frequencies and transmit power, channel bandwidths, antenna types and radiation patterns as well as the exact location with antenna height, boresight azimuth and tilt [mechanical and electrical tilt].

A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows ;

Potential Impacts of the Proposed Hills of Burrendong Wind Farm on NBN Co Spectrum Communication Assets

Referring to your email dated 28th July 2021 regarding the application for the Burrendong Wind Farm .

We confirm that NBN Co Spectrum Pty Ltd (**nbn Spectrum**) has a number of spectrum licenses within 75 km of the proposed Hills of Burrendong Wind Farm.

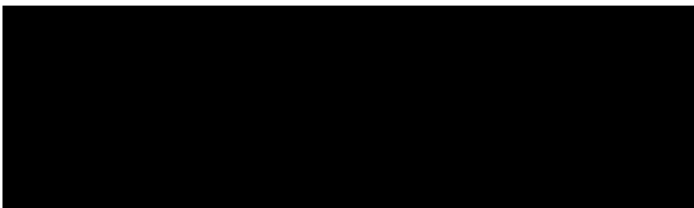
nbn have strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place.

nbn will be forced to consider its position as part of the planning should there an interference issue.

If the Application is amended before it is lodged we request that we are sent any amended Application so we can determine whether we have any objections to the amended Application.

We note that, as you would be aware, under section 197 of the *Radiocommunications Act 1992* (Cth) it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications.

Regards,



Sent: Wednesday, 28 July 2021 9:57 AM

Subject: FW: Burrendong Wind Farm: Electromagnetic Interference Consultation

NBN Classification - Commercial

HI Team

Please address the enquiry below and respond accordingly to the concerned people.

Regards

[Redacted]
[Redacted]
[Redacted]

The Innovation Building, Level 2, 1010 La Trobe Street, Docklands, VIC 3008



April'21, Celebrating 10 years of 24x7 running our **NMC**

From: [Redacted]

Sent: Wednesday, 28 July 2021 9:43 AM

To: [Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

Subject: [External] Burrendong Wind Farm: Electromagnetic Interference Consultation

Hi, Sir or Madam,

We are conducting early-stage consultation for the Burrendong Wind Farm near Yarragal in New South Wales, in particular, focussing on Electro-Magnetic Interference.

We note that there are no mobile base stations within 10 km of the wind farm site and no point-to-point links cross the site.

We attach both a Google Earth .kml file of the wind farm layout and a .csv file containing the wind turbine co-ordinates in GDA94 zone 55 for your information. Note that the rotor diameter of our turbines will be up to 180 m, with hub height of up to 160 m and maximum tip height up to 250 m.

If you have any concerns relating to the development and any potential impacts on your operations, please get in contact by return email or by calling us on the phone number listed below prior to 3rd August 2021.

Kind regards,

[Redacted]
[Redacted]
[Redacted]
[Redacted]
[Redacted]
[Redacted]
[Redacted]



Appendix A.5 Geoscience Australia

[REDACTED]

From: [REDACTED]
Sent: Friday, 9 June 2023 4:30 PM
To: [REDACTED]
Cc: [REDACTED]
Subject: RE: Geoscience Australia - Burrendong Wind Farm - 2023 Revised Layout Electromagnetic Interference Consultation [SEC=OFFICIAL]

Geoscience Australia do not foresee any impact on our GNSS reference stations or trigonometrical stations from the proposed Burrendong Wind Farm.

Kind regards,

[REDACTED]
[REDACTED]
Space Division



[Twitter](#) | [Facebook](#) | [YouTube](#) | [LinkedIn](#)

Geoscience Australia acknowledges the traditional owners and custodians of Country throughout Australia and acknowledges their continuing connection to land, waters and community. We pay our respects to the people, the cultures and the elders past and present.

[REDACTED]
[REDACTED]
[REDACTED]

Subject: FW: Geoscience Australia - Burrendong Wind Farm - 2023 Revised Layout Electromagnetic Interference Consultation [SEC=OFFICIAL]

[REDACTED]

Are you able to assist with the following request please. If you could copy Client Services into your response we'd appreciate it.

Regards

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

Mon, Tues: Work From Home | Wed, Thurs and Fri: In the Office 8.00am – 4.00pm



[Twitter](#) | [Facebook](#) | [YouTube](#) | [LinkedIn](#)

Geoscience Australia acknowledges the traditional owners and custodians of Country throughout Australia and acknowledges their continuing connection to land, waters and community. We pay our respects to the people, the cultures and the elders past and present.

[REDACTED]
Sent: Friday, May 26, 2023 2:51 PM

[REDACTED]
[REDACTED]
Subject: Geoscience Australia - Burrendong Wind Farm - 2023 Revised Layout Electromagnetic Interference Consultation

To Whom it May Concern,

We are conducting early-stage consultation for the Burrendong Wind Farm near Yarragal in New South Wales, in particular, focussing on Electro-Magnetic Interference. The proposed layout of the wind turbines has modified over the past two years, with a finalised layout consisting of 70 turbines. Our consultation particularly relates to potential impact on survey marks and GNSS stations.

We note that the WTON station is 20.5 km from the nearest WTG.

We attach both a Google Earth .kml file of the wind farm layout and a .csv file containing the wind turbine co-ordinates in GDA94 zone 55 for your information. Note that the rotor diameter of our turbines will be up to 180 m, with hub height of up to 160 m and maximum tip height up to 250 m.

Appendix A.6 Telstra



1 August 2023

██████████
██████████
Melbourne Victoria 3000

Re: Proposed Burrendong Wind Farm

██████████

To provide a better understanding of potential impacts to Telstra infrastructure a desktop assessment was undertaken. Based on this assessment, to minimise potential interference to Telstra's telecommunications network, Telstra requires the developer to confirm its agreement to the conditions and matters set out below:

- 1) There are no expected impacts to Telstra's Mobile network due to this wind farm based on the turbine locations provided.
- 2) Based on the turbine locations provided and information regarding Telstra existing point to point radio links obtained from Waypoint and maprad.io, the proposed wind farm should not impact on any of Telstra existing point to point radio links.
- 3) A detailed analysis of the full power coordination impact (Low Frequency Induction (LFI) and/or Earth Potential Rise (EPR)) of the wind farm development is required. This includes location of the wind farm switch yard, the route and potential of any associated HV transmissions lines and the LFI and EPR impact on any Telstra plant they may affect.
- 4) It is recommended that you contact Before You Dig Australia, so you are aware of the underground assets in the area. They will provide you with the location of Telstra's as well as any other utilities' underground assets.

The developer also confirms its role as the proponent and ultimate owner of the proposed wind farm and that it has the authority to ensure that the conditions set out above are implemented and complied with. If the agreement of any other person or entity is required to ensure the conditions set out in this letter are complied with, the developer undertakes to obtain that agreement in writing and to provide it to Telstra prior to lodging a development application for the wind farm.

If the proposed plans and specifications of the development are altered or amended, Telstra reserves the right to request further conditions and amendments to the development.

Should you wish to discuss any aspect of this letter please do not hesitate to contact the undersigned. Otherwise, I would appreciate you responding to me confirming the developer's agreement to the conditions and matters set out above.