

Appendix I

DNV·GL

DELBURN WIND FARM

EMI Assessment

Delburn Wind Farm Pty Ltd

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EXECUTIVE SUMMARY

DNV GL has been commissioned by Delburn Wind Farm Pty Ltd ("the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Delburn Wind Farm ("the Project") in southeastern Victoria. The results of the EMI assessment are described in this document and summarised in the table on the following page.

Background and methodology

DNV GL has assessed the potential EMI impacts for the Project in accordance with the Victorian Planning Guidelines [1] and Draft National Wind Farm Development Guidelines [2]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

A Project layout consisting of 33 wind turbines with a rotor diameter of 180 m and tip height of 250 m has been considered. These dimensions represent the maximum overall tip height within the maximum rotor and tower hub height dimensions. All identified dwellings within 5 km of the Project site boundaries have been considered in this assessment.


Outcomes of the assessment

Turbines at the Project are located within the calculated diffraction exclusion zone for one **point-to-multipoint link** operated by Gippsland Water, and hence have the potential to cause interference to that link. Gippsland Water has confirmed that there is a risk of interference to their link, although they believe potential mitigation options exist. DNV GL understands that the Customer is working with Gippsland Water to design an appropriate mitigation solution and the Customer has committed to implementing that mitigation at their own cost.

Turbines at the Project may also interfere with **digital television broadcast signals** received from nearby towers at a number of dwellings surrounding the Project. Coverage maps suggest that, for most of these towers, many of the potentially-affected dwellings are located in areas with limited to no signal coverage and therefore may not be receiving signals from that tower. However, interference to the signals from Latrobe Valley tower, which appears to be the primary transmitter for the area, could affect a large number of local residents who may not currently be able to receive signals from an alternative tower. Feedback received from BAI Communications, who operate the Latrobe Valley tower, also suggests that residents in the vicinity of the Project are at risk of experiencing interference to these signals. If interference is experienced, mitigation options may include realigning or upgrading the user's antenna, installing cable or satellite television at the affected dwelling, or installing a signal repeater on the opposite side of the Project.

There is potential for interference to **NBN wireless internet signals** received from the Boolarra NBN tower at several dwellings in the vicinity of the Project. However, NBN Co has advised that the Project is not expected to impact on the signal line of sight for any currently connected dwellings and the overall risk of interference is low. If interference is experienced, it is likely that problems could be rectified by relocating the antennas at the affected dwellings to achieve a clearer signal or to receive signals from an alternative tower.

Similarly, there is a low risk of interference to point-to-multipoint links associated with the **Latrobe Valley flood warning system**. Latrobe City Council, who operate the system, have advised that they do not expect the Project to impact on these links. If interference is experienced, mitigation



options could include replacing the existing links with alternative technologies. DNV GL is continuing to engage with the Bureau of Meteorology, who also operate flood warning infrastructure in the area around the Project, to seek feedback on the potential for interference with their systems and how any impacts may be mitigated.

Interference to **FM radio signals** from the Kids FM broadcast tower to the north of the Project may be experienced in the surrounding areas to the southwest of the Project. However, feedback received from BAI Communications indicates that they do not expect the Project to cause any noticeable interference to these signals. If interference is experienced, mitigation options may include upgrading the user's antenna, increasing the signal strength from the affected tower, or installing a signal repeater or additional tower on the opposite side of the Project.

Interference to **mobile phone signals** may theoretically occur in areas that are serviced by towers on the other side of the Project and already experience marginal coverage, although the overall risk is low and no concerns have been raised by the network operators. If localised interference is experienced, this can often be resolved by the user moving a short distance to a new or higher location or using an external antenna to improve the signal reception. For interference over a larger area, or where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a new tower on the opposite side of the Project.

Satellite television signals from two satellites that transmit programs designed for international audiences may be intercepted by turbines in the Project. However, it is relatively unlikely that residents will be receiving signals from these satellites due to their low angles of elevation and the availability of alternative signals. If interference is experienced, mitigation options could include realigning or upgrading the user's satellite dish, or seeking an alternative source of the same programming. DNV GL recommends that the Customer engages with the potentially-affected residents to determine if any are currently receiving signals from these satellites, and to establish an understanding of how any impacts may be mitigated.

Gippsland Water has also noted the potential for interference to their **mobile radio operations**, although DNV GL considers that the risk of interference to these types of services is very low. If interference to mobile radio communications is experienced, available mitigation options are similar to those described above for commercial mobile phone services.

Potential EMI impacts on **other services** considered in this assessment are considered unlikely or have been assessed through consultation with the service operators. Besides the feedback received from Gippsland Water, NBN Co, and BAI Communications, no other concerns have been raised.

DNV GL understands that, in line with the expected planning permit conditions, the Customer has committed to returning any impacted services to at least pre-construction quality at their own cost if interference to those services is attributed to the Project after construction.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radio-communication towers	One tower within 2 km of proposed turbine locations, operated by BAI Communications (Kids FM)	Low risk of interference – see findings for FM radio broadcasting	No concerns raised	See findings for FM radio broadcasting
Fixed point-to-point links	Six links crossing Project boundary, operated by: AusNet Services (one link) Gippsland Water (one link) Digital Distribution Australia (one link) Optus Mobile (two links) VerTel (one link)		No concerns raised by AusNet Services, Digital Distribution Australia, Gippsland Water, Optus Mobile, and VerTel	None required
	Diffraction effects: no turbines in DNV GL exclusion zones, no turbines in clearance zones requested by AusNet Services, Digital Distribution Australia, Optus Mobile, and VerTel	Unlikely to cause interference		
Fixed point-to-multipoint links	Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts			
	204 assignments within 75 km of Project boundary 20 base stations within 20 km of Project boundary, operated by: AusNet Services (two sites) Aussie Broadband (one site) Bureau of Meteorology (one site) EnergyAustralia Yallourn (one site) ENGIE (one site) Gippsland Water (eight sites) Latrobe City Council (one site) Loy Yang Power Management (one site) Speedweb Wireless Internet (four sites) Diffraction effects: two turbines in exclusion zone for one Gippsland Water link, detailed information not available for other links Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	High risk of interference to one link operated by Gippsland Water Unlikely to cause interference to other links	Risk of interference to one link raised by Gippsland Water No concerns raised by AusNet Services, Aussie Broadband, EnergyAustralia Yallourn, ENGIE, Esso Australia, Latrobe City Council, Loy Yang Power Management, Southern Rural Water, and Speedweb Wireless Internet No response received from BoM – base station is believed to be associated with flood warning infrastructure, see findings for Latrobe Valley flood warning system	To be developed in consultation with Gippsland Water

Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Latrobe Valley flood warning system	May experience interference if signal paths cross the Project near turbines – detailed information about signal paths not available	Low risk of interference	No concerns raised by Latrobe City Council No response received from BoM – engagement is ongoing	If required – replace fixed links with alternative technologies
Other licence types	Mobile radio systems: unlikely to be affected Other point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	Unlikely to cause interference to mobile radio systems	Risk of interference to mobile radio systems raised by Gippsland Water No concerns raised by other stakeholders	Mobile radio systems: if required – increase signal strength from affected tower, install signal repeater, install additional tower
Emergency services	Point-to-point links: no links crossing boundary Mobile radio systems: unlikely to be affected	Unlikely to cause interference	No concerns raised	Point-to-point links: none required Mobile radio systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Unlikely to be affected	Unlikely to cause interference	No concerns raised	None required
Trigonometrical stations	Trigonometrical stations: unlikely to be affected Survey marks: unlikely to be affected	Unlikely to cause interference	No concerns raised	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage to the south and southeast, for Optus Mobile coverage, and to the south and west, for Vodafone coverage	Low risk of interference	No concerns raised	If required – increase signal strength from affected tower or alternative towers, install additional tower

Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Wireless internet	<p>Likely service providers: Aussie Broadband, Speedweb Wireless Internet, mobile phone networks</p> <p>NBN: currently available as a fixed wireless and satellite service, potential for interference to fixed wireless internet signals from the Boolarra NBN tower to up to five dwellings</p>	Low risk of interference to NBN fixed wireless internet signals	<p>No concerns raised by Aussie Broadband, Speedweb Wireless Internet, and mobile phone providers</p> <p>Low risk of interference raised by NBN Co, as there are currently no connected dwellings that would be impacted</p>	<p>Mobile phone networks: as for mobile phones</p> <p>NBN: if required – re-direct antenna to alternative tower, change location of antenna, install new tower</p>
Satellite television and internet	<p>Services designed for Australian audiences: unlikely to be affected</p> <p>Services designed for international audiences: signals from two satellites at low angles of elevation may be intercepted at nearby dwellings</p>	Low risk of interference to services designed for international audiences	<p>Consultation not with operators not considered necessary</p> <p>DNV GL recommends engaging with residents of potentially-affected dwellings</p>	<p>If required – re-direct satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish</p>
Radio broadcasting	<p>AM signals: unlikely to be affected</p> <p>FM signals: may experience interference in close proximity to turbines</p> <p>FM signals from nearby Kids FM transmission tower: may experience interference in areas with marginal reception</p> <p>Digital radio signals: not available in vicinity of Project</p>	<p>Low risk of interference to Kids FM radio broadcasts through obstruction of signals</p>	No concerns raised	<p>FM signals: if required – install higher-quality antenna, increase signal strength from affected tower, move tower to new location, install signal repeater, install additional tower</p>

Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception			
	<i>Boolarra tower: 'good' coverage in southeast, 'variable' to 'poor' coverage elsewhere</i>			
	266 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Churchill tower: 'variable' to 'poor' coverage across site</i>			
	244 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Jeeralang/Yinnar South tower: 'good' coverage in east, 'variable' to 'poor' coverage elsewhere</i>			
	268 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Latrobe Valley tower: 'variable' to 'good' coverage across the site</i>			
	191 dwellings in potential interference zone to the west and northwest	High risk of interference	High risk of interference for 20 residents, low risk of interference for 257 residents in areas with marginal coverage within the Project boundaries and to the northwest and southeast	Re-align antenna to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	<i>Melbourne tower: 'variable' to 'good' coverage in northwest, 'variable' to 'poor' coverage elsewhere</i>			
	849 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	Not considered	
	<i>Newborough tower: 'good' coverage in north, 'variable' to 'poor' coverage elsewhere</i>			
	266 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Trafalgar/Yarragon tower: 'variable' to 'good' coverage in northwest, 'poor' coverage elsewhere</i>			
	863 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	

1 INTRODUCTION

Delburn Wind Farm Pty Ltd (“the Customer”) has commissioned DNV GL to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Delburn Wind Farm (“the Project”) in southeastern Victoria. The results of this work are reported here. This document has been prepared in accordance with DNV GL proposal L2C-178219-AUME-P-01 Issue A, dated 1 February 2019, and is subject to the terms and conditions in that agreement.

In accordance with the Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (Victorian Guidelines) prepared by the Department of Environment, Land, Water and Planning (DELWP) in March 2019 [1] and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [2], this assessment investigates the potential EMI impact of the Project on:

- fixed point-to-point links
- fixed point-to-multipoint links
- radiocommunication assets belonging to emergency services
- meteorological radars
- trigonometrical stations
- Citizen’s band (CB) radio and mobile phones
- wireless internet
- satellite television and internet
- broadcast radio and television.

“Radiocommunications” is used as a broad term in this report to encompass all services that rely on microwave or radio frequency electromagnetic waves to transfer information, including those listed above.



2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The proposed Project site is located in southeast Victoria, approximately 8 km south of Moe and 125 km southeast of Melbourne. The site is located within a radiata pine plantation situated on rolling hills either side of the Strzelecki Highway.

2.2 The project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 33 wind turbines [3]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 8.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Customer [4]. For the purposes of this assessment, DNV GL has considered all identified dwellings within 5 km of the Project site boundaries. The dwellings and site boundaries considered in this assessment are shown in Figure 1.

DNV GL has not carried out a detailed and comprehensive survey of building locations in the area and is relying on information provided by the Customer. For the purposes of this assessment, DNV GL has assumed that all identified dwellings are potential inhabited residential locations.

3 REGULATORY REQUIREMENTS

There are two sets of guidelines that are potentially relevant to the assessment of EMI impacts for wind farms in Victoria.

The Victorian Guidelines [1] state that *"a wind energy facility can affect the amenity of the surrounding area due to ... electromagnetic interference"* and that *"[t]he potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting"*.

Although the Victorian Guidelines state that *"potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, [and] turbine design and location"* they do not provide detailed methodologies for these assessments.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [2]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development.

In relation to EMI, the Draft National Guidelines provide advice and methodologies to identify likely affected parties, assess EMI impacts, consult with affected parties and develop mitigation steps to address the likely EMI impacts.

DNV GL considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the Victorian Guidelines. Therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 METHODOLOGY AND RESULTS

If not properly designed, wind farms have the potential to interfere with radiocommunication services. Two services that are most likely to be affected are television broadcast signals and fixed point-to-point signals. Terrestrial broadcast signals are commonly used to transmit domestic television, while point-to-point links are used for line-of-sight connections for data, voice, and video. The interference mechanisms are different for each of these and, hence, there are different ways to avoid interference.

Delburn EMI has asked DNV GL to complete this assessment based upon a layout provided for the Project consisting of 33 wind turbines, as outlined in Table 8.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 180 m and a tip height of 250 m has been considered. These dimensions represent the maximum tip height and rotor diameter under consideration for the Project. The results generated based on this turbine configuration will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying all of the following criteria:

- a rotor diameter of 180 m or less
- an upper tip height of 250 m or less.

The Draft National Guidelines recommend that a radial distance of 50 km to 60 km from the centre of a wind farm would normally capture all of the potentially affected services in the area. However, the methodology for assessing the potential radiocommunications interference used in this assessment is to locate all of the radiocommunication towers within approximately 75 km of the proposed Project site, and then assess the radiocommunication licences attached to these towers. This reduces the likelihood that radiocommunication links crossing the site are inadvertently excluded from the assessment.

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from an image of the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 7 May 2020 [5].

Other services with the potential to experience interference from the Project have also been identified, and the potential for interference to those services discussed, including meteorological radars, trigonometrical stations, CB radio and mobile phones, wireless internet, broadcast radio, satellite television and internet, and broadcast television.

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a radiocommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV GL has consulted with organisations operating services that may be impacted by the development and operation of the Project, to disseminate basic information on the Project and request feedback regarding whether they foresee any potential EMI-related impacts on their operations and services. The organisations that have been contacted and all responses received to date are summarised in Table 16.

The radiocommunication licences and services with potential to experience EMI-related impacts from the proposed Project are considered separately in the following sections. Each section contains a brief overview of the relevant technology, followed by an assessment of the identified licences and services in the area around the Project and the expected potential for interference.

Details of any feedback obtained from the service operators and potential mitigation options are also included where appropriate.

4.1 Radiocommunication towers

Wind turbines located close to radiocommunication towers have the potential to cause interference through near-field effects or reflection or scattering of the signals. According to the Draft National Guidelines [2], the near-field zone for a transmission tower can vary from several metres to approximately 720 m depending on the service type. The Draft National Guidelines therefore recommend that any radiocommunication site within 1 km of a proposed turbine location be considered as having the potential to be impacted by near-field effects. The potential for a turbine to cause reflection or scattering of signals also depends on a number of factors, including the service type, the required signal-to-noise ratio for the service, and the distances between the user, transmission tower, and turbine. Since there is no single criterion for potential impact on radiocommunication services due to near-field effects and reflection or scattering, the Draft National Guidelines recommend consulting with the service operator if any turbine is to be located within 2 km of a radiocommunication site.

4.1.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 1031 radiocommunication towers within a nominal 75 km of the Project site boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 2.

There is one radiocommunication tower located within 2 km of the proposed turbine locations (site ID 47336). This tower is a commercial FM radio broadcasting tower operated by BAI Communications on behalf of Southern Cross Austereo Group, as shown in Table 1. The location of the tower and the consultation zones recommended by the Draft National Guidelines [2] are shown in Figure 3. The potential for interference to FM radio broadcasting services is discussed further in Section 4.14.2.

Table 1 Details of radiocommunication towers located within 2 km of turbines at the proposed Project

Site ID	Associated licence types	Operator	Distance to nearest turbine [m]
47336	Broadcasting (narrowcasting)	BAI Communications (Kids FM, Latrobe Valley 91.9 MHz)	1936

There is another radiocommunication tower located 2001 m from the nearest proposed turbine location (site ID 9023463). This tower is an NBN fixed wireless internet tower operated by NBN Co. Although this tower is nominally outside the 2 km consultation zone recommended by the Draft National Guidelines [2], its location and the corresponding consultation zones are also shown in Figure 3. The potential for interference to NBN wireless internet signals is discussed further in Section 4.12.

4.1.2 Stakeholder consultation and responses

DNV GL has contacted the operator of the services associated with the tower shown in Table 1, BAI Communications, to determine the likelihood that the proposed Project will cause interference to their services through near-field effects or reflection or scattering of signals. As discussed in Section 4.14.2, BAI Communications has advised that they do not expect the Project to cause any noticeable interference to their FM radio services and has not expressed any concerns regarding the proximity of the turbines to this tower.

DNV GL has also contacted NBN Co to seek their feedback on the likelihood of interference to the signals associated with their fixed wireless internet tower located near the Project. As discussed in Section 4.12, NBN Co has advised that there is a low risk of interference to NBN fixed wireless signals received at dwellings in the vicinity of the Project but has not expressed any concerns regarding the proximity of the turbines to this tower.

4.2 Fixed licences of point-to-point type

Point-to-point links are often used for line-of-sight connections for data, voice, and video. Such links often exist on mobile phone and television broadcast towers. The frequency of common microwave signals varies from approximately 1 GHz to 30 GHz.

Wind turbines can potentially cause interference to point-to-point microwave links and, in some cases, point-to-point ultra high frequency (UHF) links through three mechanisms: diffraction of the signal, reflection or scattering of the signal, and near-field effects. It is generally possible to design around these issues as the link paths and potential interference zones for these signals can be determined.

4.2.1 Locations of point-to-point links and potential for interference

DNV GL has analysed the registered licences for each radiocommunication tower according to the ACMA RRL database to determine the transmission paths of licenced links that may experience interference from wind turbines. For this analysis, DNV GL has used a wider and more conservative frequency range of 0 GHz to 50 GHz.

Each individual link was given a unique identifier or "Assignment ID" so that it could be readily distinguished. This Assignment ID was taken as either the Device Registration ID (for spectrum licences associated with the use of certain frequency band within a particular geographic area) or the EFL ID (for apparatus licences associated with the use of a particular device).

The links paths associated with the analysed towers are shown in Figure 4. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some emergency services towers.

There are six point-to-point links recorded in the ACMA RRL database that pass over the proposed Project site. The details of the links and operators are provided in Table 9, and the link paths are shown in greater detail in Figure 5 based on information obtained from the ACMA RRL database, provided by the link operators, and extracted from satellite imagery.

4.2.1.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [2] [6] [7], typically defined in terms of the

Fresnel zones for the link. The n th Fresnel zone is comprised of all points for which, if the signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n - \lambda}{2}$, where λ = wavelength.

The radius of the n th Fresnel zone varies along the length of the signal, and is given by:

$$R_{Fn} = \sqrt{\frac{n\lambda d_1 d_2}{D}}$$

where d_1 is the distance from the transmitter

d_2 is the distance from the receiver

D is the distance from the transmitter to receiver, such that $d_1 + d_2 = D$

To avoid interference to point-to-point links caused by signal diffraction, wind turbines, including the blades, should be kept outside of an exclusion zone based on either the second Fresnel zone as recommended in [6], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [8] (although DNV GL understands that this zone is under review by the authors of that document). For each of the links crossing the proposed Project site, DNV GL has established a diffraction exclusion zone based on the second Fresnel zone for that link.

It is common practice to have multiple Assignment IDs for the same physical link to cover practicalities such as licensing for sending or receiving signals. Accordingly, the second Fresnel zone for each link has been calculated based on the Assignment ID with the lowest frequency.

The potential diffraction exclusion zones in the horizontal plane are shown in Figure 5. Each exclusion zone includes the rotor radius for turbines with a 180 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer for each link is based on the deviations between the tower locations provided by the link operators and the apparent locations determined from satellite imagery.

DNV GL has also assessed the potential for the turbine blades to intersect with the diffraction exclusion zone for each point-to-point link in the vertical plane. This was achieved by examining the elevation and antenna heights at the end of each link, as well as the approximate elevation of areas within the Project boundaries over which the link crosses.

The results of this analysis are summarised in Table 2.

There is one turbine located within the exclusion zone in the horizontal plane for the point-to-point link operated by VerTel. However, this link passes over the Project at a height that is well above the maximum proposed turbine tip height of 250 m. Consequently, the diffraction exclusion zone established by DNV GL for this link is clear of the turbine blades in the vertical plane. As discussed in Section 4.2.2, DNV GL has contacted VerTel to confirm that they do not expect the Project to cause any interference to their link.

There are no turbines located within the diffraction exclusion zones in either the horizontal or vertical plane for any other point-to-point links. Therefore it is not expected that the Project will cause interference to the point-to-point links through diffraction of the signals.

Table 2 Details of turbines located within the diffraction exclusion zones established by DNV GL for point-to-point links crossing the proposed Project site

Link no.	Operator	Turbines within diffraction exclusion zone	
		Horizontal plane	Vertical plane
1	AusNet Transmission Group Pty Ltd (AusNet Services)	None	None
2	Central Gippsland Region Water Corporation (Gippsland Water)	None	None
3	Digital Distribution Australia Pty Limited	None	None
4	Optus Mobile Pty Limited	None	None
5	Optus Mobile Pty Limited	None	None
6	Vertical Telecoms Pty Limited (VerTel)	T21	None, zone passes over turbines

4.2.1.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a wind turbine will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [6].


Reference [6] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a wind turbine at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and wind turbine, and comparing this to the required C/I ratio, a potential interference zone can be defined.

DNV GL has assessed that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid reflection or scattering effects and so it is not expected that the Project will cause interference to the point-to-point links through this mechanism.

4.2.1.3 Interference caused by near-field effects

The potential for interference to fixed point-to-point links caused by near-field effects can generally be avoided by keeping clear of the near-field zone for the transmitting or receiving antenna. Within the near-field zone, local inductive and capacitive effects are significant and it is difficult to predict the potential impacts of other objects on the transmitted or received signal. Although the near-field distance typically varies with direction relative to the link path, for most practical purposes the near-field zone can be approximated as a sphere centred on the transmitting or receiving antenna.

Reference [6] presents an equation for estimating the radius of the near-field zone for a point-to-point link from the properties of the transmitting or receiving antenna.



DNV GL has assessed that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid near-field effects and so it is not expected that the Project will cause interference to the point-to-point links through this mechanism.

4.2.2 Stakeholder consultation and responses

DNV GL has contacted the operators of the point-to-point links crossing the proposed Project site to determine the likelihood that the proposed Project will cause interference to their operations and services through diffraction, reflection or scattering, or near-field effects.

No concerns were raised by AusNet Services, Digital Distribution Australia, Optus Mobile, or VerTel. Based on a preliminary turbine layout, Gippsland Water noted the potential for turbines at the Project to interfere with their point-to-point links. The turbine layout was then modified by the Customer in response to these concerns, based on the feedback received from Gippsland Water. DNV GL has considered the modified turbine layout in this assessment, and believes that this layout addresses the concerns raised by Gippsland Water and is unlikely to interfere with their links. Details of the current turbine layout and DNV GL's conclusion that impact is unlikely have been provided to Gippsland Water, and no further concerns have been raised.

To avoid any risk of interference to their point-to-point links, AusNet Services, Digital Distribution Australia, Optus Mobile, and VerTel asked that specific clearances be maintained with respect to those links. While Gippsland Water did not request a specific clearance distance for their point-to-point links, they acknowledged the second Fresnel zone exclusion zones established by DNV GL. The requested clearances are summarised in Table 3.

The clearance requested by AusNet Services is the same as the diffraction exclusion zone applied by DNV GL, and is shown in Figure 5 and discussed in Section 4.2.1.1.

The clearances requested by Digital Distribution Australia, Optus, and VerTel in the horizontal plane are shown in Figure 6. In each case the clearance zones shown in Figure 6 include the rotor radius for turbines with a 180 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations, as described in Section 4.2.1.1. DNV GL has also assessed the potential for the turbine blades to intersect with the point-to-point link clearances requested by Digital Distribution and VerTel in the vertical plane.

The results of the analysis based on the requested clearance zones are also summarised in Table 3.

There is one turbine located within the requested clearance zone in the horizontal plane for the point-to-point link operated by VerTel. However, as discussed in Section 4.2.1.1, this link passes over the Project at a height that is well above the maximum proposed turbine tip height and so the requested clearance zone is clear of the turbine blades in the vertical plane. This advice has been provided to VerTel, and VerTel has confirmed that they do not expect turbines at the Project to interfere with their point-to-point link.

There are no turbines located within the requested clearance zones in either the horizontal or vertical plane for any other point-to-point links. Therefore DNV GL considers that the current turbine layout satisfies the clearances specified by the operators of the point-to-point links crossing the Project site, and is unlikely to cause interference to those links.

Table 3 Details of turbines located within the clearance zones requested by the operators for point-to-point links crossing the proposed Project site

Link no.	Operator	Requested clearance zone	Turbines within requested clearance zone	
			Horizontal plane	Vertical plane
1	AusNet Transmission Group Pty Ltd (AusNet Services)	Second Fresnel zone, or reduce turbine tip height to 180m	None	None
2	Central Gippsland Region Water Corporation (Gippsland Water)	None requested	-	-
3	Digital Distribution Australia Pty Limited	Third Fresnel zone	None	None
4	Optus Mobile Pty Limited	30 m from link path in horizontal plane	None	-
5	Optus Mobile Pty Limited	30 m from link path in horizontal plane	None	-
6	Vertical Telecoms Pty Limited (VerTel)	First Fresnel zone plus 15 m buffer	T21	None, zone passes over turbines

4.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of the point-to-point type. The difference between them is administrative. A point-to-point licence permits communication between two static sites, where the locations of the sites are detailed in the ACMA RRL database. A point-to-multipoint licence allows communication between one or more static sites and multiple points or between the points, and is usually registered for a defined operational area.

Administratively, the ACMA RRL database details the location of the static station for a fixed licence of the point-to-multipoint type but does not include the remote stations that communicate with the static station. Hence, the paths of the transmission vectors are not readily identifiable.

4.3.1 Locations of point-to-multipoint licences and potential for interference

From the ACMA RRL database, DNV GL has identified 204 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project site. These licences are shown in Figure 7. The details of the licence holders as given in the ACMA RRL database are provided in Table 10.

There are 20 point-to-multipoint base stations within 20 km of the Project boundary. There are also several point-to-multipoint base stations located more than 20 km from the site.

Wind turbines can cause interference to point-to-multipoint links through the same mechanisms as described for point-to-point links in Section 4.2.1. However, as it is not possible to know the link paths in a point-to-multipoint network without obtaining further information about the locations of each station in the network, consultation with the relevant operators is needed to determine the potential for interference.

4.3.2 Stakeholder consultation and responses

DNV GL has contacted the operators of all potentially-affected point-to-multipoint base stations within 60 km of the Project to determine the likelihood that the proposed Project will cause interference to their services.

No concerns were raised by AusNet Services, Aussie Broadband, ENGIE, Esso Australia, Loy Yang Power Management, Southern Rural Water, Speedweb Wireless Internet, or Latrobe City Council.

EnergyAustralia Yallourn has indicated that they do not expect the Project to cause interference to their point-to-multipoint links during operation, but that there may be potential for impact from radiocommunication equipment used during the construction of the Project. DNV GL recommends that the Customer informs EnergyAustralia of the relevant details regarding radiocommunication equipment to be used during construction, as requested, so that EnergyAustralia can review the potential for interference and advise on any actions that should be taken to avoid impact.


Based on a preliminary turbine layout, Gippsland Water noted the potential for turbines at the Project to interfere with their point-to-multipoint links. The turbine layout was then modified by the Customer in response to these concerns, based on details of the station locations and link paths for the point-to-multipoint network provided by Gippsland Water. Subsequent feedback received from Gippsland Water identified a new point-to-multipoint link with the potential to be impacted by turbines at the Project. DNV GL has considered the modified turbine layout and all of the point-to-multipoint link paths provided by Gippsland Water in this assessment.

From the information provided by Gippsland Water, DNV GL has identified 19 point-to-multipoint links associated with the Gippsland Water Moe South base station that pass over the proposed Project site. For each of the Gippsland Water point-to-multipoint links crossing the Project boundary, DNV GL established a diffraction exclusion zone based on the second Fresnel zone for the lowest frequency of that link as described in Section 4.2.1.1 for fixed point-to-point links. The potential for the turbine blades to intersect with the diffraction exclusion zones in both the horizontal and vertical planes was then assessed. Each interference zone included an additional buffer to account for potential inaccuracies in the station locations in the horizontal plane.

Based on this analysis, there are two turbines located within the diffraction exclusion zone established by DNV GL for one of the Gippsland Water point-to-multipoint links passing over the proposed Project site. Therefore, it is possible that the Project will cause interference to that link through diffraction effects. Gippsland Water has confirmed that there is a risk of interference to their point-to-multipoint link but has advised that they believe mitigation options exist, as outlined in Section 4.3.3 below.

The stations for all of the Gippsland Water point-to-multipoint links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid reflection, scattering, or near-field effects and so it is not expected that the Project will cause interference to the point-to-multipoint links through these mechanisms.

Through the consultation process, Latrobe City Council advised that their point-to-multipoint licences are repeater stations for a flood warning system in the region around the proposed Project. The potential for interference to the Latrobe Valley flood warning system is discussed in further detail in Section 4.4, although DNV GL notes that feedback received from Latrobe City Council indicates that they do not expect the Project to cause interference to this system.



Feedback has not yet been received from the Bureau of Meteorology (BoM) regarding their point-to-multipoint licences in the vicinity of the Project, including the licence located within 20 km of the Project boundary. However, DNV GL notes that this licence operates at a frequency of 151.5 MHz and is also likely to be associated with the Latrobe Valley flood warning system. As discussed in Section 4.4, DNV GL considers that there is a relatively low risk of interference to flood warning systems operating at this frequency. DNV GL is continuing to engage with the BoM to determine the nature of their operations, and to establish an understanding of how any impact to their point-to-multipoint licences may be mitigated.

4.3.3 Mitigation options

Since there is a high risk of interference with one of the point-to-multipoint links operated by Gippsland Water, DNV GL understands that the Customer is working with Gippsland Water to design a mitigation solution and has committed to implementing that mitigation at their own cost.

Gippsland Water has advised that they believe mitigation options exist for any potential impacts to their point-to-multipoint link, and that they are willing to work with the Customer to develop and implement an appropriate mitigation solution.

4.4 Latrobe Valley flood warning system


Through the consultation process, Latrobe City Council advised that they operate a flood warning system in the region around the proposed Project in conjunction with the BoM. DNV GL understands that this system consists of a network of monitoring stations that measure rainfall and river height data, then transmit that data in real time to the Latrobe City Council, Victorian State Emergency Service (VICSES), and BoM Flood Warning Service [9] [10].

Surface water monitoring data for rivers and streams in the area around the Project is also available through the Water Measurement Information System (WMIS) administered by the Department of Environment, Land, Water and Planning (DELWP) [11], although DNV GL has been unable to establish whether this data is recorded by the same monitoring stations as those operated by Latrobe City Council. Advice received from the DELWP indicates that the data available through the WMIS is collected by the BoM, local councils, and state water authorities, and that the DELWP does not operate any flood monitoring infrastructure of their own.

The Latrobe Valley flood warning system currently uses VHF radiocommunication signals at a frequency of 151.5 MHz to transmit the recorded data. Data is usually transmitted on an hourly basis, although the rate of data transfer may be greater in situations where the river heights are increasing or decreasing rapidly. However, DNV GL understands that other systems in the BoM flood warning network and WMIS, particularly those located in remote areas, have been configured to transmit data using mobile internet or satellite communication technologies.

4.4.1 Locations of monitoring stations and potential for interference

According to Latrobe City Council, the flood warning system comprises approximately 20 remote monitoring stations with repeater stations at Jeeralang and Mt Tassie, which are registered with ACMA as point-to-multipoint base stations as discussed in Section 4.3. Based on advice from Latrobe City Council, DNV GL believes that the point-to-multipoint base station operated by the BoM in the vicinity of the Project may also be associated with the flood warning system, although this has not yet been confirmed by the BoM. DNV GL understands that the remote monitoring stations near the Project include sensors located at Moe South, Thorpdale Peak, Thorpdale, Yarragon South, Traralgon, and Traralgon South. However, the exact locations of the monitoring



stations and the associated radiocommunication links could not be confirmed by Latrobe City Council.

Interference to the VHF links associated with the Latrobe Valley flood warning system may occur through either diffraction of the signals, reflection or scattering of the signals, or near-field effects. In the absence of further information about the link paths, DNV GL has not been able to establish potential interference zones for these links. However, considering the low frequency of the links and the relatively low rate of data transfer, DNV GL acknowledges that there is some uncertainty around whether interference will occur during normal operation. Although it is likely that the radiocommunication links associated with the flood warning system will cross the proposed Project site, based on the relative locations of the remote monitoring stations and the repeater stations, DNV GL considers that there is a relatively low risk of interference to the system.

4.4.2 Stakeholder consultation and responses

DNV GL has contacted Latrobe City Council and the BoM to obtain further information about the Latrobe Valley flood warning system and the potential for the Project to interfere with the operation of that system.

Feedback received from Latrobe City Council indicates that they do not expect turbines at the Project to interfere with the operation of the flood warning system, since the signals are able to operate without a clear line of sight and do not transmit data continuously. Discussions with the BoM are ongoing, and specific feedback regarding the potential for the Project to interfere with their flood warning systems has not yet been received.

4.4.3 Mitigation options

Although the feedback received from Latrobe City Council indicates that interference to the Latrobe Valley flood warning system is unlikely, DNV GL understands that the Customer has committed to implementing any necessary mitigation at their own cost if interference to the system is attributed to the Project after construction. If interference is experienced, mitigation options could include replacing the existing VHF links with either mobile internet or satellite communication technologies. DNV GL understands that these technologies are currently in use at other monitoring stations in the BoM flood warning network and DELWP WMIS.

DNV GL is continuing to engage with the BoM to seek feedback on the potential for interference with their flood warning infrastructure, and how any impacts may be mitigated.


4.5 Other licence types

Besides fixed point-to-point and point-to-multipoint licences, other licence types recorded in the ACMA RRL database include spectrum licences that permit a range of radiocommunications in a specific geographic area and frequency band, private mobile radio and public telecommunications service (PTS) licences, television and radio broadcasting licences, amateur apparatus licences, and aeronautical licences for ground to aircraft communications.

4.5.1 Locations of other licences and potential for interference

DNV GL has identified a number of other licences in the ACMA RRL database within 75 km of the proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 8 and Table 11.

Most of the licences identified can be broadly described as base to mobile station or point-to-area style communications, including commercial and private mobile telephony and radio and television



broadcasting. These licence types are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation, and other forms of signal obstruction.

The potential for interference to emergency services signals and commercial mobile telephony signals is discussed further in Sections 4.6 and 4.11 respectively, while the potential for interference to radio and television broadcasting services is considered in Sections 4.14 and 4.15.

A number of aeronautical licences, and radiodetermination licences which may be used for aircraft navigation, have been identified. DNV GL understands that potential impacts to these services will be considered as part of an aviation impact study.

4.5.2 Stakeholder consultation and responses

Feedback received from the operators of emergency services signals, commercial mobile phone services, FM radio broadcasting services, and television broadcasting services is summarised in Sections 4.6.2, 4.11.2, 4.14.2.2, and 4.15.2 respectively. DNV GL has not explicitly contacted the operators of other point-to-area style communications in the vicinity of the Project, due to the relatively low risk of interference to these services.

However, through the consultation process, Gippsland Water raised concerns about the potential for turbines at the Project to interfere with digital mobile radio (DMR) signals from their radiocommunications tower at Moe South (site ID 9011755, Gippsland Water Site, Moe South Road, Moe South). The Gippsland Water tower is located approximately 4.1 km from the Project boundary and 3.7 km from the nearest turbine.

As noted above, mobile radio systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction. Reference [8] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts to these systems. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for point-to-area style services [12].

Given the distance of the Gippsland Water tower from the Project, DNV GL considers it unlikely that the Project will cause interference to DMR signals from that tower. This advice has been provided to Gippsland Water, who have acknowledged the advice and noted that it will not be possible to determine the extent of any impacts until after construction of the Project.

4.5.3 Mitigation options

Although interference with the DMR system operated by Gippsland Water is considered unlikely, DNV GL understands that the Customer has committed to returning this service to at least pre-construction quality at their own cost if interference is attributed to the Project after construction. Gippsland Water has also advised that they are willing to work with the Customer to develop and implement an appropriate mitigation solution, if mitigation is required.

If localised interference to DMR signals is experienced, this can often be mitigated by the user moving a short distance to a new or higher location to receive a clearer signal or by using an external antenna to improve the signal reception. Other mitigation options may include increasing the signal strength from the Gippsland Water Moe South tower, or installing a signal repeater or additional tower on the opposite side of the Project.

4.6 Emergency services

Licence types operated by emergency services, such as state ambulance, police, fire, and rescue services, typically comprise fixed point-to-point links and mobile radio communications.

4.6.1 Locations of emergency services licences and potential for interference

DNV GL has reviewed the ACMA RRL database to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 12 along with their contact details. The nearest licence is associated with a tower located approximately 2 km from the site boundary.

There are no emergency services point-to-point links crossing the proposed Project site, and so there is no potential for interference with point-to-point licences operated by emergency services.

All other licences operated by emergency services in the vicinity of the Project are mobile telephony licences used for mobile radio and paging systems. As discussed in Section 4.5, mobile telephony systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction, and so DNV GL considers that these services are unlikely to be affected by the Project.

4.6.2 Stakeholder consultation and responses

DNV GL has contacted the operators of all potentially-affected stations within approximately 60 km of the Project to seek feedback regarding any potential impact that the Project could have on their operations and services. Responses have been received from all of the operators contacted, and no concerns have been raised.

4.6.3 Mitigation options

As noted above, there is no risk of impacts to point-to-point links operated by emergency services, and interference with mobile telephony services is considered unlikely. If localised interference to mobile radio or paging system signals is experienced, this can often be mitigated by the user moving a short distance to a new or higher location to receive a clearer signal or by using an external antenna to improve the signal reception. Other mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower.


4.7 Aircraft navigation systems and radar

DNV GL understands that a separate aviation impact study will be undertaken to assess the impact of the Project on nearby aviation navigation systems and radar.

4.8 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather radars across Australia consisting of high-resolution Doppler radars and standard weather watch or weather surveillance radars. Operation of the BoM's part-time wind finding radar installations ceased in August 2019 [13].

Standard weather watch radars emit pulsed microwave radiation and use reflections or "echoes" of that radiation from water particles in the atmosphere to detect rain and storm activity. Doppler radar installations operate in the same way but are also able to measure the speed of the moving water particles, and therefore can provide information about wind speed and direction [14] [15].



While the uninhibited operation of meteorological radars may not be as critical as aviation radar, there are implications for public safety if severe weather is not predicted or if its approach is masked due to EMI. Because radar installations monitor the current weather situation over a wide area, the information they provide can be used to indicate the possibility and approach of severe storms, tropical cyclones, and flooding events. Wind profile measurements are also used to ensure the safe and economical operation of aircraft and provide an important source of data for the BoM's general weather forecasting system.

The optimal coverage area for a weather radar generally extends approximately 200 km from the radar installation at a height of around 3000 m [16] [17], and approximately 100 km at a height of 1000 m [17]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high risk of interference to the radar signal and subsequent loss of weather data [18]. For wind farms located within 20 km of a radar, the WMO recommends consultation and analysis be undertaken to assess the likelihood of turbines interfering with the radar signals or Doppler velocity measurements. Similarly, the Network of European Meteorological Services (EUMETNET) recommends that, to avoid potential for interference, wind turbines should not be located within 5-10 km of a meteorological radar, depending on the antenna frequency band, and that an impact study should be undertaken for wind turbines located within 20-30 km of a radar site [19].

According to the Draft National Guidelines, operators of weather radars within 250 nautical miles (463 km) of the proposed Project should be consulted [2].

4.8.1 Locations of meteorological radars and potential for interference

DNV GL has identified that the BoM operates eight weather radars within 250 nautical miles of the proposed Project with the closest radar, "Bairnsdale", located approximately 116 km northeast of the Project site or 119 km from the nearest wind turbine. The locations of these radars are shown in Figure 9 and the details of each radar can be found in Table 13.

It is not expected that the Project will cause interference with BoM radar installations, as, given the distance between the site and radar installations and the nature of the intervening terrain, it is likely that radar signals will be intercepted by terrain before they are able to be influenced by the Project.


4.8.2 Stakeholder consultation and responses

DNV GL has contacted the BoM regarding the Project, in accordance with the recommendations of the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely. A response has been received from the BoM, and no concerns have been raised.

4.9 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes.

Some trig points may host surveying equipment such as Global Positioning System (GPS) antennas and electronic distance measuring (EDM) devices. EDM devices measure the distance from the trig



point to the target object by means of a beam of known velocity which is reflected back to the unit from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed.

The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 km to 5 km, and could be intercepted or obstructed by the presence of turbines. However, the risk of impact is considered low as it is likely to be possible to relocate the target to obtain an unobstructed view of the trig point. Microwave systems can measure distances up to 150 km, but such systems are not limited by the line of sight or affected by visibility [20].

Global navigation satellite system (GNSS) technology is also commonly used for surveying and distance measurements, as it enables users to accurately determine their geographic location using positioning and timing information received from satellite signals. Geoscience Australia currently operates several GNSS networks across Australia, including the Australian Regional GNSS Network (ARGN) and the AuScope GNSS network [21]. The ARGN is comprised of 20 permanent GNSS Continuously Operating Reference Stations (CORS) which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Eight stations from the ARGN form the Australian Fiducial Network (AFN) [22], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country. In Victoria, the DELWP also operates a state-wide GNSS CORS network, known as GPSnet, which is used to provide geospatial data for mapping, surveying, agriculture, and industry [23]. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, or satellite communications.

4.9.1 Locations of trigonometrical stations and potential for interference


According to Geoscience Australia [24], there are 35 trig points within 20 km of the Project site boundary. The details of all 35 trig points are provided in Table 14 and illustrated in Figure 10. There are also 374 permanent survey marks within 5 km of the Project site boundary [25] as shown in Figure 11. The closest survey mark is located 178 m east of the nearest turbine (T09).

DNV GL has reviewed the primary geodetic network of Australia [26] and observed that the Project is located within the third-order triangulation region. First-order triangulation depends on trig points of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation are then used for the second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

The closest ARGN or AuScope GNSS station is located approximately 7 km northeast of the Project, at Yallourn [24]. Due to the distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network. The closest GPSnet GNSS station is also located approximately 7 km northeast of the Project at Yallourn [27].

4.9.2 Stakeholder consultation and responses

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV GL has contacted Geoscience Australia and the



DELWP to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

Both Geoscience Australia and DELWP have indicated that they do not expect turbines at the Project to interfere with their operations. However DELWP have also requested that any potential disturbance to survey marks be avoided during construction of the Project. DNV GL understands that all the identified survey marks are outside the proposed disturbance areas for the Project, and that the Customer will take the locations of these marks into consideration during development.

4.10 Citizen's band radio

Citizen's band radio, also known as CB radio, is a class-licensed two-way, short distance communication service that can be used by any person in Australia for private or work purposes. It is commonly used in rural areas for emergency communications, road safety information, communication between recreational travellers, and general conversation. The class licence implies that all users of the CB radio operate within the same frequency range on a shared basis and no individual licence is required.

The CB radio service can be used for voice communication activities, telemetry, and telecommand applications. The radio service operates on two frequency bands, namely the high frequency (HF) band between 26.965 MHz and 27.405 MHz and the ultra-high frequency (UHF) band between 476.425 MHz and 477.400 MHz.

The HF CB radio service was legalised in Australia in the 1970s as a temporary move to switch to UHF CB over the following five years, and transmits signals in either AM (amplitude modulation) or SSB (single side band) transmission mode. The actual range over which the signal is transmitted depends on the antenna used, the terrain, and the interference levels. Over the last decade, the use of the HF CB radio service has declined and has been replaced by UHF CB radio service.

The UHF CB radio service is unique in Australia and uses the FM (frequency modulation) transmission mode. It provides clear communication over 5–20 km and is less susceptible to power line noise. However, the UHF CB radio service requires a clear line-of-sight for a strong signal and is easily hindered by hilly terrain and forested areas. Even in the absence of physical obstructions, UHF CB radio signals generally cannot travel beyond the effective radio horizon, which depends on elevation, antenna height, weather, and atmospheric conditions. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. However, under normal conditions on flat ground, signal range is typically limited to around 5 km. CB repeater stations are often set up on hilltops by community groups and commercial organisations to transmit signals from one channel to another.

No individual or organisation owns or has the right to use a channel exclusively. However, out of the 40 channels available, some of them will be allocated to emergency, telemetry, or repeater inputs.

4.10.1 Locations of CB radio devices and potential for interference

Since users of CB radio services do not require a licence, there is no record of users of the service and their locations and the channels are shared among the users and the repeater stations without a right of protection from interference. Given the limitations of UHF radio signals, CB radio services are typically only intended for local or short-range communications. CB radio signals passing through the Project site are likely to be intercepted by existing obstructions such as terrain and vegetation, and there is little evidence in the literature to suggest that wind turbines pose a

particular risk of interference to these systems. Therefore, the impact of the Project on CB radio services is expected to be minimal.

4.10.2 Mitigation options

If interference to CB radio signals is experienced, simple steps such as moving a short distance to a new or higher location until the signal strength improves may help to mitigate the impact. CB radio users can also increase their signal range and improve reception by switching their equipment to a higher power setting, using a longer antenna, or increasing the antenna mounting height.

4.11 Mobile phones

Mobile phone networks typically operate at frequencies of either between 700 and 900 MHz, or between 1800 and 2600 MHz, however some new services may operate at up to 3500 MHz. At such frequencies, signals may be affected by physical obstructions such as buildings and wind turbines. However, mobile phone networks are designed to operate in such conditions and in most cases, if there is sufficient mobile network coverage and signal strength, the presence of wind turbines is unlikely to cause any interference.

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is theoretically possible that wind turbines could cause some interference to the signal. However, there is little evidence in the literature of wind turbines interfering with mobile phone signals, and DNV GL notes that previous advice received from mobile phone network operators in Australia has generally indicated that they do not expect wind farm developments to interfere with their services.

4.11.1 Availability of mobile phone services and potential for interference

DNV GL has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 12. The nearest mobile phone tower is located approximately 1.2 km southeast of the Project boundary.


Mobile phone network coverage maps have been obtained for Optus, Telstra, and Vodafone.

Figure 13 shows the Optus Mobile network coverage for the Project area [28]. Outdoor 4G Plus coverage is available in many areas around the Project site, but the network is either not available or limited to outdoor 3G coverage in areas across the west, south, and southeast.

Figure 14 shows the Telstra network coverage for the Project area [29]. Either 3G or 4G coverage is available across most of the Project site and surrounding area, although coverage is marginal or unavailable in some locations within the Project boundaries and to the south, southwest, and southeast of the site.

Figure 15 shows the Vodafone network coverage for the Project area [30]. Outdoor 4G coverage is available across most of the Project site and areas to the north and east, with several regions able to receive good indoor 4G coverage. However, coverage is limited to the 3G network in many locations to the west, south, and southeast, and there is marginal or no coverage in the southwest.

In general, for areas with good coverage, interference to mobile phone signals is unlikely. However, for areas where the reception is likely to be marginal, such as those where an external antenna is required, the possibility for interference exists if a wind turbine intercepts the signal between a mobile phone and the tower. This may be the case in areas to the south and southeast



of the site, for Optus Mobile coverage, and to the south and west of the site, for Vodafone coverage, as these locations are likely to be serviced by towers on the other side of the Project. Given the locations of the Telstra coverage areas and mobile phone towers in relation to the Project, the risk of interference to Telstra mobile phone services is considered very low.

4.11.2 Stakeholder consultation and responses

DNV GL has contacted Optus, Telstra, and Vodafone to inform them of the proposed Project and seek feedback on any potential impact that the Project could have on their services. The responses received from all three operators indicate that they do not have any concerns regarding potential impacts on their mobile services.

4.11.3 Mitigation options

Although the feedback received from the mobile network operators indicates that interference to their services is unlikely, DNV GL understands that the Customer has committed to returning mobile phone services to at least pre-construction quality at their own cost if interference to these services is attributed to the Project after construction.

If localised interference is experienced by mobile phone users, this can often be rectified by the user moving a short distance to a new or higher location until the signal improves, or using an external antenna to improve the signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing an additional tower on the opposite side of the Project.

4.12 Wireless internet

Wireless internet services in Australia include wireless broadband provided by mobile phone network operators and other internet service providers, and fixed wireless or satellite internet services through the National Broadband Network (NBN).

4.12.1 Wireless broadband services

Wireless broadband services allow the user to connect to the internet without the need for a phone line or cable connection. The wireless signals may operate by line of sight between a base station and the user's antenna as part of a point-to-multipoint network, or may use point-to-area style transmissions such as mobile phone networks.

4.12.1.1 Availability of wireless broadband and potential for interference

Aussie Broadband and Speedweb Wireless Internet hold point-to-multipoint licences in the vicinity of the Project, with the nearest base stations located 19 km northeast and 10 km north of the Project site respectively. As the locations of Aussie Broadband and Speedweb Wireless Internet customers are not known, it is not possible to determine whether there is the potential for interference to this service, however it is possible that stations at these distances may be servicing customers in the vicinity of the proposed Project.

Additionally, residents in the vicinity of the Project are likely to use wireless broadband services provided by Optus, Telstra, and Vodafone. These wireless broadband services use the same networks as mobile phone services for those providers, and therefore the comments made in Section 4.11 are applicable here. Specifically, there is a low theoretical risk of interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower, but the network operators have not expressed concerns regarding impacts on any of their services.

4.12.1.2 Stakeholder consultation and responses

DNV GL has contacted Aussie Broadband and Speedweb Wireless Internet to seek feedback regarding the potential for interference to their services. Responses have been received from both operators, and no concerns have been raised.

As discussed in Section 4.11.2, feedback received from Optus, Telstra, and Vodafone indicates that they do not have any concerns regarding potential impacts on their mobile services.

4.12.1.3 Mitigation options

Although the feedback received from the mobile network operators indicates that interference to their services is unlikely, DNV GL understands that the Customer has committed to returning wireless broadband services using mobile networks to at least pre-construction quality at their own cost if interference to these services is attributed to the Project after construction.

If interference to the wireless broadband services provided by mobile phone networks occurs, the mitigation options given in Section 4.11 may be applicable. Specifically, localised interference can often be rectified by the user moving a short distance or using an external antenna to improve signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower on the opposite side of the Project.

4.12.2 National Broadband Network

The NBN is a national wholesale broadband access network, which consists of fixed line, fixed wireless, and satellite internet services.


NBN fixed line services use wired connections to provide internet signals directly to the user. This technology is typically only available in urban areas and is not expected to be affected by wind farm developments.

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a maximum range of 14 km [31]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [32].

NBN satellite internet signals are available to rural and remote users in areas that are not able to receive fixed line or fixed wireless services. The potential for interference to satellite internet signals from the NBN Sky Muster I and II satellites is considered in Section 4.13.

4.12.2.1 Availability of NBN services and potential for interference

The National Broadband Network (NBN) website [33] indicates that the network is currently available as a fixed wireless service and satellite internet service using the NBN Sky Muster I and II satellites in the areas surrounding the Project site. It is therefore likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. The locations of NBN fixed wireless towers within 75 km of the Project site are shown in Figure 12, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 16. According to the NBN website [33], residents located outside the fixed wireless coverage areas shown in Figure 16 are being offered the NBN Sky Muster satellite service.



NBN towers servicing the Project area are located at Moe South in the north, Narracan in the northwest, Thorpdale in the west, Boolarra in the southeast, and Yinnar in the east. Given the relative positions of the NBN towers and nearby dwellings, and the fixed wireless coverage areas shown in Figure 16, there is potential for the Project to impact residents who may currently be receiving NBN fixed wireless internet signals.

DNV GL has assumed that all residential dwellings located within both (i) 100 m of the fixed wireless coverage areas shown in Figure 16 and (ii) 14 km of any NBN tower have the potential to receive wireless internet signals from that tower. The 100 m buffer was applied to account for potential inaccuracies in the wireless coverage map and the dwelling locations, and the possibility that the NBN antenna at any dwelling may be installed a short distance from the main building. The 14 km radius from the NBN towers is equal to the maximum signal range for NBN fixed wireless signals as described in Section 4.12.1.1 above. The locations of the corresponding dwellings are shown in Figure 16. It is noted that these dwellings have been identified using a desktop analysis only, and there is no publicly-available information regarding which residents are currently accessing the NBN fixed wireless service or which tower is servicing each dwelling.

If the signal path between an NBN tower and a dwelling is obstructed by a turbine, interference to that signal may occur. Given the maximum range of the NBN fixed wireless signals, the intervening terrain, and the locations of the NBN towers and dwellings, only signals from the Boolarra and Narracan NBN towers are likely to be affected. DNV GL has identified 36 dwellings to the west and southwest of the Project site that may be receiving wireless internet signals from the Boolarra or Narracan NBN towers and have potential to experience interference to those signals, based on their location relative to the Project. The coordinates of these dwellings are presented in Table 15.

For each of the signal paths between a potentially-affected dwelling and the corresponding NBN tower, DNV GL has established a potential interference zone based on the second Fresnel zone for the lowest frequency signal transmitted by the tower as described in Section 4.2.1.1 for fixed point-to-point links. Each interference zone includes the rotor radius for turbines with a 180 m rotor diameter, and an additional buffer of 25 m on either side to account for potential inaccuracies in the tower or dwelling locations. The potential interference zones are shown in Figure 16.

The turbines located within the potential interference zone for each signal path to a potentially-affected dwelling are summarised in Table 4 and Table 5 for the Boolarra and Narracan towers respectively. There are three turbines (T28, T30, T31) located within the potential interference zones for NBN fixed wireless signal paths from the Boolarra NBN tower to seven dwellings. There are no turbines in the potential interference zones for NBN fixed wireless signal paths from the Narracan NBN tower.

DNV GL has also carried out an assessment to determine whether each of the potentially-affected fixed wireless signal paths is clear of terrain obstructions and passes over the Project at a height that has potential to intersect with the turbine blades. This was achieved by examining the elevation and antenna heights at the NBN tower and the dwelling, as well as the approximate elevation of the areas over which the signal path crosses. The results of this assessment are also summarised in Table 4.

It was determined that the signal paths are clear of terrain for four of the seven potentially-affected dwellings, which suggests that these dwellings are likely to be receiving signals from the Boolarra NBN tower. The signal paths for these four dwellings also pass over the Project at a height that may intersect the rotor swept area for the turbines, which increases the potential for

interference. For two of the three dwellings for which the signal path is obstructed or potentially obstructed by terrain, however, the second Fresnel zone for the signal from the Boolarra NBN tower passes below the rotor swept area for the turbines and therefore is unlikely to be affected.

Based on this assessment, there are four dwellings in the vicinity of the Project that may experience interference to fixed wireless internet signals from the Boolarra NBN tower as a result of the Project (dwellings 45, 1220, 1221, 1222). Interference to fixed wireless internet signals from the Boolarra NBN tower is possible for one additional dwelling (dwelling 44), although analysis of the signal path from the NBN tower to this dwelling suggests that the signals may already be obstructed by terrain.

Table 4 Potential for impact to fixed wireless internet signals from the Boolarra NBN tower to dwellings in the vicinity of the Project

Dwelling ID	Turbines within interference zone	Line of sight of signal path ¹		Expected impact
		Relative to terrain	Relative to turbines	
44	T31	Potentially obstructed	Intersects rotor swept area	Potential for interference, but dwelling may not be receiving coverage
45	T31	Clear	Intersects rotor swept area	Potential for interference
46	None	-	-	Unlikely
62	None	-	-	Unlikely
63	None	-	-	Unlikely
64	None	-	-	Unlikely
67	None	-	-	Unlikely
68	None	-	-	Unlikely
93	None	-	-	Unlikely
94	None	-	-	Unlikely
95	None	-	-	Unlikely
764	None	-	-	Unlikely
765	None	-	-	Unlikely
766	None	-	-	Unlikely
795	None	-	-	Unlikely
796	None	-	-	Unlikely
811	None	-	-	Unlikely
826	T30	Obstructed	Passes below rotor swept area	Unlikely
827	None	-	-	Unlikely
828	None	-	-	Unlikely
829	None	-	-	Unlikely
830	None	-	-	Unlikely
832	T28	Potentially obstructed	Passes below rotor swept area	Unlikely

Table 4 Potential for impact to fixed wireless internet signals from the Boolarra NBN tower to dwellings in the vicinity of the Project (continued)

Dwelling ID	Turbines within interference zone	Line of sight of signal path ¹		Expected impact
		Relative to terrain	Relative to turbines	
1202	None	-	-	Unlikely
1203	None	-	-	Unlikely
1211	None	-	-	Unlikely
1220	T31	Clear	Intersects rotor swept area	Potential for interference
1221	T31	Clear	Intersects rotor swept area	Potential for interference
1222	T31	Clear	Intersects rotor swept area	Potential for interference
1450	None	-	-	Unlikely
4180	None	-	-	Unlikely
4181	None	-	-	Unlikely
4182	None	-	-	Unlikely
4184	None	-	-	Unlikely
4185	None	-	-	Unlikely
4534	None	-	-	Unlikely

1. Not assessed for signal paths with no turbines located within the potential interference zone.

Table 5 Potential for impact to fixed wireless internet signals from the Narracan NBN tower to dwellings in the vicinity of the Project


Dwelling ID	Turbines within interference zone	Line of sight of signal path ¹		Expected impact
		Relative to terrain	Relative to turbines	
826	None	-	-	Unlikely
827	None	-	-	Unlikely
828	None	-	-	Unlikely
829	None	-	-	Unlikely
830	None	-	-	Unlikely
831	None	-	-	Unlikely
832	None	-	-	Unlikely
4534	None	-	-	Unlikely

1. Not assessed for signal paths with no turbines located within the potential interference zone.

4.12.2.2 Stakeholder consultation and responses

DNV GL has contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps.

The response received from NBN Co indicates that they believe there is a low risk of interference to NBN fixed wireless internet signals received at dwellings in the vicinity of the Project. There are



currently no dwellings that are connected to the fixed wireless service for which the signal line of sight would be intercepted by a turbine at the Project. Although there are a number of dwellings in the coverage area that are not yet connected, including dwellings within the Project boundaries (dwellings 828 and 829), NBN Co have advised that most of these locations are likely to be serviced by a tower on the same side of the Project and therefore are unlikely to be affected.

4.12.2.3 Mitigation options

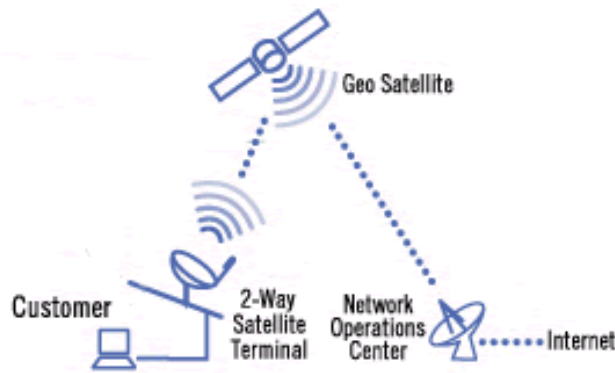
If interference to NBN fixed wireless signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available to improve the signal reception. NBN Co has advised that, in most instances where the signal line of sight from a given tower is obstructed, an alternative tower can be used to service the affected dwelling. If an alternative tower is not available, interference can usually be rectified by moving the outdoor antenna at the affected dwelling a short distance from the building, to a location where the signal is not impacted by the turbines, and connecting that antenna to the dwelling via a cable (described by NBN Co as a “non-standard install process” [34]). It may also be possible to avoid impact by micro-siting the turbines in some cases, or by installing a new NBN tower to service the affected dwellings. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

4.13 Satellite television and internet

In some rural or remote areas, television and internet access can only be provided through satellite signals.

Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. Satellite television signals are typically transmitted to the user’s antenna in one of two frequency bands: the C-band between 4 GHz and 8 GHz, or the Ku-band between 12 GHz and 18 GHz. Signals in the C-band are susceptible to interference due to radio relay links, radar systems, and other devices operating at a similar frequency. Signals in the Ku-band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. DNV GL understands that there are currently 20 satellites that can provide television to the east coast of Australia [35]. The main satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [36] [37].

In the case of satellite internet, the user’s computer is connected to a satellite modem which is in turn linked to a satellite dish or antenna mounted on the building roof. When the user accesses the internet, a request is sent to the operation centre of the satellite internet provider via the satellite antenna. Data is then sent back to the user’s computer via the same path as shown in the figure below. Satellite internet signals are typically transmitted in the Ku-band, as for satellite television, or the Ka-band, with frequencies ranging from 26.5 GHz to 40 GHz. Like signals in the Ku-band, signals in the Ka-band are susceptible to deterioration caused by moisture in the air, but newer satellites contain technologies that help to minimise the loss of signal quality associated with rain and other weather conditions. The main satellites for providing satellite internet in Australia are the IPSTAR (THAICOM-4) and Optus D2 satellites, and the NBN Sky Muster I and II satellites.



Two-way connection to the internet via satellite [38]

4.13.1 Locations of satellite vectors and potential for interference

Due to marginal coverage of some communication services, some residents in the vicinity of the Project may use satellite television and internet.

A number of satellites transmit television and internet signals that can be received in Australia. DNV GL has analysed the line of sight to dwellings in the vicinity of the Project for satellites which provide any television or internet services to eastern Australia. Although only a small number of satellites are likely to be providing services specifically intended for Australia, all theoretically viewable satellites have been considered.

The analysis has shown that television signals from the Eutelsat 70B and Apstar 7 satellites to a number of nearby dwellings may be intercepted by turbines at the Project. DNV GL understands that the programs transmitted by these satellites are designed for international audiences [39] [40]. At the Project site location, the approximate elevations of these satellites above the horizon are 2.8° and 7.3° respectively [41].

For the Eutelsat 70B satellite, all of the programs transmitted on the beam footprint that covers Australia are also available through other satellite services which have a higher angle of elevation above the horizon and are not expected to be intercepted by turbines at the Project [39] [42]. Satellite signals at low elevation angles are more likely to experience degradation caused by atmospheric effects or to already be intercepted by terrain and other obstacles than those received at higher angles of elevation. Therefore, given the extremely low angle of elevation of the Eutelsat 70B satellite and the availability of alternative signals for the same programming, DNV GL considers it unlikely that any residents in the vicinity of the Project will be receiving signals from this satellite.

However, DNV GL understands that many of the programs transmitted on the beam footprint for the Apstar 7 satellite that covers Australia are not available through other satellites that service Australia [40] [43]. Therefore, it is possible that some residents in the vicinity of the Project may be receiving signals from this satellite despite the low angle of elevation. The line of sight analysis described above suggests that signals from the Apstar 7 satellite to approximately 22 dwellings to the east of the Project may be intercepted by turbines. All of the potentially affected dwellings are within 3 km of the nearest turbine locations. DNV GL recommends that the Customer engages with these residents to determine if any are currently receiving signals from the Apstar 7 satellite, and to establish an understanding of how any impact to these services may be mitigated.

4.13.2 Mitigation options

If interference to satellite television signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available. If an alternative source of the same programming is available, the satellite dishes at affected dwellings can simply be re-directed to receive signals from the other satellite. In some cases, residents may also be able to access the affected programs directly over the internet. If an alternative source of programming is not available, it may be possible to rectify interference by installing a larger or higher-quality satellite dish, or by changing the height or location of the dish to obtain a stronger signal.

4.14 Radio broadcasting

Radio stations typically broadcast using one of two forms of transmission: either amplitude modulation (AM) or frequency modulation (FM). In Australia, AM radio operates in the medium wave (MW) band at frequencies between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency (VHF) band between 87.5 MHz and 108 MHz.

4.14.1 AM radio

AM radio signals are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also reflected or refracted by the ionosphere at night. This means that AM radio waves are able to travel significant distances under the right conditions. Due to their long wavelength, they can readily propagate around physical obstructions on the surface of the earth (such as wind turbines), however they do not propagate easily through some dense building materials such as brick, concrete, and aluminium.

The distance over which AM radio signals can travel means that the signal may be weak and susceptible to interference by the time it reaches a receiver. Some of the possible sources of interference to AM radio waves include changes in atmospheric conditions, signals from distant AM broadcasters operating on a similar frequency, electrical power lines, and electrical equipment including electric motors.


4.14.1.1 Locations of AM transmitters and potential for interference

The locations of AM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [44], and are shown in Figure 17.

As AM radio signals are able to propagate around obstructions such as turbines, it is expected that the Project will not cause significant interference for a receiver. Additionally, due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [45]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna or amplifier.

4.14.2 FM radio

FM radio signals are better suited to short range broadcasting. Unlike lower frequency signals (such as AM signals), they are not reflected or refracted off the ionosphere. The waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon, however they may be blocked by significant terrain features. FM radio stations therefore tend to have only local coverage, which means that signals are less susceptible to interference from distant FM broadcasters. FM signals are also less susceptible to interference from changes in atmospheric conditions and electrical equipment than AM signals.



FM radio signals are susceptible to interference from buildings and other structures, although they are less vulnerable than higher frequency signals. Interference to FM signals can occur by two mechanisms: reflection or scattering of the radio waves, or physical obstruction and attenuation of the broadcast signal.

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [46]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [45] [47].

Wind turbines located close to an FM transmission tower may also present a physical obstruction to the radio signal. If the line-of-sight between the tower and a radio receiver is blocked by a turbine, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [46]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmission tower [48].

4.14.2.1 Locations of FM transmitters and potential for interference

The locations of FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [44], and are shown in Figure 17.

The closest FM broadcast transmission tower is a Kids FM broadcast tower located adjacent to the proposed Project boundary, 1.9 km northeast of the nearest wind turbine (turbine T03) and within 4 km of six turbines (turbine T01, T02, T03, T04, T05, T06). Given the relatively small distance between the broadcast tower and the site, it is possible that the FM radio signals from this tower could be affected by physical obstruction from turbines at the Project. The location of the broadcast tower in relation to the Project and the sector in which physical obstruction of the signal may occur is shown in Figure 18. Since the transmission tower is located to the northeast of the proposed turbine locations, the potential interference sector extends to the southwest of the Project site. Residents within this zone, which includes the townships of Delburn, Boolarra, Mirboo, and Mirboo North and may extend as far as Koonwarra, Meeniyar, and Foster, may experience interference to Kids FM radio signals broadcast from this tower.

It is unlikely that any permanent FM radio receivers will be located sufficiently close to the Project to be affected by reflection or scattering of FM radio signals from the turbines.

4.14.2.2 Stakeholder consultation and responses

DNV GL has contacted the operator of the Kids FM broadcasting tower, BAI Communications, to seek feedback on whether interference to their broadcasting services is likely. BAI Communications has advised that, based on previous measurements of FM reception strength in the vicinity of wind farms, they do not expect turbines at the Project to interfere with FM radio services in the region, including signals from the Kids FM broadcasting tower. Although wind turbines can theoretically cause reflection or scattering of FM radio signals, BAI has indicated that any such effects are expected to be minor and would not noticeably affect the signal quality at the receiver.

4.14.2.3 Mitigation options

Although the feedback received from BAI Communications indicates that interference to their FM radio services is unlikely, DNV GL understands that the Customer has committed to returning FM radio services to at least pre-construction quality at their own cost if interference to these services is attributed to the Project after construction.

In the event that interference to FM radio signals is experienced, mitigation options may include installing high-quality antennas or amplifiers at affected dwellings, increasing the broadcast signal strength from the transmission tower, moving the tower to a new location further away from the turbines, or installing a signal repeater or additional tower on the opposite side of the Project.

4.14.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne, and Sydney [49]. Digital radio broadcasts in Australia operate in the VHF band at frequencies between 174 MHz and 230 MHz, and therefore tend to have only local coverage within the visual horizon.

4.14.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage map available on the ABC website [50], digital radio is not yet available in the Project region. Hence, while there are no digital radio broadcasts in the vicinity of the Project, no interference to digital radio signals is possible.

4.15 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in Australia are now digital broadcasts [44]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV GL has experience in situations where dwellings were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

The United Kingdom telecommunications regulator Ofcom [46] states the following with regard to interference to DTV reception:

"Digital television signals are much better at coping with signal reflections, and digital television pictures do not suffer from ghosting. However a digital receiver that has to deal with reflections needs a somewhat higher signal level than one that has to deal with the direct path only. This can mean that viewers in areas where digital signals are fairly weak can experience interruptions to their reception should new reflections appear... reflections may still affect digital television reception in some areas, although the extent of the problem should be far less than for analogue television."

DNV GL has drawn two conclusions from this report:

- Firstly, that DTV is very robust and does not suffer from ghosting. In most cases DTV signals are not susceptible to interference from wind farm developments.
- Secondly, that areas of weak DTV signal can experience interruptions to their reception should new reflections appear, such as those from nearby wind turbines.

For television broadcast signals, which are omni-directional or point-to-area signals, interference from wind turbines is dependent on many factors including:

- the proximity of wind turbines to the television broadcast tower
- the proximity of wind turbines to receivers (dwellings)
- the location of wind turbines in relation to dwellings and television broadcast towers
- the rotor blade material, rotor speed, and rotor blade direction (always into the wind)
- the properties of the receiving antenna (e.g., type, directionality, and height)
- the location of the television receiver in relation to terrain and other obstacles
- the frequency and power of the television broadcast signal.

4.15.1 Availability of DTV broadcasting and potential for interference

The locations of DTV broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [44], and are shown in Figure 17. The main DTV transmitter used by residents in the vicinity of the Project is the Latrobe Valley transmitter at Mt Tassie. However, according to the Australian Government mySwitch website [51], the area around the Project is also able to receive DTV signals from the Boolarra, Churchill, Jeeralang/Yinnar South, Melbourne, Newborough, and Trafalgar/Yarragon broadcast towers. Coverage maps for these broadcast transmitters are reproduced in Figure 19 to Figure 25.

4.15.1.1 Interference caused by large scale effects

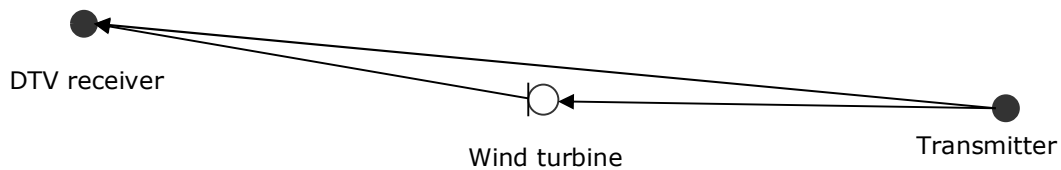
For DTV broadcast signals, large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay transmitters are more commonly found in rural areas. Primary transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay transmitters, while a clearance of at least 6 km is recommended for primary transmitters [7].

The closest DTV transmitter to the Project is the Boolarra relay transmitter, which is approximately 1.2 km from the Project boundary and 3.1 km from the nearest turbine, and there are no primary transmitters located within 6 km of the Project. Therefore, it is considered unlikely that the Project will cause large scale interference to the signals from these transmitters.

4.15.1.2 Interference caused by forward and back scatter

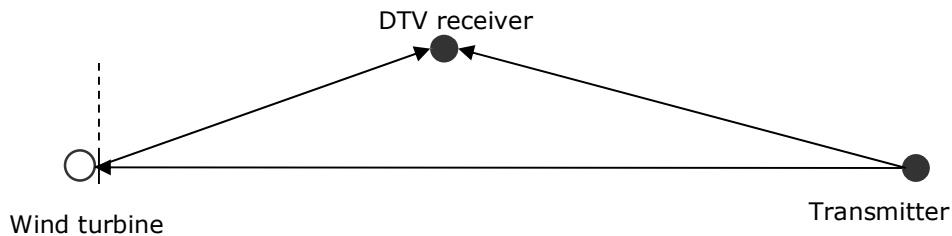
Wind turbines can cause interference to DTV signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A wind turbine has the potential to scatter electromagnetic waves carrying DTV signals both forward and back.

Forward scatter can occur when the transmitter, one or more wind turbines, and receiver are almost aligned as shown below. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [52]. Both of these effects can potentially degrade the DTV signal quality.



Forward scatter signal path

Back scatter from wind turbines occurs when DTV signals are reflected from turbine towers and turbine blades onto a receiver as shown below. The reflected signals are attenuated, time-delayed and phase-shifted (due to a longer path from transmitter to receiver) compared to the original signal. The reflected signals are also time-varying due to the rotation of the blades and vary with wind direction. The resultant signal at the receiver includes the original signal (transmitter to receiver) and a series of time-varying multipath signals (transmitter-turbine-receiver).



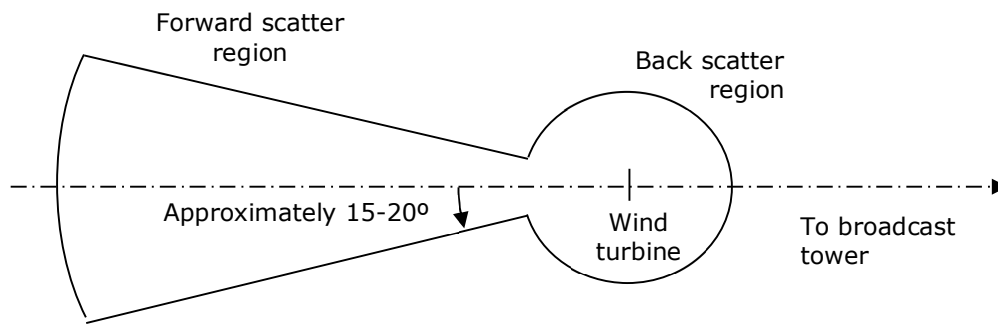
Back scatter signal path

Interference of DTV signals from wind turbine developments can potentially occur in both the forward and backward scatter region. The effect of a wind turbine on a DTV signal can be different depending on the scattering region where the receiver is located [52].

According to Ofcom [46], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [7] [53]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the wind turbines [46]. The shape of this region, assuming a relatively high gain, directional antenna, can be represented by a circular segment with an azimuthal range of approximately $\pm 15^\circ$ to $\pm 20^\circ$, corresponding to the beam width of the antenna. If a lower gain or omni-directional antenna is being used, this region is likely to be larger.

Back scattered signals arrive at the dwelling delayed relative to the source signal from the broadcast tower. The back scatter region generally does not extend further than 500 m [7] [51], assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio, or an omni-directional antenna is used, this region is likely to be larger.

The combination of the forward and back scatter regions, as shown in the following figure, resembles a keyhole.



Potential television interference zones around a wind turbine

Television interference mechanisms rely on many factors, as described in Section 4.15, and are complex to calculate. Previous experience has shown that even after great effort has been put into performing such calculations, they tend to have limited accuracy, and would require field validation after the wind farm is operational.

In Australia, DTV signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [54] states the following in regards to the forward scatter region for DVB-T signals:

"In most of the situations where the impact of a wind farm to DVB-T reception quality was analyzed, the threshold C/N [carrier-to-noise] ratios obtained were similar to those expected in environments with the absence of wind farms. More precisely, in the forward scattering region of the wind turbines, where the transmit antenna, one or more turbines and the receive antenna are lined-up ($\pm 60^\circ$ behind the wind turbine), the DVB-T reception quality may not be affected though further work of analysis is needed in order to confirm this point, especially in the vicinity of 0° ."

In other words, wind turbines are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [55] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more wind turbines, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [55].

With regards to back scattering, the ITU states:

"In the case of the backscattering region, in those situations where the scattered signals from wind turbines are significant in amplitude and variability, the threshold C/N ratio necessary for quasi error free (QEF) condition is higher."

In other words, the C/N ratio needs to be higher in the presence of significant back scatter to achieve the same QEF condition as is the case without the presence of wind turbines, which effectively means that interference is more likely to occur as coverage quality decreases. The implications of this conclusion for dwellings in the vicinity of the Project are discussed in Section 4.15.1.4.

4.15.1.3 Theoretical models for wind turbine scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [56]. This comparison with empirical data found:

"...none of the analyzed methods seems to be accurate enough to provide realistic estimations of the signal scattered by the wind turbines. In conclusion, a more complete scattering model is needed in order to provide more practical estimations of the scattered signals and evaluate their potential impact on the broadcasting services."

Notably, the scattering model proposed by the ITU to specifically address DTV signals [54], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally, DNV GL notes that it only applies to a single wind turbine rather than a wind farm as a whole. Due to the lack of an accurate scattering model, DNV GL has not performed detailed scatter calculations to predict DTV interference.

As an alternative, it is common practice to identify those dwellings or areas that are most likely to experience potential television interference based on likely forward and back scatter regions. As introduced above, this is often referred to as the 'keyhole' approach, and is an established technique for predicting where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [46]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring. The results of using this approach to identify the dwellings that have increased potential to receive scattered signals from a turbine in the Project, and hence have an increased likelihood of experiencing interference to DTV signals, are described in Section 4.15.1.4.

4.15.1.4 Potential impacts for nearby dwellings

Although DTV signals are generally unlikely to be susceptible to interference from wind turbines in areas of adequate coverage, interference could be encountered in areas where coverage is marginal and antennas at dwellings may receive a reflected signal from a turbine that is of sufficient power to interfere with the signal received directly from the transmitter. Based on the coverage maps for the area around the Project, it is possible that some areas could be deemed to have marginal reception, and interference could be encountered.

The coverage maps in Figure 19 to Figure 25 suggest that the primary transmitter for the area is the Latrobe Valley tower, which offers 'good' to 'variable' coverage across the site. Coverage from the nearby Boolarra, Jeeralang/Yinnar South, Newborough, and Trafalgar/Yarragon towers, which are understood to be relay transmitters, is 'good' in the immediate vicinity of the tower and generally 'variable' to 'poor' elsewhere. Coverage from the Melbourne tower is 'variable' to 'good' in the northwest but 'variable' to 'poor' elsewhere, while coverage from the Churchill tower is 'variable' to 'poor' across the site.

Dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine in the Project (assuming an antenna with a sufficiently narrow beam width and sufficiently high front-to-back ratio is being used) have been highlighted using the 'keyhole' approach described above.

The results of the analysis can be seen in Figure 19 to Figure 25. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 6. The number of dwellings with the potential to be affected is very high. Note that if the

signal received at a dwelling from the transmitter is sufficiently weak, or an antenna with insufficient directional discrimination is installed (i.e., a low gain or omni-directional antenna), interference may still occur outside of the identified interference zones.

Dwellings to the west of the Project have increased potential to experience interference to DTV signals from the Latrobe Valley broadcast tower, particularly in areas where the signal is already marginal. The potential interference zones for the Latrobe Valley tower include the townships of Narracan and Delburn, and may extend to Thorpdale or beyond. Given that the Latrobe Valley tower appears to be the primary transmitter for the area, interference to the signals from this tower could have a significant impact on local residents. Consequently, it may be necessary to install a relay transmitter to service those dwellings on the western side of the Project that are currently receiving signals from the Latrobe Valley broadcast tower.

A number of dwellings have also been identified in the potential interference zones for the Boolarra, Churchill, Jeeralang/Yinnar South, Melbourne, Newborough, and Trafalgar/Yarragon broadcast towers, but the coverage maps suggest that there is little to no signal coverage from those towers in most of the potentially-affected areas.

The method used here to assess the potential interference to television signals from the Project represents a simplified approach which is expected to capture locations where interference is most likely to occur. This simplified analysis is deemed appropriate in most cases as the implications of potential television interference are typically low. If reception difficulties are encountered, there are a number of mitigation options available as discussed in further detail in Section 4.15.3.

Table 6 Number of dwellings located within potential interference zones for digital television broadcast towers in the vicinity of the Project site

Digital television broadcast tower	Number of dwellings in potential interference zone	Signal coverage in potential interference zone
Boolarra	266	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower
Churchill (Mills Trig)	244	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower
Jeeralang/Yinnar South (Silcocks)	268	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower
Latrobe Valley (Mt Tassie)	191	Variable to good
Melbourne (Mt Dandenong)	849	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower
Newborough (Moe/Haunted Hills)	266	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower
Trafalgar/Yarragon (Yarragon South/Earls Road)	863	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower

4.15.2 Stakeholder consultation and responses


DNV GL has contacted BAI Communications, who are responsible for broadcasting of national public television services in Australia, and RBA Holdings, who are responsible for the Boolarra relay transmitter, to inform them of the proposed Project and seek feedback on any potential impact that the Project could have on DTV signals in the surrounding area.

BAI Communications has conducted an assessment of the potential for turbines at the Project to interfere with DTV signals from their Mt Tassie (Latrobe Valley) and Mills Trig (Churchill) towers and the relay transmitters at Boolarra, Silcocks (Jeeralang/Yinnar South), Haunted Hills (Newborough), and Earls Road (Trafalgar/Yarragon) operated by RBA Holdings [57]. Signals from the Melbourne tower were not considered, as that transmitter is not intended to be servicing the area around the Project. The method used involved modelling the reflection or scattering of DTV signals from the wind turbines, and identifying locations within 10 km of the Project where the resulting C/I ratio for a directional antenna oriented towards the tower of interest would be less than required for adequate signal reception.

From the results of their modelling, BAI Communications have advised that they do not expect the Project to cause interference to DTV signals from the Churchill tower or any of the nearby relay transmitters operated by RBA Holdings. However, the modelling has predicted that the Project will cause interference to DTV signals from the Latrobe Valley tower. This is broadly consistent with the overall conclusions drawn by DNV GL, as discussed in Section 4.15.1.4. Based on population density data for the area around the Project, BAI Communications concluded that 747 residents are at low risk of experiencing interference to DTV signals from the Latrobe Valley tower and 23 residents are at high risk. When the Churchill tower was considered as an alternative to the Latrobe Valley tower, BAI Communications found that 257 residents are at low risk of experiencing interference to DTV signals and 20 people are at high risk of experiencing interference.

The results of the modelling conducted by BAI Communications for signals from the Latrobe Valley tower, with the Churchill tower considered as an alternative source of signals, is compared to the coverage map for that tower and the interference zones established by DNV GL in Figure 26. Both analyses show a potential for interference across the Project site and in areas to the immediate northwest. However, there are some areas identified in one assessment as having potential to experience interference that have not been identified in the other. In particular, the BAI Communications modelling suggests that interference may be experienced in areas to the east and southeast of the Project that are not within the potential interference zones established by DNV GL. Based on the coverage map and the local terrain, it is possible that dwellings in the areas identified by BAI Communications may not have a direct line of sight to the Latrobe Valley transmitter and therefore could receive a backscattered signal from the turbines that is stronger than the signal from the transmitter.

DNV GL notes that there are limitations associated with both assessments considered here. The method used by DNV GL is based on a simplified geometric approach, as described above, and assumes that the forward scatter and back scatter regions do not extend further than 5 km and 500 m respectively from the turbines. The BAI Communications modelling considers potential interference caused by both forward and backward scattered signals to a distance of 10 km from the turbines, and appears to take terrain effects and existing signal quality into account. However, neither assessment considers whether the dwellings in the potentially-affected areas are currently receiving signals from the Latrobe Valley tower. Based on the coverage maps shown in Figure 19 and Figure 21, it is possible that dwellings located in the interference zones modelled by BAI



Communications to the east and southeast of the Project are currently receiving signals from the Jeeralang/Yinnar South and Boolarra towers, and therefore may not be affected by interference to signals from the Latrobe Valley tower. Dwellings located in other potentially-affected areas may also be able to receive alternative signals from nearby relay transmitters operated by RBA Holdings. DNV GL recommends that the Customer undertakes a pre-construction survey of the DTV reception strength in the areas around the Project, with a particular focus on those areas identified as having potential to experience interference, to determine the average signal strength and identify which towers are most likely to be servicing those areas.

4.15.3 Mitigation options

In the event that television interference is an issue during construction or after commissioning of the Project, there are several amelioration options available:


1. Realigning the user's television antenna more directly towards their existing transmitter.
2. Tuning the user's antenna into alternative sources of the same television signal or a substitute signal.
3. Installing a more directional or higher gain antenna at the affected dwelling.
4. Relocating the antenna to a less affected position.
5. Installing cable or satellite television at the affected dwelling.
6. Installing a television relay station.

In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. However, the effectiveness of this mitigation may be reduced if there is no clear line of sight from the antenna to the transmitter. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue however, as noted in [52], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [55] identified that the receiver height can also affect interference. In areas that are relatively flat and free of vegetation, reflections can enhance or decrease the received signal strength relative to the free path signal strength. The ITU found that the received signal strength may not increase monotonically with receiver height. In other words, lowering the receiver height can improve reception in some cases.

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription based broadcasts. Residents in areas which are unable to receive DTV through their normal television antenna due to local interference, terrain, or distance from the transmitter in their area may be eligible to access the Australian Government funded Viewer Access Satellite Television (VAST) service [58].

In addition to the mitigation options outlined above, the Victorian Guidelines [1] include example permit conditions stating that, prior to commencing development, a survey must be undertaken to determine the average television and radio reception strength within 5 km of the wind farm site. If a complaint is later received regarding the effect of the wind farm on television or radio reception at a pre-existing dwelling within 5 km of the site, the operator must investigate that complaint. If the investigation finds that the wind farm has had a detrimental impact on the quality of television



or radio reception, the operator must then restore reception at the affected dwelling to at least the quality determined in the pre-development survey to the satisfaction of the responsible authority.

In line with the expected planning permit conditions for the Project, DNV GL understands that the Customer has committed to returning terrestrial television services to at least pre-construction quality at their own cost if interference to these services is attributed to the Project after construction.

5 CONCLUSIONS

Broadcast towers and transmission paths around the Project were investigated to determine if EMI would be experienced as a result of the development and operation of the Project. The Project will involve the installation of 33 wind turbine generators. DNV GL has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 180 m or less and an upper tip height of 250 m or less.

The results of this assessment, including feedback obtained from relevant stakeholders and potential mitigation options, are summarised in Table 7.

Turbines at the Project are located within the calculated diffraction exclusion zone for one point-to-multipoint radiocommunication link operated by Gippsland Water, and hence have the potential to cause interference to that link. Gippsland Water has confirmed that there is a risk of interference to their link, although they believe potential mitigation options exist. DNV GL understands that the Customer is working with Gippsland Water to design an appropriate mitigation solution and has committed to implementing that mitigation at their own cost.


Turbines at the Project may also interfere with DTV broadcast signals received from nearby towers at a number of dwellings surrounding the Project. Coverage maps suggest that, for most of these towers, the potentially-affected dwellings are located in areas with limited to no signal coverage and therefore may not be receiving signals from that tower. However, interference to the signals from the Latrobe Valley tower could affect a large number of local residents who may not currently be able to receive signals from an alternative tower. Feedback received from BAI Communications also suggests that residents in the vicinity of the Project are at risk of experiencing interference to these signals. If interference is experienced, a range of mitigation options are available.

There is potential for interference to wireless internet signals received from the Boolarra NBN tower at several dwellings in the vicinity of the Project. However, NBN Co has advised that the Project is not expected to impact on the signal line of sight for any currently connected dwellings and the overall risk of interference is low. If interference is experienced, it is likely that problems could be rectified by relocating the antennas at the affected dwellings to achieve a clearer signal or to receive signals from an alternative tower.

Similarly, there is a low risk of interference to point-to-multipoint links associated with the Latrobe Valley flood warning system. Latrobe City Council, who operate the system, have advised that they do not expect the Project to impact on these links. If interference is experienced, mitigation options could include replacing the existing links with alternative technologies. DNV GL is continuing to engage with the BoM, who also operate flood warning infrastructure in the area around the Project, to seek feedback on the potential for interference with their systems and how any impacts may be mitigated.

Interference to FM radio signals from the Kids FM broadcast tower to the north of the Project may be experienced in the surrounding areas to the southwest of the Project. However, feedback received from BAI Communications indicates that they do not expect the Project to cause any noticeable interference to these signals. If interference is experienced, there are a range of mitigation options available.

Interference to mobile phone signals may theoretically occur in areas that are serviced by towers on the other side of the Project and already experience marginal coverage, although the overall risk is relatively low and no concerns have been raised by the network operators. If interference is



experienced, the available mitigation options vary depending on whether the impact is localised or experienced over a larger area.

Satellite television signals from two satellites that transmit programs designed for international audiences may be intercepted by turbines at the Project. DNV GL recommends that the Customer engages with the potentially-affected residents to determine if any are currently receiving signals from these satellites, and to establish an understanding of how any impacts may be mitigated.

Gippsland Water has noted the potential for interference to their mobile radio operations, although DNV GL considers that the risk of interference to these types of services is very low.

Potential EMI impacts on other services considered in this assessment are considered unlikely or have been assessed through consultation with the service operators. Besides the feedback received from Gippsland Water, NBN Co, and BAI Communications, no other concerns have been raised.

DNV GL understands that, in line with the expected planning permit conditions, the Customer has committed to returning any impacted services to at least pre-construction quality at their own cost if interference to those services is attributed to the Project after construction.

Table 7 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radiocommunication towers	One tower within 2 km of proposed turbine locations, operated by BAI Communications (Kids FM) Nearest tower: 1936 m from turbines	Low risk of interference – see findings for FM radio broadcasting	No concerns raised	See findings for FM radio broadcasting
Fixed point-to-point links	Six links crossing Project boundary, operated by: AusNet Services (one link) Gippsland Water (one link) Digital Distribution Australia (one link) Optus Mobile (two links) VerTel (one link) Diffraction effects: no turbines in DNV GL exclusion zones, no turbines in clearance zones requested by AusNet Services, Digital Distribution Australia, Optus Mobile, and VerTel Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	Unlikely to cause interference	No concerns raised by AusNet Services, Digital Distribution Australia, Gippsland Water, Optus Mobile, and VerTel	None required
Fixed point-to-multipoint links	204 assignments within 75 km of Project boundary 20 base stations within 20 km of Project boundary, operated by: AusNet Services (two sites) Aussie Broadband (one site) Bureau of Meteorology (one site) EnergyAustralia Yallourn (one site) ENGIE (one site) Gippsland Water (eight sites) Latrobe City Council (one site) Loy Yang Power Management (one site) Speedweb Wireless Internet (four sites) Diffraction effects: two turbines in exclusion zone for one Gippsland Water link, detailed information not available for other links Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	High risk of interference to one link operated by Gippsland Water Unlikely to cause interference to other links	High risk of interference to one link raised by Gippsland Water No concerns raised by AusNet Services, Aussie Broadband, EnergyAustralia Yallourn, ENGIE, Esso Australia, Latrobe City Council, Loy Yang Power Management, Southern Rural Water, and Speedweb Wireless Internet No response received from the BoM – base station is believed to be associated with flood warning infrastructure, see findings for Latrobe Valley flood warning system	To be developed in consultation with Gippsland Water

**Table 7 Summary of EMI assessment results for the proposed Project
(continued)**

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Latrobe Valley flood warning system	May experience interference if signal paths cross the Project near turbines – detailed information about signal paths not available	Low risk of interference	No concerns raised by Latrobe City Council No response received from BoM – engagement is ongoing	If required – replace fixed links with alternative technologies
Other licence types	Mobile radio systems: unlikely to be affected Other point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	Unlikely to cause interference to mobile radio systems	Risk of interference to mobile radio systems raised by Gippsland Water No concerns raised by other stakeholders	Mobile radio systems: if required – increase signal strength from affected tower, install signal repeater, install additional tower
Emergency services	Point-to-point links: no links crossing boundary Mobile radio systems: unlikely to be affected	Unlikely to cause interference	No concerns raised	Point-to-point links: none required Mobile radio systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest station: "Bairnsdale", 116 km from Project Unlikely to be affected	Unlikely to cause interference	No concerns raised	None required
Trigonometrical stations	35 stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by turbines Survey marks: unlikely to be affected	Unlikely to cause interference	No concerns raised	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required

**Table 7 Summary of EMI assessment results for the proposed Project
(continued)**

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Mobile phones	Fair to good coverage across most of the site, with limited coverage in some areas to the west, southwest, south, and southeast Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage to the south and southeast, for Optus Mobile coverage, and to the south and west, for Vodafone coverage	Low risk of interference	No concerns raised	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	Likely service providers: Aussie Broadband, Speedweb Wireless Internet, mobile phone networks NBN: currently available as a fixed wireless and satellite service, potential for interference to fixed wireless internet signals from the Boolarra NBN tower to up to five dwellings	Low risk of interference to NBN fixed wireless internet signals	No concerns raised by Aussie Broadband, Speedweb Wireless Internet, and mobile phone network providers Low risk of interference raised by NBN Co, as there are currently no connected dwellings that would be impacted	Mobile phone networks: as for mobile phones NBN: if required – re-direct antenna to alternative tower, change location of antenna, install new tower
Satellite television and internet	Services designed for Australian audiences: unlikely to be affected Other designed for international audiences: signals from two satellites at low angles of elevation may be intercepted at nearby dwellings	Low risk of interference to services designed for international audiences	Consultation with operators not considered necessary DNV GL recommends engaging with residents of potentially-affected dwellings	If required – re-direct satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference in close proximity to turbines FM signals from nearby Kids FM transmission tower: may experience interference in areas with marginal reception Digital radio signals: not available in vicinity of Project	Low risk of interference to Kids FM radio broadcasts through obstruction of signals	No concerns raised	FM signals: if required – install higher-quality antenna, increase signal strength from affected tower, move tower to new location, install signal repeater, install additional tower


**Table 7 Summary of EMI assessment results for the proposed Project
(continued)**

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception			
	<i>Boolarra tower: 'good' coverage in southeast, 'variable' to 'poor' coverage elsewhere</i>			
	266 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Churchill tower: 'variable' to 'poor' coverage across site</i>			
	244 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Jeeralang/Yinnar South tower: 'good' coverage in east, 'variable' to 'poor' coverage elsewhere</i>			
	268 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	Re-align antenna to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	<i>Latrobe Valley tower: 'variable' to 'good' coverage across the site</i>			
	191 dwellings in potential interference zone to the west and northwest	High risk of interference	High risk of interference for 20 residents, low risk of interference for 257 residents in areas with marginal coverage within the Project boundaries and to the northwest and southeast	
	<i>Melbourne tower: 'variable' to 'good' coverage in northwest, 'variable' to 'poor' coverage elsewhere</i>	Low risk of interference	Not considered	
	849 dwellings in potential interference zone, but signal coverage is limited in that area			
	<i>Newborough tower: 'good' coverage in north, 'variable' to 'poor' coverage elsewhere</i>			
	266 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk of interference	No concerns raised	
	<i>Trafalgar/Yarragon tower: 'variable' to 'good' coverage in northwest, 'poor' coverage elsewhere</i>			
	863 dwellings in potential interference zone, but signal coverage is limited in that area	Low risk interference	No concerns raised	

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