Appendix J

Electromagnetic Impact Assessment Report

TARONG WEST WIND FARM

EMI Assessment

AECOM Australia Pty Ltd

Report No.: PP319950-AUME-R-02, Rev. A
Date: 7 February 2024
Status: FINAL

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Project name:	Tarong West Wind Farm	DNV Energy Systems
Report title:	EMI Assessment	Level 12, 350 Queen Street
Customer:	AECOM Australia Pty Ltd	Melbourne VIC 3000
	Level 8, 540 Wickham Street	Australia
	Fortitude Valley QLD 4006	Tel: +61 3 8615 1515
Date of issue:	7 February 2024	ABN 14 154 635 319
Project No.:	PP319950	
Report No.:	PP319950-AUME-R-02, Rev. A	
Document No.:	PP319950-AUME-R-01-A	

Task and objective:
Tarong West Wind Farm EMI Assessment

Prepared by:	Verified by:	Approved by:
N Brammer Senior Engineer Energy Analytics	J Jobin Principal Engineer Energy Analytics	T Gilbert Principal Engineer Energy Analytics
E Tomlinson Engineer Project Development & Analytics	N Brammer Senior Engineer Project Development & Analytics	

Document classification:
Customer's Discretion
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Keywords:
Tarong West Wind Farm EMI Assessment

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2024-02-07	Prepared for Development Application	N Brammer E Tomlinson	J Jobin N Brammer	T Gilbert

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EXECUTIVE SUMMARY

DNV has been commissioned by AECOM Australia Pty Ltd ("AECOM" or "the Customer") on behalf of RES Australia Pty Ltd ("RES" or "the Developer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Tarong West Wind Farm ("the Project") in southeastern Queensland. The results of the EMI assessment are described in this document and summarised in the table on the following pages.

Background and methodology

DNV has assessed the potential EMI impacts for the Project in accordance with the Queensland State Development Assessment Provisions [1], Queensland Wind Farm Development Planning Guidance [2], and Draft National Wind Farm Development Guidelines [3]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

This assessment considers a Project layout consisting of up to 97 Wind Turbine Generators (WTGs), and a WTG geometry that will be conservative for WTG configurations with dimensions satisfying all of the following criteria: a rotor diameter of 180 m or less, an upper tip height of 280 m or less, and a lower tip height of 64 m or more. At the request of the Customer, DNV has also considered the potential for EMI to be caused by four temporary meteorological masts and three permanent meteorological masts that are proposed to be installed at the Project site.

Ninety-four potential dwellings have been identified within 5 km of the Project, six of which are associated dwellings.

Outcomes of the assessment

Based on this assessment, DNV expects that the Project will achieve performance outcome PO3 of State Code 23 (which requires that the Project be designed, located, and sited to protect pre-existing radiocommunications from EMI-related impacts) once necessary micro-siting of turbines, mitigation, and stakeholder liaison has occurred. Feedback received from the Bureau of Meteorology (the Bureau), Telstra, and BAI Communications indicates that there is a potential for the Project to impact on their services and operations. As outlined below, these impacts may be managed through micro-siting of turbines, appropriate mitigation measures, or ongoing liaison between the Developer and relevant stakeholders. In most other cases, where a potential for EMI exists, the overall impact is likely to be low or it is expected that options will be available to mitigate that impact.

The main way that a wind farm can interfere with radiocommunication signals is by the physical presence of the WTGs causing obstruction, diffraction, scattering, or near-field effects. Given the nature of the wind farm and WTG design, it is considered unlikely that electromagnetic emissions from the Project will cause interference to radiocommunication services in the surrounding area. It is also considered unlikely that the temporary and permanent meteorological masts proposed as part of the Project will cause material interference to nearby radiocommunication services.

Based on the WTG layout considered in this assessment, there is one WTG located within the clearance zone requested by Telstra for one fixed point-to-point radiocommunication link passing over the Project boundaries. However, DNV understands that the Developer is intending to micro-site this WTG to be outside the requested clearance zone prior to construction of the Project. While there are also two WTGs located within the potential reflection or scattering interference zone

established by DNV for this link, neither of which are located within the clearance zone requested by Telstra, Telstra have not expressed any concerns about the potential for WTGs outside of their requested clearance zone to cause interference.

Feedback received from the Bureau indicates that there is potential for the Project to materially impact on the operation of their Darling Downs radar facility at Wichello, and the associated weather monitoring and prediction services. To help manage and mitigate these impacts, the Bureau has asked the Developer to formally commit to advising the Bureau of the final WTG layout and any changes to the Project design, notifying the Bureau prior to any planned shutdown of the Project to allow calibration of their systems, and cooperating with any requests from the Bureau to temporarily shut down selected WTGs in the event of severe weather conditions.

WTGs at the Project may also interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. Dwellings in the vicinity of the Project may experience interference to digital television signals from the Darling Downs broadcast tower, particularly in areas to the west of the Project where there is potential for dwellings to receive a reflected signal from a WTG that is stronger than the signal from the transmitter. Feedback received from the operator of the Darling Downs tower, BAI Communications, also suggests that some residents in the vicinity of the Project are at risk of experiencing interference to these signals. While digital television signals from the Wide Bay broadcast tower may be impacted, the coverage maps suggest that most of the potentially-affected dwellings are unlikely to be receiving signals from that tower. The overall risk of interference to mobile phone and radio broadcasting services is relatively low, and DNV notes that no concerns have been raised by any of the relevant operators.

If interference to these services is experienced, a range of options are available to rectify issues. These may involve realigning or upgrading the user's antenna at affected residences, increasing the signal strength from the transmission tower, or installing a signal repeater on the opposite side of the Project. To further evaluate the potential for interference to television broadcasting signals, BAI Communications has recommended undertaking a more detailed assessment of the likely impacts. DNV also understands that the Developer is willing to perform a pre-construction baseline survey of existing radio and television signals in the area around the Project, if required as a planning condition, to assess the potential risk of interference and allow any post-construction impacts attributable to the Project to be identified and rectified.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely impacts. DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact. Concerns raised by South Burnett Regional Council about the potential for interference from electromagnetic emissions and reflection or scattering of signals in their point-to-multipoint network have been addressed by DNV to the satisfaction of the Council, and interference to these assets is not expected. Apart from the potential for interference noted by the Bureau, Telstra, South Burnett Regional Council, and BAI Communications, no concerns have been raised.

DNV notes that the Project is located in an area of high wind farm development activity, with several wind farms in various stages of development nearby. The potential cumulative impacts of the Project in conjunction with the nearby wind farms have not been presented in this report.

DNV understands that the Developer is seeking to apply a 100 m micro-siting allowance to all proposed WTG locations. As noted above, this will allow WTGs to be relocated to be outside the clearance zone requested by Telstra for their point-to-point link passing over the Project boundaries prior to construction, hence reducing the potential for interference to that link. For all other radiocommunication services considered in this assessment, provided that the clearances detailed in this report are maintained, DNV considers it unlikely that movement of the WTGs within the 100 m micro-siting allowance will change the conclusions presented here.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact based on DNV assessment	Stakeholder feedback (to date)
Radio-communication towers	One tower within 2 km of proposed WTG locations, operated by Telstra	Potential for interference – see findings for point-to-point links	No concerns raised regarding proximity of WTGs to the tower
Fixed point-to-point links	Two links crossing Project boundary, operated by Telstra Diffraction effects: no WTGs in exclusion zones established by DNV, one WTG in requested clearance zone for one link Reflection/scattering effects: two WTGs in potential interference zone established by DNV for one link Near-field effects: no WTGs in potential interference zones established by DNV	Potential for interference to one link through reflection or scattering of signals	Clearance zone of 200 m either side of link path requested by Telstra – one WTG located within requested clearance zone for one link
Fixed point-to-multipoint links	68 assignments within 75 km of Project boundary One base station within 20 km of Project boundary, operated by Fransfarm Pty Ltd	Unlikely to cause interference	No concerns raised by Bureau of Meteorology (the Bureau), Ergon Energy, Fransfarm Pty Ltd, Department of Transport and Main Roads, Seqwater, Stanwell Corporation Concerns raised by South Burnett Regional Council – satisfactorily addressed by DNV, no further concerns raised
Emergency services	Point-to-point links: no links crossing boundary Mobile telephony systems: unlikely to be affected	Unlikely to cause interference	No concerns raised
Meteorological radar	Nearest radar: Darling Downs, 76 km from Project	Potential for interference if WTGs can be detected by radars	Concerns raised regarding potential for interference to Darling Downs radar The Bureau has asked the Developer to enter into a formal agreement to advise the Bureau of the final WTG layout and any changes to the Project design, notify the Bureau prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the Bureau in the event of severe weather conditions

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

Licence or service type	Assessment findings	Expected impact based on DNV assessment	Stakeholder feedback (to date)
Trigonometrical stations	Unlikely to be affected Survey mark clearance zones: no WTGs in requested clearance zones	Unlikely to cause interference	No concerns raised
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	-
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Potential for interference	No concerns raised
Wireless internet	Available services: mobile phone networks, NBN NBN currently available as a fixed wireless and satellite service	Potential for interference to mobile services Unlikely to cause interference to NBN	No concerns raised
Satellite television and internet	Services intended for Australia: unlikely to be affected Other services: signals from 42 satellites intercepted at 34 dwellings	Potential for interference to services intended for international audiences	-
Radio broadcasting	AM and FM signals: may experience interference in close proximity to WTGs Digital radio signals: Project is outside the intended coverage area	Potential for interference to AM and FM signals	No concerns raised
Television broadcasting	May experience interference in areas with poor or marginal reception *Darling Downs tower: 'variable' to 'good' coverage across most of the site, 'poor' to 'variable' coverage to the west and southwest* 22 dwellings in potential interference zone *Wide Bay tower: 'poor' to non-existent coverage* 24 dwellings in potential interference zone, although potentially-affected dwellings may not be receiving signals from this tower	High potential for interference, especially to the west of the Project Potential for interference	Potential for interference to signals from the Darling Downs tower for up to 6 residents BAI Communications expects any impact to be rectified as part of the Project

1 INTRODUCTION

AECOM Australia Pty Ltd ("AECOM" or "the Customer") on behalf of RES Australia Pty Ltd ("RES" or "the Developer") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Tarong West Wind Farm ("the Project", formerly known as the Iron Leaf Wind Farm) in southeastern Queensland. The results of this work are reported here.

The purpose of this assessment is to address compliance with performance outcome PO3 of the Queensland State Development Assessment Provisions (SDAP), State Code 23: Wind Farm Development, prepared by the Queensland Department of State Development, Infrastructure, Local Government and Planning in December 2021 [1]. In accordance with the Queensland Wind Farm Development Planning Guidance (Queensland Planning Guidance) prepared by the Department of State Development, Infrastructure, Local Government and Planning in February 2022 [2] and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [3], 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.

The assessment also considers potential EMI impacts caused by electromagnetic emissions from Wind Turbine Generators (WTGs) at the Project, including electromagnetic fields and electromagnetic radiation.

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The proposed Project site is located in southeastern Queensland, approximately 30 km west of Kingaroy and 170 km northwest of Brisbane. The site consists of undulating terrain that is predominantly used for cattle grazing.

2.2 The project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of up to 97 WTGs [4]. A map of the site with the proposed WTG layout is shown in Figure 1, and the coordinates of the proposed WTG locations are presented in Table 8.

DNV understands that the Developer is seeking to apply a 100 m micro-siting allowance to all proposed WTG locations. As discussed in Section 4.3.5, this will allow WTGs to be relocated to be outside the clearance zone requested by Telstra for their point-to-point link passing over the Project boundaries prior to construction, hence reducing the potential for interference to that link. For all other radiocommunication services considered in this assessment, provided that the clearances detailed in this report are maintained, DNV considers it unlikely that movement of the WTGs within the 100 m micro-siting allowance will change the conclusions presented here.

2.2.2 Proposed meteorological mast locations

The Project is proposed to include four temporary meteorological masts and three permanent meteorological masts, as advised by the Customer [5, 6]. The temporary masts, which are to be located at proposed WTG positions, will be installed during the construction of the Project and removed before the respective WTGs are constructed. However, the permanent masts will remain installed for the lifetime of the Project. The proposed locations of the meteorological masts are shown in Figure 1, and the coordinates of these masts are presented in Table 9.

2.2.3 Dwelling locations

There are 94 potential dwellings within 5 km of the Project, six of which have been identified as associated dwellings [7]. The coordinates of these dwellings are presented in Table 10, and the dwellings and site boundaries considered in this assessment are also shown in Figure 1. As indicated in Table 10, one dwelling (dwelling 19) has been identified by the Customer as uninhabited and 17 dwellings have been identified by the Customer as sheds.

DNV 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 has considered all potential dwellings provided by the Customer, including those listed as uninhabited or as sheds.

3 REGULATORY REQUIREMENTS

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

The Queensland Planning Guidance [2] provides *"supporting information and actions that may be required to demonstrate compliance"* with State Code 23: Wind Farm Development contained in the SDAP [1]. With respect to EMI impacts, performance outcome PO3 in State Code 23 requires that:

> *"Development is designed, located and sited to protect pre-existing television, radar and radio transmission and reception from electromagnetic interference."*

The Queensland Planning Guidance states that compliance with this performance outcome may be demonstrated, by an EMI impact assessment that *"detail[s] potential EMI impacts and how these will be mitigated and managed"* and an assessment of the *"electromagnetic emissions generated by the wind turbines and their associated transmission infrastructure"* that *"consider[s] potential interference to nearby radio communications systems"*. The Queensland Planning Guidance also provides methodologies for identifying potentially affected radiocommunication services and assessing the likely EMI impacts of the wind farm on those services.

The EMI assessment methodology outlined in the Queensland Planning Guidance has been largely adapted from the National Wind Farm Development Guidelines. 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) [3]. 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 considers that the recommendations of the Draft National Guidelines are broadly consistent with the requirements of the Queensland Planning Guidance, and has considered the advice and methodologies presented in both guidelines when preparing this assessment.

4 EMI CAUSED BY THE PHYSICAL PRESENCE OF WTGS

4.1 Assessment approach

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.

The Customer has asked DNV to complete this assessment based upon a layout provided for the Project consisting of up to 97 WTGs, as outlined in Table 8.

DNV understands that the WTG rotor diameter for the Project has not yet been finalised. However, for the purpose of the EMI assessment, a hypothetical WTG with the specifications outlined in Table 1 has been considered here with the agreement of the Developer.

Table 1 WTG specifications

Feature	Specification
WTG type	Horizontal-axis WTG
Number of WTGs	Up to 97 WTGs
WTG name plate capacity	Up to 4.5 MW
Project name plate capacity	Up to 436.5 MW
Upper tip height	Up to 280 m
Lower tip height	64 m or more
Rotor diameter	Up to 180 m
Hub height	Up to 190 m
Blade length	Up to 90 m
Blade chord thickness	Up to 4500 mm
Colour of WTG	Light grey, off white or white

The results generated based on this WTG configuration will be conservative for all WTG configurations with dimensions that remain inside the WTG envelope by satisfying all of the following criteria:

- a rotor diameter of 180 m or less
- an upper tip height of 280 m or less
- a lower tip height of 64 m or more.

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 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 a copy of the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 28 September 2023 [8].

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

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a WTG 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 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 responses from the organisations regarding whether they foresee any potential EMI-related impacts on their operations and services. Consultation with these operators has been undertaken in four stages:

1. consultation with all identified organisations based on a WTG layout consisting of 152 WTGs with a rotor diameter of 162 m and an upper tip height of 280 m ("the preliminary WTG layout and dimensions")
2. further consultation with those organisations that had expressed concerns or had not previously responded based on a WTG layout consisting of 151 WTGs with a rotor diameter of 162 m and an upper tip height of 280 m ("the first interim WTG layout and dimensions")
3. further consultation with those organisations that had expressed concerns or had not previously responded based on a WTG layout consisting of 97 WTGs with a rotor diameter of 172 m and an upper tip height of 280 m ("the second interim WTG layout and dimensions")
4. further consultation with those organisations that had expressed concerns or had not previously responded based on a WTG layout consisting of 128 WTGs with a rotor diameter of 180 m and an upper tip height of 280 m ("the third interim WTG layout and dimensions")
5. further consultation with those organisations that had expressed concerns or had not previously responded based on the WTG layout and dimensions considered in this assessment ("the current WTG layout and dimensions", consisting of up to 97 WTGs with a rotor diameter of 180 m and an upper tip height of 280 m, four temporary meteorological masts, and three permanent meteorological masts).

The organisations that have been contacted and all responses received to date are summarised in Table 20.

DNV notes that the Project is located in an area of high wind farm development activity, with several other wind farms in various stages of development nearby. The potential cumulative

impacts of the Project in conjunction with the nearby wind farms have not been presented in this report.

4.2 Radiocommunication towers

From the ACMA RRL database, there are 448 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.

WTGs located close to radiocommunication sites have the potential to cause interference through near-field effects or reflection or scattering of the signals. According to the Queensland Planning Guidance [2], the near-field zone for a transmission tower can vary from several metres to approximately 720 m depending on the service type. The Queensland Planning Guidance recommends that any radiocommunication site within 1 km of a proposed WTG location be considered as having the potential to be impacted by near-field effects. The potential for a WTG 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 WTG. Since there is no single criterion for potential impact on radiocommunication services due to near-field effects and reflection or scattering, the Queensland Planning Guidance recommends consulting with the service operator if any WTG is to be located within 2 km of a radiocommunication site.

There is one radiocommunication tower located within 2 km of the proposed WTGs locations. The location of the tower, and the consultation zones recommended by the Queensland Planning Guidance [2], are shown in Figure 3 based on information obtained from the ACMA RRL database, the operator of the services associated with that tower, and satellite imagery. Each consultation zone includes the rotor radius for WTGs with a 180 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower location. The size of the uncertainty buffer is based on the deviations between the tower location provided by the operator and the apparent location determined from satellite imagery. Details of the tower and associated licences are given in Table 2.

Potential impacts to the fixed point-to-point licence associated with the tower are discussed in Section 4.3.

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

Site ID	Associated licence types	Operators	Distance to nearest WTG [m]
16345	Fixed point-to-point links	Telstra	870

4.2.1 Stakeholder consultation and responses

DNV has contacted Telstra to determine the likelihood that the proposed Project will cause interference to their services through near-field effects or reflection or scattering of signals.

The response received from Telstra in relation to the fixed point-to-point link associated with this tower is detailed in Section 4.3.5. No concerns have been raised by Telstra regarding the proximity

of WTGs to this tower, based on the preliminary, first interim, and second interim WTGs layouts and dimensions. DNV has also provided the current WTG layout and dimensions to Telstra for their review and feedback, but no response has been received to date.

Telstra have also advised that, in addition to an assessment of potential EMI impacts on their wireless radiocommunications, they need to consider the potential impact of proposed wind farms on any physical network infrastructure such as underground copper cables. DNV understands that the Developer is intending to engage with Telstra directly to facilitate this assessment.

4.3 Fixed licences of point-to-point type

WTGs 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.

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. For this analysis, DNV has used a wider and more conservative frequency range of 0 GHz to 50 GHz.

The registered radiocommunication licences for each tower according to the ACMA RRL database were analysed to determine the transmission paths of licenced links that may experience interference from WTGs.

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 two point-to-point links recorded in the ACMA RRL database that pass over the proposed Project site (operated by Telstra). The details of the links are provided in Table 11, and the link paths are shown in greater detail in Figure 5 based on information obtained from the ACMA RRL database, the link operator, and satellite imagery.

The potential interference mechanisms and interference zones established by DNV for these links are described in Sections 4.3.1, 4.3.2, and 4.3.3, and summarised in Section 4.3.4. Feedback obtained from the operator of the links, including their recommended clearance zones to reduce the risk of interference, is summarised in Section 4.3.5 and Table 20.

4.3.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [3] [9] [10], 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, WTGs, including the blades, should be kept outside of an exclusion zone based on either the second Fresnel zone as recommended in [2] and [9], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [11] (although DNV understands that this zone is under review by the authors of that document). DNV had reviewed the link frequency and line of sight with respect to terrain for each of the point-to-point links passing over the proposed Project site. For both links, the direct path between the transmitter and the receiver is obstructed by terrain. Therefore, for each of the identified links crossing the proposed Project site, DNV 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. Each exclusion zone includes the rotor radius for WTGs with a 180 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the radiocommunication tower locations. The size of this uncertainty buffer is based on the deviations between the tower locations provided by the link operators and the apparent locations determined from satellite imagery. The potential diffraction exclusion zones in the horizontal plane are shown in Figure 5.

The WTGs located within the diffraction exclusion zone for each point-to-point link crossing the proposed Project site are summarised in Table 3. There are no WTGs located within the exclusion zones established by DNV for any of the point-to-point links passing over proposed Project site. Therefore, it is not expected that the Project will cause interference to the point-to-point links through diffraction of the signals. However, DNV notes that Telstra has requested that a larger clearance zone be applied to their point-to-point links crossing the proposed Project site, as discussed in Section 4.3.5.

DNV has also assessed the potential for the WTG blades to intersect with the diffraction exclusion zone for each point-to-point link in the vertical plane. This was achieved by examining the elevations and tower heights at each end of the link, as well as the approximate elevation of the areas within the Project boundaries over which the link crosses. Based on this analysis, the diffraction exclusion zones for both links pass over the Project at a height that would be intersected by the WTG blades.

4.3.2 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 WTG will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [9].

Reference [9] 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 WTG at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and WTG, and comparing this to the required C/I ratio, a potential interference zone can be defined. For each of the identified links with a transmission tower near the proposed WTG locations, DNV has established a reflection/scattering interference zone based on the antenna gains and length of the link, the worst-case RCS for the WTG calculated according to the equation proposed in [12], and an assumed minimum C/I ratio of 20 dB [12]. The radiation patterns for the antennas were approximated using the reference radiation patterns given in the International Telecommunication Union (ITU) Recommendation F.699-8 [13]. Each interference zone also includes the rotor radius for WTGs with a 180 m rotor diameter, and an additional buffer to account for potential inaccuracies in the radiocommunication tower locations as described in Section 4.3.1. The potential reflection/scattering interference zones are shown in Figure 5.

For comparison, Figure 5 also shows the 2 km radius consultation zones for reflection or scattering effects as recommended by the Queensland Planning Guidance, centred on the transmission towers for the point-to-point links crossing the Project site.

The WTGs located within the reflection/scattering interference zone for each point-to-point link crossing the proposed Project site are summarised in Table 3. There are two WTGs located within the potential reflection/scattering interference zone established by DNV for one point-to-point link passing over the proposed Project site. However, as discussed in Section 4.3.5, these WTGs are outside the clearance zone requested by Telstra for their point-to-point links.

The method used to establish the reflection/scattering interference zones shown in Figure 5 assumes that the direct path for the point-to-point link has a clear line-of-sight with respect to the first Fresnel zone, and that the paths for the reflected or scattered signal from the transmitter to the WTG and from the WTG to the receiver are also line-of-sight [9]. For low frequency links, the direct path between the transmitter and the receiver is often obstructed by terrain. In this situation, a signal that has been reflected or scattered from a WTG with a clear line of sight to the transmitter or receiver may be considerably stronger than the direct signal and therefore have greater potential to cause interference [11]. As discussed in Section 4.3.1 and indicated in Table 3, the two point-to-point links crossing the Project site do not have a clear line of sight between the transmitter and receiver. Therefore, the necessary clearance zones to minimise the potential for interference caused by reflection or scattering may be larger than those shown in Figure 5.

Nevertheless, DNV notes that the reflection/scattering interference zones shown in Figure 5 are approximations only and may be overly conservative [3]. The WTG RCS and C/I ratios used to establish the interference zones were based on recommendations developed on behalf of the United Kingdom telecommunications regulator Ofcom [12], and may not be appropriate for point-to-point links operating in Australia. Uncertainties are also associated with the assumptions used to derive the Ofcom recommendations, and the use of ITU reference radiation patterns rather than the actual radiation patterns for the transmitting and receiving antennas.

To account for these uncertainties, the potential for the Project to cause interference to fixed point-to-point links passing over the proposed Project site through reflection or scattering has been further assessed through consultation with the operator of those links. As discussed in Section 4.3.5, Telstra have confirmed that they do not expect the Project to have any impact on their point-to-point links and no concerns have been raised about the potential for interference from the WTGs located within the potential reflection/scattering interference zones shown in Figure 5.

4.3.3 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 [9] 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. For each of the identified links with a transmission tower located near the proposed WTG locations, DNV has established a near-field interference zone based on the operating frequency and antenna gain for that link. Each interference zone also includes the rotor radius for WTGs with a 180 m rotor diameter, and an additional buffer to account for potential inaccuracies in the radiocommunication tower locations as described in Section 4.3.1. The potential near-field interference zones are shown in Figure 5.

The WTGs located within the near-field interference zone for each point-to-point link crossing the proposed Project site are summarised in Table 3. There are no WTGs located within the near-field interference zone established by DNV for any of the point-to-point links passing over the proposed Project site. Therefore, it is not expected that the Project will cause interference to the point-to-point links through near-field effects.

4.3.4 Summary of point-to-point interference effects

Table 3 summarises the WTGs located within the calculated diffraction, reflection/scattering, and near-field interference zones for each of the point-to-point links crossing the Project site.

Table 3 Details of WTGs located within the interference zones established by DNV for point-to-point links crossing the proposed Project site

Link no.	Operator	WTGs within potential interference zone established by DNV		
		Diffraction	Reflection/scattering	Near-field
1	Telstra	None	None[1]	None
2	Telstra	None	2 WTGs [1] (T74, T92)[2]	None

1. Direct link path does not have a clear line-of-sight with respect to the first Fresnel zone. The necessary clearance zone to minimise potential for interference caused by reflection or scattering may be larger than shown in Figure 5 for this link.
2. WTGs T74 and T92 are outside the clearance zone requested by Telstra for their point-to-point links and Telstra have not expressed any concerns about the potential for impact from WTGs outside the requested clearance zone, as discussed in Section 4.3.5.

4.3.5 Stakeholder consultation and responses

DNV has contacted Telstra 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.

The response received from Telstra based on the preliminary WTG layout and dimensions indicated that there was a potential for interference to one of their fixed point-to-point links crossing the Project site. To avoid the risk of interference, Telstra asked that the WTGs at the Project be kept clear of an area 200 m either side of the link path. The requested clearance zones for the two Telstra point-to-point links crossing the Project site boundary are shown in Figure 6. Each clearance zone also includes the rotor radius for WTGs with a 180 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations as described in Section 4.3.1.

The WTGs located within the requested clearance zone for each point-to-point link crossing the proposed Project site are summarised in Table 4. There is one WTG in the current WTG layout located within the clearance zone requested by Telstra for one of their point-to-point links. However, given the very small distance by which the WTG is within the clearance zone, DNV understands that the Developer is intending to microsite this WTG to be outside the requested clearance zone prior to construction of the Project.

DNV has also provided the current WTG layout and dimensions to Telstra for their review and feedback, but no response has been received to date. DNV also understands that the Developer is intending to provide the final WTG layout to Telstra for their review and feedback prior to construction of the Project.

Table 4 Details of WTGs located within the requested clearance zones for point-to-point links crossing the proposed Project site

Link no.	Operator	WTGs within requested clearance zone
1	Telstra	None
2	Telstra	1 WTG (T125 by approximately 3 m)

4.4 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 licence register. A point-to-multipoint licence allows communication between one or more static sites and multiple points or between the points. The point-to-multipoint type is usually licensed 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. Hence, the paths of the transmission vectors are not readily identifiable. A review of fixed point-to-multipoint licences was undertaken and 68 Assignment IDs

were identified within approximately 75 km of the proposed site. These licences are shown in Figure 7. The details of the licence holders as per the ACMA database are provided in Table 12.

There is one point-to-multipoint base station listed in the ACMA RRL database within 20 km of the Project boundary. This station is operated by Fransfarm Pty Ltd. There are also several point-to-multipoint base stations located more than 20 km from the site.

4.4.1 Stakeholder consultation and responses

Since it is not possible to determine if there are any potential impacts to a point-to-multipoint network without knowing the locations of each station in the network, DNV has contacted the operators of all potentially-affected base stations within 60 km of the Project to determine the likelihood that the proposed Project will cause interference to their services.

The responses received from the Ergon Energy, Fransfarm Pty Ltd, Department of Transport and Main Roads, Seqwater, and Stanwell Corporation based on the preliminary WTG layout and dimensions indicated that they do not expect the Project to have any impact on their operations and services. Further consultation with these operators is not considered necessary. Similarly, the response received from the Bureau of Meteorology (the Bureau) based on the second interim WTG layout and dimensions has indicated that they do not expect the Project to have any impact on their point-to-multipoint licences.

South Burnett Regional Council confirmed that none of the link paths associated with their point-to-multipoint licence cross the proposed Project site, but expressed concerns regarding the potential for WTGs at the Project to cause interference to their services through electromagnetic emissions or reflection or scattering of the signals. DNV obtained further information from South Burnett Regional Council [14] [15], and has assessed the potential for WTGs at the wind farm to cause reflection or scattering of the signals between three identified remote sites and the repeater base station at Mount Wooroolin (site ID 130697). Details of the sites are given in Table 13 and the site locations and corresponding radiocommunication links are shown in Figure 8. The potential for electromagnetic emissions produced by WTGs to interfere with radiocommunications signals and equipment is discussed in Section 6.

For each of the radiocommunication links shown in Figure 8, DNV has established a potential reflection/scattering interference zone based on the antenna and link properties provided and a worst-case RCS for the WTG, as described in Section 4.3.2. The radiation patterns for the directional antennas were approximated using the reference radiation patterns given in ITU Recommendation F.699-8 [16], while the gain for the omnidirectional antenna was taken as equal to the maximum gain in all directions.

Since it is likely that the interfering signals reflected from the WTGs will have the same frequency as the signal produced by the transmitter, a minimum C/I ratio equal to the measured co-channel rejection ratio of 8 dB for the antennas at a frequency of 460 MHz was considered [15]. However, DNV notes that the method used to determine the co-channel rejection involves applying different modulation signals to the wanted and unwanted signals used in the test [17]. If the signal reflected from a WTG has the same frequency and modulation as the signal produced by the transmitter, a higher C/I ratio and hence a greater clearance distance from the transmitting and receiving sites may be required. To account for this possibility, DNV has also established potential reflection/scattering interference zones for an assumed minimum C/I ratio of 20 dB as proposed in [12], although it is noted that this value may be conservative.

Potential reflection/scattering interference zones were modelled for all relevant frequencies and link directions at each site in Table 13, and combined to give an overall interference zone for that site. Each interference zone also includes the rotor radius for WTG with a 180 m rotor diameter, and an additional buffer of 25 m to account for potential inaccuracies in the radiocommunication tower locations as DNV understands that the coordinates given in Table 13 are based on satellite imagery rather than surveyed locations [14].

The potential reflection/scattering interference zones are shown in Figure 8. There are no WTGs located within the reflection/scattering interference zone for any of the South Burnett Regional Council links, even for a conservative minimum C/I ratio. Therefore, it is not expected that the Project will cause interference to these links through reflection or scattering of the signals.

This advice, and advice regarding the potential for electromagnetic emissions produced by WTGs to interfere with radiocommunications signals and equipment, has been provided to South Burnett Regional Council. Subsequent feedback received from South Burnett Regional Council has indicated that they are satisfied with the assessment and advice provided by DNV, and accept that the Project is unlikely to impact on their radiocommunication assets and services. Further consultation with South Burnett Regional Council is not considered necessary.

4.5 Other licence types

Other licences in the ACMA database were reviewed. These licences and associated Assignment IDs are shown in Table 14 and Figure 9.

Many of the licences identified can be broadly described as base to mobile station style communications, including radio broadcasting and commercial and private mobile telephony. These licence types are generally not affected by the presence of WTGs any more than other effects such as terrain, vegetation, and other forms of signal obstruction. Should reception difficulty be encountered, mitigation consists of the user simply moving to receive a clearer signal.

Potential impacts to emergency services signals and commercial mobile telephony signals are considered in Sections 4.6 and 4.11 respectively.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services and are 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 understands that potential impacts to these services will be considered as part of an aviation impact study.

4.6 Emergency services

A review of the ACMA RRL database was conducted to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 15 along with their contact details. DNV has contacted the operators of all 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.

All of the responses received have indicated that those operators do not expect the Project to impact on their services under normal operating conditions, based on the preliminary WTG layout and dimensions. Further consultation with these operators is not considered necessary.

4.7 Aircraft navigation systems and radar

DNV 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 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 Bureau's part-time wind finding radar installations ceased in August 2019 [18].

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 [19] [20].

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 Bureau'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 [21] [22], and approximately 100 km at a height of 1000 m [22]. 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 WTGs should not be located within 5 km of a meteorological radar site, due to the high potential for complete or partial blockage of the radar signal and subsequent loss of weather data [23, 24]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of WTGs causing reflection or scattering of the radar signals or interfering with Doppler velocity measurements. At distances of between 20 km and 45 km, the presence of a wind farm may produce radar echoes or signal clutter that can cause loss of data or be mistaken for rain. Significant impacts are generally not expected for wind farms located more than 45 km from a meteorological radar, since in most cases the WTG will below the radar scan line of sight. However, the WMO notes that these guidelines are only applicable to typical radar installations in flat terrain and may need to be modified for higher-powered radars or specific situations.

Recent advice received from the Bureau also suggests that there may be potential for interference to meteorological radar operations from wind farms over much greater distances than indicated by the WMO guidelines, depending on the relative elevations of the radar and the wind farm and the intervening terrain.

According to the Draft National Guidelines, operators of weather radars within 250 nautical miles (463 km) of the proposed Project should be consulted [3]. DNV has identified that the Bureau operates 12 weather radars within that range, with the closest being the Darling Downs radar

located approximately 76 km southeast of the Project site at Wichello. The locations of these radars are shown in Figure 10 and the details of each radar are given in Table 16.

Although the distance between the Project and the nearest Bureau radar is greater than the distances at which the WMO suggests impact may occur, consultation with the Bureau is needed to determine the potential for interference.

DNV has contacted the Bureau 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. The response received from the Bureau indicates that the Project has potential to materially impact the operation of their Darling Downs radar at Wichello. Specifically, analysis undertaken by the Bureau has suggested that, based on the current WTG layout and dimensions, up to two-thirds of the WTGs at the Project have the potential to be visible on the first three scan angles for the Darling Downs radar and hence interfere with weather monitoring and predictions from this facility. The Bureau has also noted that WTGs 127 and 128 are expected to be visible to the Mt Kanigan radar.

To minimise the potential for impacts to their services and operations, the Bureau has requested that the Developer enter into a formal legal agreement to establish a strategic collaborative framework with the Bureau that will enable the Project to proceed while minimising and managing the potential impacts on the Bureau's operations. The Bureau has provided a template for an agreement, which requires that the Developer commit to:

- informing the Bureau of the final WTG layout for the Project and changes to the Project design, including changes to the WTG locations or height
- giving the Bureau advance notice of any planned shutdown of the Project, to allow the Bureau to calibrate their systems while the WTGs are not operating and hence account for the presence of the Project in their signal processing and interpretation
- collaborating and cooperating with the Bureau in the event of severe weather conditions in the interests of community safety, where such cooperation may include complying with a request from the Bureau to shut down selected WTGs during critical weather conditions for an agreed period of time.

The Queensland Planning Guidance for State Code 23 states that a mitigation strategy should be developed to reduce the potential EMI impacts of the Project on nearby radiocommunication services, and hence protect those services from interference as required by performance outcome PO3. However, it is noted that there is no requirement under State Code 23 to enter into legal agreements with the relevant operators that would potentially involve shutting down WTGs in the event of interference.

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 WTGs. 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 [25].

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 [26]. 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) [27], 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, and several private and state-based GNSS CORS networks. 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.

The closest GNSS station is located approximately 39 km north of the Project, at Proston [28]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network.

DNV has also undertaken a review of the primary geodetic network of Australia [29] and has observed that the Project is located within the second-order triangulation region. First-order triangulation depends on trigonometrical stations 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.

According to Geoscience Australia [30], there are eight trig points within 20 km of the Project site boundary. The details of all eight trig points are provided in Table 17 and illustrated in Figure 11. Figure 11 also shows the 284 survey marks identified by the Queensland Government within 20 km of the Project site boundary [31].

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 has contacted Geoscience Australia and the Department of Resources (formerly the Department of Natural Resources, Mines and Energy) to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

The responses received from Geoscience Australia and the Department of Resources, based on the preliminary WTG layout and dimensions, indicated that they do not expect the Project to have any impact on their assets and operations. However, the Department of Resources have asked that the WTG towers be kept clear of a 150 m radius around each survey mark. The requested clearance

zones for the survey marks are shown in Figure 12. There are no WTGs located within the requested clearance zones for the Queensland Government survey marks.

Further consultation with Geoscience Australia and the Department of Resources is not considered necessary.

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 and is easily hindered by hilly terrain and forested areas. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. Repeater stations are 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.

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. The impact of the Project on CB radio services is expected to be minimal. In the event of interference from the WTGs, simple steps such as moving a short distance until the signal strength improves would help to mitigate the impact.

4.11 Mobile phones

Mobile phone networks typically operate at frequencies of either between 700 and 900 MHz, or between 1800 MHz and 2600 MHz, however some new services may operate at up to 3500 MHz. At such frequencies, signals are likely to be affected by physical obstructions such as buildings and WTGs. 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 WTGs 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 WTGs could cause some interference to the signal, although there is little evidence of this in the literature.

DNV has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 13. The nearest mobile phone tower is located approximately 4 km south of the Project boundary.

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

Figure 14 and Figure 15 show the Optus network coverage for the Project area [32]. Coverage is patchy across most of the Project site and surrounding area, with 3G and 4G coverage being either non-existent or dependent on an external antenna in many areas, although outdoor 3G and 4G coverage is available without the need for an external antenna in some locations to the east and southeast of the site.

Figure 16 and Figure 17 show the Telstra network coverage for the Project area [33]. Coverage on the 3G and 4G networks is available to the northeast, east, and southeast of the Project, but most other areas around the Project site have either patchy or no coverage.

Figure 18 shows the Vodafone network coverage for the Project area [34]. Coverage is available across most of the Project site, although there are some locations within the site boundaries and to the north of the site where no coverage is available. Locations to the east and west of the Project can receive outdoor 3G or 4G coverage, but indoor 4G coverage is broadly restricted to areas in the south and southeast.

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 WTG intercepts the signal between a mobile phone and the tower.

DNV has contacted Optus, Telstra, and Vodafone to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. The responses received from all three operators, based on the preliminary WTG layout and dimensions, indicated that they do not expect the Project to have any impact on their mobile phone services. Further consultation with these operators in relation to potential impacts on their mobile phone services is not considered necessary.

In cases of marginal network coverage, simple procedures are available to mitigate interference, such as moving a short distance to a new or higher location until the signal improves, or using an external antenna to improve the signal.

4.12 Wireless internet

Residents in the vicinity of the Project are likely to use wireless broadband services provided by Optus, Telstra, and Vodafone, where network coverage is available. 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, the presence of WTGs is unlikely to cause any interference. However, should interference occur, the simple mitigation options given in Section 4.11 may be applicable.

The National Broadband Network (NBN) website [35] indicates that the network is currently available as a fixed wireless service in areas to the southeast of the Project site, and as a satellite internet service using the NBN SkyMuster I and II satellites in other areas. 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 13, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 19. Given the relative positions of the NBN towers and coverage areas, it is considered unlikely that the Project will impact users of the NBN fixed wireless service.

DNV 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, based on the current WTG layout and dimensions, has indicated that they do not expect the Project to have any impact on their fixed wireless internet service. However, NBN Co has requested that the Customer provides details of any radiocommunication equipment planned to be used during construction or operation of the Project, once this information is available, so that any potential for interference from that equipment can also be assessed.

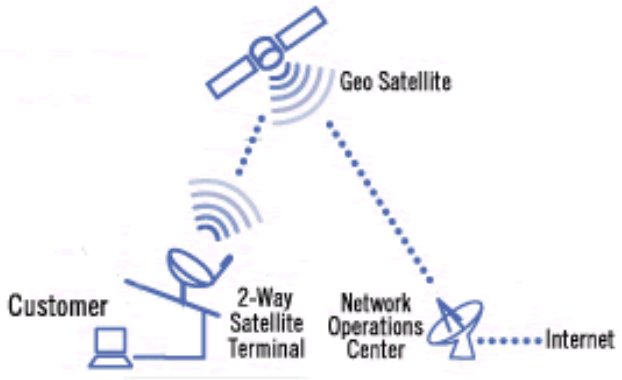
The potential for signals from the NBN SkyMuster I and II satellites to be intercepted by WTGs at the Project has been considered as part of the analysis described in Section 4.13.

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. 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 SkyMuster I and II satellites.



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

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. Although only a small number of satellites are likely to be providing services specifically intended for Australian audiences, DNV has considered the line of sight to dwellings in the vicinity of the Project from all theoretically viewable satellites.

The results of the analysis are shown in Table 18 and summarised in Table 5. Based on these results, WTGs at the Project may intercept signals from 42 satellites at 34 nearby dwellings. Seven of these dwellings have been identified by the Customer as sheds and two are associated dwellings, one of which has been identified as uninhabited.

DNV understands that all the potentially affected satellites shown in Table 18 provide television signals intended for international audiences or are used for private communication systems, and considers it unlikely that residents in the vicinity of the Project will currently be receiving signals from these satellites. Many of the satellites have a low angle of elevation above the horizon at the wind farm site location, and so degradation caused by atmospheric effects or interference from terrain or other obstacles may already prevent the signals from being received at the affected dwellings. For some of these satellites, the programs transmitted on the beam footprints that cover Australia may also be available through other satellite services which have a higher angle of elevation above the horizon and are not expected to be intercepted by WTGs at the Project. If residents are not currently receiving signals from the satellites identified in Table 18, either by choice or because those signals are not available due to existing degradation or interference, there will be no potential for the Project to impact on those services.

Table 5 Number of satellites with potential for signals to nearby dwellings to be intercepted by the proposed Project

Satellite service	Number of potentially affected satellites	Number of potentially affected dwellings
Services intended for Australian audiences	None	None
Services intended for international audiences	42	34 (2 associated dwellings, one of which has been identified as uninhabited, and 8 sheds)

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. The locations of AM and FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [39], and are shown in Figure 20.

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 WTGs), 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.

As AM radio signals are able to propagate around obstructions such as WTGs, 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 WTG [40]. 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 WTGs 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 [41]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of WTG, where the signal-to-noise ratio is low [40] [42]. It is unlikely that any permanent FM radio receivers will be located sufficiently close to the Project to be affected.

WTGs 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 WTG, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [41]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing WTG. 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 WTGs are located within approximately 4 km of the transmission tower [43].

The closest FM broadcast transmission tower is located approximately 23 km from the proposed site boundary. Due to the considerable distance between the transmission tower and the site, it is not expected that the Project will cause interference to the FM radio signals from this tower.

Due to the low risk of interference to FM radio broadcasting, DNV has not specifically consulted with the operators of nearby broadcasting towers. However, through the consultation process BAI Communications, who operate both television and FM radio broadcasting services from a tower at Mt Mowbullan, indicated that they also consider there is a low risk of impact to FM transmissions.

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

In addition to these mitigation options, DNV understands that the Developer is willing to perform a pre-construction baseline survey of existing radio broadcasting signals in the area around the Project, if required as a planning condition, to assess the potential risk of interference and allow any post-construction impacts attributable to the Project to be identified and rectified.

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 all Australian capital cities [44]. 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. According to the digital radio coverage search functions available on the Digital Radio Plus website [45], the Project is outside the intended service area for digital radio broadcasts. Since it is therefore unlikely that residents in the vicinity of the Project are currently receiving digital radio signals, it is not expected that the Project will cause interference to these services.

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 [39]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from WTGs. DNV 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 [41] 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 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 WTGs.

The ACMA Broadcast Transmitter Database [39] was examined to identify broadcasters nearby to the proposed Project, with those found shown in Figure 20. The main television transmitter used by residents in the vicinity of the Project is the Darling Downs transmitter at Mt Mowbullan. However, it is also possible that some residents may receive television signals from the Wide Bay transmitter at Woowoonga.

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

- the proximity of WTGs to the television broadcast tower
- the proximity of WTGs to receivers (dwellings)
- the location of WTGs 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 Large scale interference

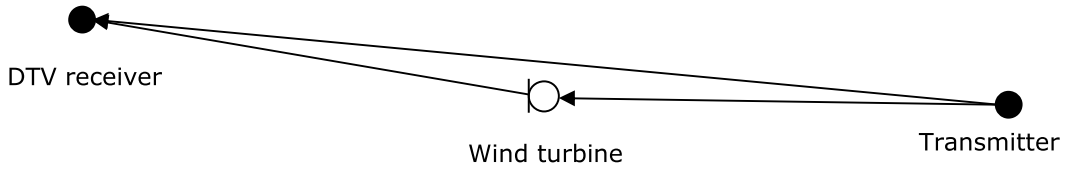
For broadcast signals, large scale interference can generally be avoided by placing the WTGs distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay television transmitters are more commonly found in rural areas. Primary television

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 television transmitters, while a clearance of at least 6 km is recommended for primary television transmitters [10]. The closest digital television transmitter to the Project is the Darling Downs transmitter at Mt Mowbullan, which is approximately 22 km away, and so the Project is not expected to cause large scale interference.

4.15.2 Forward and back scatter

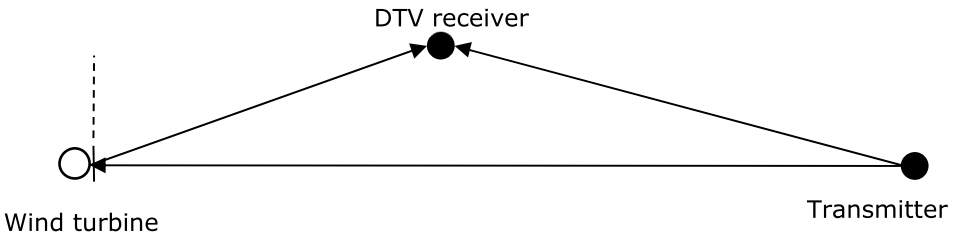
WTGs cause interference to television signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A WTG has the potential to scatter electromagnetic waves carrying television signals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

Forward scatter can occur when the transmitter, one or more WTGs, 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 WTG, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [46]. Both of these effects can potentially degrade the DTV signal quality.



Forward scatter signal path

Back scatter from WTGs occurs when DTV signals are reflected from WTG towers and WTG blades onto a DTV 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).



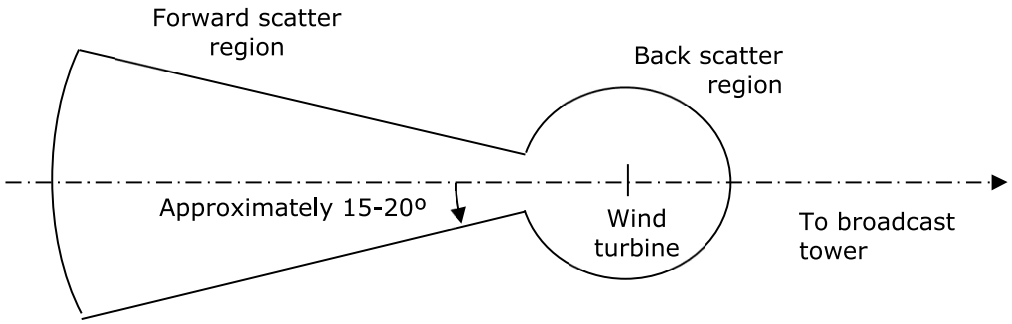
Back scatter signal path

Interference of DTV signals from WTG developments can potentially occur in both the forward and backward scatter region. The effect of a WTG on a DTV signal can be different depending on the scattering region where the receiver is located [46].

According to Ofcom [41], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [10] [47]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the WTGs [41]. 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 ±15° to ±20°, 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 [10] [41], 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 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 WTG

Television interference mechanisms rely on many factors (as previously mentioned) 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, digital television signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. ITU Recommendation BT.1893 [48] 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 (±60° 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, WTGs are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [49] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more WTGs, 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 [49].

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 WTGs, 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 4.15.4.

4.15.3 Theoretical models for WTG 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 [50]. 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 [48], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally, DNV notes that it only applies to a single WTG rather than a wind farm as a whole. Due to the lack of an accurate scattering model, DNV 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 WTG location [41]. 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 WTG in the Project, and hence have an increased likelihood of experiencing interference to television signals, are described in Section 4.15.4.

4.15.4 Potential impacts for dwellings

According to the Australian Government mySwitch website [51], the area around the Project is able to receive DTV signals from the Darling Downs and Wide Bay broadcast towers. The coverage maps

for the Darling Downs and Wide Bay broadcast towers are reproduced in Figure 21 to Figure 22 respectively.

Although DTV signals are generally unlikely to be susceptible to interference from WTGs 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 WTG 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.

While signal coverage from the Darling Downs tower is 'variable' to 'good' across most of the Project site and surrounding areas, there are some areas to the west and southwest of the Project where coverage from this tower is marginal or non-existent. DNV understands that this effect is due to obstruction of the broadcast signals by Mt Mowbullan in the Bunya Mountains approximately 23 km south of the Project site. As such, there is a risk that some dwellings in the vicinity of the Project may be screened from the Darling Downs tower and could receive a reflected signal from WTGs at the Project that is stronger than the direct signal from the transmitter.

Signal coverage from the Wide Bay tower is generally poor to non-existent across the area around the Project site, and so it is likely that most residents will not be receiving signals from this tower.

Dwellings that have increased potential to receive back-scattered or forward-scattered signals from a WTG 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 Table 19 and Figure 21 to Figure 22. The dwellings that are most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 6 below. 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. In particular, although DNV has considered the potential for interference to DTV signals at dwellings within 5 km of the proposed WTG locations, previous advice received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, has indicated that interference to DTV broadcasting may be experienced at distances of up to 10 km from WTGs. For comparison, Figure 21 to Figure 22 also show the area within 10 km of the proposed WTG locations, although a more detailed assessment would be required to determine whether there is any potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

Dwellings within the Project boundary and to the north and west of the Project have increased potential to experience interference to DTV signals from the Darling Downs broadcast tower, particularly in areas where the signal is already marginal. Due to signal obstruction caused by Mt Mowbullan, as discussed above, dwellings to the west of the Project could receive a reflected signal from the WTGs that is stronger than the signal from the transmitter. Signals received from the Darling Downs tower at dwellings in this area may therefore be especially susceptible to interference.

The potential interference zone for the Wide Bay broadcast tower includes several dwellings located to the south and west of the Project. However, the coverage map in Figure 22 shows that there is

little to no signal coverage from this tower in the potentially-affected areas. Since it is unlikely that these dwellings are currently receiving signals from the Wide Bay tower, the consequences of any interference are expected to be low.

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
Darling Downs (Mt Mowbullan)	22 (3 associated dwellings, one of which has been identified as uninhabited, and 10 sheds)	Variable to good to the north of the site Marginal to the west and southwest of the site due to terrain shadowing from Mt Mowbullan
Wide Bay (Woowoonga)	24 (5 associated dwellings, one of which has been identified as uninhabited, and 7 sheds)	Limited – dwellings in the potential interference zone are unlikely to be receiving signals from this tower

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, however conditions in the vicinity of this Project may warrant a more detailed analysis as described above. If reception difficulties are encountered, there are a number of mitigation options available as discussed in further detail in Section 4.15.5.

DNV has contacted BAI Communications, who are responsible for broadcasting of national public television services in Australia, 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 WTGs at the Project to interfere with DTV signals from the Darling Downs broadcast tower, based on the third interim WTG layout and dimensions [52]. The method used involved modelling the reflection or scattering of DTV signals from the WTGs, and identifying locations within 10 km of the Project where the resulting C/I ratio would be less than required for adequate signal reception. Based on population density data for the area around the Project, BAI Communications concluded that up to six residents are at low risk of experiencing DTV interference from the Project. DNV has also provided the current WTG layout and dimensions to BAI Communications for their review and feedback, but no response has been received to date.

The results of the modelling conducted by BAI Communications are compared to the interference zones established by DNV for the Darling Downs broadcast tower in Figure 23. The findings of both analyses are broadly consistent, with the greatest impact expected to be confined to the Project site and immediate surrounds. However, there are some areas identified as having potential for impact in one assessment that have not been identified in the other. In particular, the BAI Communications modelling suggests that interference may be experienced in areas to the south and southwest of the Project that are not within the potential interference zones established by DNV. Based on the coverage map for the Darling Downs tower, it is possible that dwellings in these

areas may not have a direct line of sight to the transmitter and could therefore could receive a backscattered signal from the WTGs that is stronger than the signal from the transmitter.

DNV notes that there are limitations associated with both assessments considered here. While the method used by DNV is based on a simplified geometric approach, as described above, the BAI Communications results are highly discrete and may not fully represent the potential impacts of the Project. Although the number of potentially-affected residents determined from their modelling is low, BAI Communications has recommended undertaking a more detailed assessment of the potential for impact to DTV signals from the Darling Downs tower and adopting a precautionary approach in the design of the Project to minimise the risk of interference.

4.15.5 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 dwelling's television antenna more directly towards their existing transmitter.
2. Tuning the dwelling'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. 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 [46] DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [49] 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 [53].

In addition to the mitigation options described above, DNV understands that the Developer is willing to perform a pre-construction baseline survey of existing DTV broadcasting signals in the area around the Project, if required as a planning condition, to assess the potential risk of interference and allow any post-construction impacts attributable to the Project to be identified and rectified.

5 EMI CAUSED BY METEOROLOGICAL MASTS

The presence of meteorological masts can potentially cause EMI to radiocommunications signals and services through the same mechanisms as for other physical obstacles such as WTGs. Diffraction or obstruction of signals by meteorological masts may decrease the signal strength or quality at the receiving antenna. Similarly, reflection, scattering, or re-radiation of signals by masts can reduce the strength of the received signal or cause multi-path errors that result in degradation or distortion of the primary signal from the transmitter. Near-field effects may also occur if the mast is located too close to a transmitting or receiving antenna. The potential for interference depends primarily on the signal characteristics and the location of the mast in relation to the transmitting and receiving antennas. The susceptibility of different radiocommunication signals and services to EMI from physical obstructions is discussed in Section 4. However, since meteorological masts are predominantly static structures and considerably smaller than modern WTGs, the potential for a mast to cause EMI through its physical presence is likely to be less than for a WTG.

For the purpose of the EMI assessment, a meteorological mast design consisting of up to a 166 m tall steel lattice tower with a width of approximately 500 mm has been considered [54] [55]. Based on standard configurations for similar sized masts, DNV expects that the instruments will be mounted on boom arms with a length of approximately 3.5 m from the centreline of the mast. The masts are expected to be supported by a series of guy wires, with the outermost wires attached near the top of the mast and anchored at a distance in the order of 100 m from the base of the mast.

The potential for interference to point-to-point links through diffraction, reflection or scattering, or near-field effects can usually be avoided by keeping clear of an appropriate exclusion zone around the link path or the transmitting or receiving antenna, as described in Section 4.3. To avoid interference to point-to-point links caused by signal diffraction, static structures such as meteorological masts should be kept outside of an exclusion zone based on some fraction of the first Fresnel zone (typically 60% to 100%) [9] [10] [11]. Reflection or scattering of signals from tall steel structures like meteorological masts can be significant [41], although this is only expected to be an issue if the mast is sufficiently close to either the radiocommunication tower or the direct link path. The necessary clearance zone to avoid interference to point-to-point links through near-field effects is a function of the signal frequency and antenna gain [9], and does not depend on the nature of the interfering structure.

For each point-to-point link crossing the proposed Project site, as identified in Section 4.3, DNV has established a diffraction exclusion zone based on the first Fresnel zone for that link and a near-field interference zone based on the signal frequency and antenna gain. Each zone includes a buffer of 5 m to encompass the width of the mast and the length of the boom arms, with some allowance for potential increases in the mast dimensions, and an additional buffer on either side to account for potential inaccuracies in the radiocommunication tower locations. The locations of the point-to-point links, diffraction exclusion zones, and near-field interference zones in relation to the proposed mast locations are shown in Figure 24, along with the clearance zones requested by Telstra as discussed in Section 4.3.5.

There are no meteorological masts located within the exclusion or interference zones established by DNV or the clearance zones requested by Telstra for either of the point-to-point links passing over the Project site. All proposed mast locations are at least 860 m away from the nearest radiocommunication tower, and there are no masts within approximately 7 km of the direct link

paths. Therefore, it is not expected that the masts will cause interference to the point-to-point links through diffraction, reflection, or scattering of the signals or near-field effects.

Meteorological masts can potentially cause interference to point-to-multipoint links through diffraction, reflection, or scattering of the signals as described above for point-to-point links. However, as discussed in Section 4.4.1, consultation with the operators of point-to-multipoint base stations within 60 km of the Project has suggested that there are no point-to-multipoint links passing over the Project in the vicinity of WTGs. Therefore, since the proposed meteorological mast locations are close to (or the same as) the proposed WTG locations, it is not expected that the masts will interfere with point-to-multipoint links.

Based on the relative locations of the meteorological masts and nearby dwellings, and the NBN fixed wireless towers and service coverage areas shown in Figure 19, it is also not expected that the masts will interfere with NBN fixed wireless internet signals.

Structures such as meteorological masts may theoretically cause interference to point-to-area style services such as radio and DTV broadcasting or mobile phone services through physical obstruction or reflection or scattering of the signals [41]. However, as discussed in Sections 4.11, 4.14, and 4.15, these services are typically designed to operate in the presence of obstructions and are therefore unlikely to be affected by masts. The potential for interference to point-to-area services depends on the locations of the mast and receiving antenna with respect to the transmitted signal. The nearest dwelling is located approximately 1.3 km from the nearest temporary meteorological mast, and 1.6 km from the nearest permanent mast, at which distance impacts to television and radio broadcasting from similar types of structures are generally considered unlikely [56]. If interference is experienced, the mitigation options given in Sections 4.11, 4.14, and 4.15 may be applicable. The proposed locations of the masts are sufficiently far from transmission towers for DTV, radio, and mobile phone signals to avoid any large-scale interference.

DNV is not aware of any evidence in the literature of structures such as meteorological masts causing significant interference to other types of services such as meteorological radar, GNSS signals, and satellite television or internet signals. Therefore, impacts to these services from the proposed masts are considered unlikely.

Nevertheless, DNV has provided information about the proposed meteorological masts to those organisations who have previously expressed concerns about the potential for the Project to interfere their licences or services, for their review and feedback. To date, no concerns have been raised regarding the potential for the meteorological masts to interfere with nearby radiocommunications.

6 EMI CAUSED BY ELECTROMAGNETIC EMISSIONS FROM WTGS

6.1 Radiated and conducted disturbances

Most electromagnetic emissions produced by electrical equipment such as WTGs can be broadly categorised as either radiated or conducted disturbances. Radiated disturbances include both electromagnetic fields (EMF) and electromagnetic radiation (EMR), while conducted disturbances include harmonics, voltage and power fluctuations, and electrical transients [57]. These emissions have the potential to interfere with radiocommunications equipment or other forms of electronic circuitry.

EMF is a physical field produced by a moving electric charge that consists of both an electric field component and a magnetic field component. The strength of the electric field is proportional to the voltage of the EMF source, while the strength of the magnetic field is proportional to the current. Both the electric field strength and the magnetic field strength decrease rapidly as the distance from the source increases. Electric fields are effectively shielded by earthed conductive materials, and to a lesser extent by other opaque objects, but magnetic fields are able to pass through most common materials without attenuation. However, for both electric and magnetic fields, the presence of an opposing field of equal magnitude will act to cancel the original field and produce a net field strength of zero. In practice, this can be achieved by using adjacent wires carrying electricity with opposing voltages or phases and opposing currents. EMF associated with the generation, distribution, and use of electricity is classified as extremely low frequency (ELF) EMF.

EMR describes the propagation of electric and magnetic energy through space, far from the original source, in the form of electromagnetic waves. All electrical equipment produces EMR, although the amount of power radiated depends on the characteristics of the source. For some equipment, such as transmitting antennas used in telecommunication systems, EMR is intentional and necessary for the operation of that equipment. In most cases, however, EMR is an undesired effect and is limited by design to comply with mandatory standards. The power radiated by transmission lines, wiring, and many other electrical components operating normally at 50 Hz is so small that these sources are not typically classified as radiating systems.

Unlike radiated disturbances, which can propagate through space away from the original source, conducted disturbances are generated internally by a device and propagate along interconnected cables and power lines. Interference from conducted disturbances can therefore only occur when there is a direct electrical connection between the source of the disturbance and the affected system or equipment. Conducted disturbances may be caused by a discontinuous switching of energy, such as in thermostatically or electrically controlled appliances, or by a continuous timed switching of energy at a given frequency, such as in electric motors, switch mode power supplies, and micro-controllers.

6.2 Potential impacts of electromagnetic emissions

Modern WTGs are typically designed, constructed, and operated in accordance with international and local standards and accepted industry practices, which limit the potential for electromagnetic emissions. IEC standard 61400-1 for WTG design cites several other standards that are relevant to the electromagnetic compatibility (EMC) of WTGs [58]. With respect to electromagnetic emissions, WTGs certified to IEC standard 61400-1 must also comply with the requirements of IEC standard 61000-6-4, which are intended *"to ensure that disturbances generated by apparatus operating normally… do not exceed a level that could prevent other apparatus from operating as intended"*

[59]. WTGs also contain sensitive electronic components that may themselves be affected by electromagnetic emissions, which provides further incentive for WTG manufacturers to control radiated and conducted disturbances at the source.

EMF strengths associated with wind farms are generally considered low. The electric fields produced by cabling in the tower of a WTG will be shielded by the tower itself, which is earthed, but electric fields produced in the nacelle may not be completely shielded. However, voltages used in the nacelle are typically low, which corresponds to low electric field strengths. Additionally, the cables for the three phases of power are located in close proximity and balanced such that the resulting electric fields will tend to cancel each other out, even when high voltages are used. Similarly, the use of adjacent wires carrying currents flowing in opposite directions causes the magnetic fields generated by those currents to cancel out. Other electrical components used in wind farms are typical of similar equipment used in other installations and do not pose a unique risk of EMF. Scientific studies have found that the EMF associated with operating wind farms is indistinguishable from background levels at 2 m to 3 m from the WTGs [60] [61].

Common sources of EMR in WTGs include switch mode power supplies, microprocessors, and variable speed drives. These types of components are widely used in other devices in homes, offices, and industrial environments, and are designed to meet standards that limit their emissions. In WTGs, these components are typically housed inside metal panels, which absorb the emitted energy and provide a shielding effect, and are located within the WTG tower or other metallic components such as the hub, which provides further shielding.

Field measurements of EMR from operating WTGs were conducted by DNV in 1992, in response to concerns regarding the potential EMI impacts of a proposed wind farm on nearby telecommunication systems [62]. Measurements were carried out at various locations relative to the WTGs, and across all frequencies of interest for EMC purposes. The study found that EMR from the WTG was only detectable when the measurement equipment was located inside the WTG tower. These emissions were attributed to the switch mode power supplies within the WTG control unit. When measurements were taken outside the tower, with the tower door shut, no emissions were detected. These results demonstrated that, rather than amplifying electromagnetic emissions, the earthed tubular steel construction of the WTG tower behaves as a shield for both EMF and EMR. Although newer WTGs contain additional components with the potential to cause EMR, EMC standards designed to control such emissions have also evolved, and it is expected that the conclusions of this study will be broadly applicable to any WTG with a tubular steel tower whose components are built to the applicable standards. In a more recent study into the potential EMI impacts of a proposed wind farm on a radar test facility, theoretical calculations predicted that the electromagnetic emissions from 191 WTGs at a distance of three miles would be considerably less than the limits specified by IEC 61000-6-4 [59], even under worst case conditions, and that the emissions from an individual WTG would be almost undetectable in practice [63].

The main source of conducted disturbances for a wind farm is high-frequency signal switching in the power converters located in each WTG. These power converters are designed to meet harmonic voltage distortion levels set by the appropriate EMC standards, which reduces the potential for interference with other systems. The Australian National Electricity Rules [64] also contain requirements designed to limit the harmonic voltage distortion caused by grid-connected generators in accordance with the relevant Australian and international standards. In addition, radiocommunication systems will typically be connected to the electricity grid at a different point of connection to any nearby wind farm developments. Consequently, any harmonic distortion

produced by a wind farm is expected to be largely damped by the intervening electrical transformers.

Given that WTGs are typically constructed in accordance with standards that are recognised EMC regulations in Australia, and the nature of WTG and wind farm design means that any emissions are likely to be counteracted, shielded, or damped, DNV considers it unlikely that electromagnetic emissions from the Project will have an adverse effect on radiocommunications services in the surrounding area.

7 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 up to 97 WTGs. DNV has considered a WTG geometry that will be conservative for WTG configurations with dimensions satisfying all of the following criteria: a rotor diameter of 180 m or less, an upper tip height of 280 m or less, and a lower tip height of 64 m or more. At the request of the Customer, DNV has also considered the potential for EMI to be caused by four temporary meteorological masts and three permanent meteorological masts that are proposed to be installed at the Project site.

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

Based on this assessment, DNV expects that the Project will achieve performance outcome PO3 of State Code 23 (which requires that the Project be designed, located, and sited to protect pre-existing radiocommunications from EMI-related impacts) once necessary micro-siting of turbines, mitigation, and stakeholder liaison has occurred. Feedback received from the Bureau of Meteorology (the Bureau), Telstra, and BAI Communications indicates that there is a potential for the Project to impact on their services and operations. As outlined below, these impacts may be managed through micro-siting of turbines, appropriate mitigation measures, or ongoing liaison between the Developer and relevant stakeholders. In most other cases, where a potential for EMI exists, the overall impact is likely to be low or it is expected that options will be available to mitigate that impact.

The main way that a wind farm can interfere with radiocommunication signals is by the physical presence of the WTGs causing obstruction, diffraction, scattering, or near-field effects. Given the nature of the wind farm and WTGs design, it is considered unlikely that electromagnetic emissions from the Project will cause interference to radiocommunication services in the surrounding area. It is also considered unlikely that the temporary and permanent meteorological masts proposed as part of the Project will cause material interference to nearby radiocommunication services.

Based on the WTG layout considered in this assessment, there is one WTG located within the clearance zone requested by Telstra for one fixed point-to-point radiocommunication link passing over the Project boundaries. However, DNV understands that the Developer is intending to micro-site this WTG to be outside the requested clearance zone prior to construction of the Project. While there are also two WTGs located within the potential reflection or scattering interference zone established by DNV for this link, neither of which are located within the clearance zone requested by Telstra, Telstra have not expressed any concerns about the potential for WTGs outside of their requested clearance zone to cause interference.

Feedback received from the Bureau indicates that there is potential for the Project to materially impact on the operation of their Darling Downs radar facility at Wichello, and the associated weather monitoring and prediction services. To help manage and mitigate these impacts, the Bureau has asked the Developer to formally commit to advising the Bureau of the final WTG layout and any changes to the Project design, notifying the Bureau prior to any planned shutdown of the Project to allow calibration of their systems, and cooperating with any requests from the Bureau to temporarily shut down selected WTGs in the event of severe weather conditions.

Interference is possible for point-to-area style communications such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal

signal coverage. Dwellings in the vicinity of the Project may experience interference to digital television signals from the Darling Downs broadcast tower, particularly in areas to the west of the Project where there is potential for dwellings to receive a reflected signal from a WTG that is stronger than the signal from the transmitter. Feedback received from the operator of the Darling Downs tower, BAI Communications, also suggests that some residents in the vicinity of the Project are at risk of experiencing interference to these signals. While digital television signals from the Wide Bay broadcast tower may also be impacted, the coverage maps suggest that most of the potentially-affected dwellings are unlikely to be receiving signals from that tower. The overall risk of interference to mobile phone and radio broadcasting services is relatively low, and DNV notes that no concerns have been raised by any of the relevant operators.

If interference to these services is experienced, a range of options are available to rectify issues. These may involve realigning or upgrading the user's antenna at affected residences, increasing the signal strength from the transmission tower, or installing a signal repeater on the opposite side of the Project. To further evaluate the potential for interference to television broadcasting signals, BAI Communications has recommended undertaking a more detailed assessment of the likely impacts. DNV also understands that the Developer is willing to perform a pre-construction baseline survey of existing radio and television signals in the area around the Project, if required as a planning condition, to assess the potential risk of interference and allow any post-construction impacts attributable to the Project to be identified and rectified.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely impacts. DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact. Concerns raised by South Burnett Regional Council about the potential for interference from electromagnetic emissions and reflection or scattering of signals in their point-to-multipoint network have been addressed by DNV to the satisfaction of the Council, and interference to these assets is not expected. Apart from the potential for interference noted by the Bureau, Telstra, South Burnett Regional Council, and BAI Communications, no concerns have been raised.

DNV notes that the Project is located in an area of high wind farm development activity, with several wind farms in various stages of development nearby. The potential cumulative impacts of the Project in conjunction with the nearby wind farms have not been presented in this report.

DNV understands that the Developer is seeking to apply a 100 m micro-siting allowance to all proposed WTG locations. As noted above, this will allow WTGs to be relocated to be outside the clearance zone requested by Telstra for their point-to-point link passing over the Project boundaries prior to construction, hence reducing the potential for interference to that link. For all other radiocommunication services considered in this assessment, provided that the clearances detailed in this report are maintained, DNV considers it unlikely that movement of the WTGs within the 100 m micro-siting allowance will change the conclusions presented here.

Table 7 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact based on DNV assessment	Stakeholder feedback (to date)
Radio-communication towers	One tower within 2 km of proposed WTG locations Nearest tower: 870 m from WTGs	Potential for interference – see findings for point-to-point links	No concerns raised regarding proximity of WTGs to the tower
Fixed point-to-point links	Two links crossing Project boundary, operated by Telstra Diffraction effects: no WTG in exclusion zones established by DNV, one WTG in requested clearance zone for one link Reflection/scattering effects: two WTGs in potential interference zone established by DNV for one link Near-field effects: no WTGs in potential interference zones established by DNV	Potential to cause interference to one link through reflection or scattering of signals	Clearance zone of 200 m either side of link path requested by Telstra – one WTG located within requested clearance zone for one link
Fixed point-to-multipoint links	68 assignments within 75 km of Project boundary One base station within 20 km of Project boundary, operated by Fransfarm Pty Ltd	Unlikely to cause interference	No concerns raised by the Bureau, Ergon Energy, Fransfarm Pty Ltd, Department of Transport and Main Roads, Seqwater, Stanwell Corporation Concerns raised by South Burnett Regional Council – satisfactorily addressed by DNV, no further concerns raised
Other licence types	Base to mobile station style communications: unlikely to be affected (see "Emergency services", "Mobile phones", "Radio broadcasting", "Television broadcasting") Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-	-
Emergency services	Point-to-point links: no links crossing boundary Base to mobile station style communications: unlikely to be affected	Unlikely to cause interference	No concerns raised

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

Licence or service type	Assessment findings	Expected impact based on DNV assessment	Stakeholder feedback (to date)
Meteorological radar	Nearest radar: Darling Downs, 76 km from Project	Potential for interference if WTGs can be detected by radars	Concerns raised regarding potential for interference to Darling Downs radar The Bureau has asked the Developer to enter into a formal agreement to advise the Bureau of the final WTG layout and any changes to the Project design, notify the Bureau prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the Bureau in the event of severe weather conditions
Trigonometrical stations	Eight stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by WTGs Survey mark clearance zones: no WTGs in requested clearance zones	Unlikely to cause interference	No concerns raised
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	-
Mobile phones	Good coverage to the east and southeast, limited coverage elsewhere Unlikely to be affected, may experience interference in areas with marginal coverage	Potential for interference	No concerns raised
Wireless internet	Available services: mobile phone networks, NBN NBN: available as a fixed wireless and satellite service in areas surrounding the Project	Potential for interference to mobile services Unlikely to cause interference to NBN	No concerns raised
Satellite television and internet	Services intended for Australia: unlikely to be affected Other services: signals from 42 satellites intercepted at 34 dwellings (2 associated dwellings, one of which has been identified as uninhabited, and 7 sheds)	Potential for interference to services intended for international audiences	-

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

Licence or service type	Assessment findings	Expected impact based on DNV assessment	Stakeholder feedback (to date)
Radio broadcasting	AM and FM signals: may experience interference in close proximity to WTGs Digital radio signals: Project is outside the intended coverage area	Potential for interference to AM and FM signals	No concerns raised
Television broadcasting	May experience interference in areas with poor or marginal reception *Darling Downs tower: 'variable' to 'good' coverage across most of the site, 'poor' to 'variable coverage to the west and southwest* 22 dwellings (3 associated dwellings, one of which has been identified as uninhabited, and 10 sheds) in potential interference zone *Wide Bay tower: 'poor' to non-existent coverage* 24 dwellings (5 associated dwellings, one of which has been identified as uninhabited, and 7 sheds) in potential interference zone, although potentially-affected dwellings may not be receiving signals from this tower	High potential for interference, especially to the west of the Project Potential for interference	Potential for interference to signals from the Darling Downs tower for up to 6 residents BAI Communications expects any impact to be rectified as part of the Project

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LIST OF TABLES

Table 8 Proposed WTG layout for the Project site [4]

WTG ID	Easting[1] [m]	Northing[1] [m]	Based elevation[2] [m]	WTG ID	Easting[1] [m]	Northing[1] [m]	Based elevation[2] [m]
T1	358373	7047561	514	T72	354277	7057258	495
T3	358115	7048069	516	T73	345794	7057309	473
T4	354061	7048104	580	T74	355083	7057375	490
T5	354742	7048122	557	T75	351627	7057609	527
T6	355302	7048317	544	T76	356853	7057663	477
T7	357725	7048612	520	T77	346592	7057753	489
T8	356329	7060549	460	T78	345795	7057807	470
T10	357592	7059734	458	T80	351580	7058168	520
T11	357613	7049179	544	T82	350517	7058495	500
T13	354575	7049425	543	T83	348500	7058583	456
T17	355459	7049850	547	T84	356277	7058557	513
T21	349902	7050210	576	T85	346929	7058639	450
T22	355855	7050269	546	T86	357025	7058599	481
T23	350828	7050310	553	T87	351147	7058647	519
T25	350170	7050696	560	T88	352204	7058852	514
T26	351175	7050736	536	T89	350030	7059013	520
T27	354086	7050802	544	T90	355701	7059156	476
T29	355824	7050897	529	T91	351582	7059381	513
T30	348641	7051055	523	T92	354001	7059449	487
T31	350201	7051230	533	T93	356749	7059450	486
T32	352997	7051251	530	T94	349658	7059680	477
T36	350550	7051738	535	T95	348047	7059757	477
T37	352695	7051765	504	T96	351707	7059891	507
T38	356200	7051895	523	T97	357184	7050800	520
T40	349497	7052152	498	T98	347350	7060199	463
T41	350946	7052228	547	T99	353525	7060270	482
T42	351670	7052301	520	T100	347944	7060380	498
T44	353803	7052493	547	T102	351493	7060575	473
T45	356332	7052501	533	T103	346679	7060840	446
T46	352131	7052622	520	T105	348454	7061325	517
T48	351301	7052937	529	T106	349420	7061300	484
T49	354039	7052973	541	T107	345727	7062745	438
T50	350275	7053052	527	T108	346587	7061391	450
T51	353241	7053173	528	T109	352928	7061566	460
T53	350848	7053489	515	T111	346585	7061874	462
T54	353876	7053653	536	T112	352605	7062022	446
T55	354909	7053646	545	T113	349070	7062423	503
T56	352926	7053676	517	T114	347742	7062649	475
T57	351405	7053908	510	T118	350619	7063236	460
T58	355433	7054425	522	T119	346286	7063224	449
T60	347686	7055290	478	T120	346927	7063604	441
T63	352841	7055886	534	T122	351589	7063641	456
T64	347701	7056123	468	T123	348752	7063653	483
T65	356704	7056175	476	T124	347640	7064140	447
T66	354177	7056747	512	T125	348418	7064889	461
T67	352337	7056817	486	T126	349204	7065046	452
T68	347272	7056901	450	T127	349375	7065675	459
T69	356885	7056858	485	T128	349697	7066171	470
T71	347924	7057250	451				

1. Coordinate system: MGA zone 56, GDA94 datum.
2. Base elevations have been determined by DNV based on publicly available SRTM1 data.
3. Based on layout PAUSilf138

Table 9 Proposed meteorological mast locations for the Project [5, 6]

Meteorological mast ID	Easting[1] [m]	Northing[1] [m]	Mast type
TMM 1	358373	7047561	Temporary
TMM 60	347686	7055290	Temporary
TMM 65	356704	7056175	Temporary
TMM 69	356885	7056858	Temporary
MM 1	358781	7047416	Permanent
MM 60	347313	7054984	Permanent
MM 6569	357127	7056458	Permanent

1. Coordinate system: MGA zone 56, GDA94 datum.

Table 10 Potential dwellings in the vicinity of the proposed Project [7]

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest WTG [km]
1	350033	7048010	Not associated	2.2
2	342380	7056737	Not associated	3.5
3	342758	7054371	Not associated	4.2
4	347082	7049227	Not associated	2.4
5	351960	7067211	Not associated	2.5
6	354931	7066259	Not associated	4.2
7	353829	7065016	Not associated	2.6
8	345309	7065736	Not associated	2.7
9	343168	7062331	Not associated	2.6
10	346952	7049270	Not associated	2.5
11	343741	7054626	Not associated	3.4
12	340556	7060027	Not associated	5.7
13	351884	7048043	Not associated	2.2
14	346268	7053150	Not associated	2.6
15	*352581*	*7049680*	*Associated*	*1.6*
16	343622	7055412	Not associated	2.9
17	*344450*	*7060814*	*Associated*	*2.2*
18	*345283*	*7055357*	*Associated*	*2.0*
19[2]	*353716*	*7058498*	*Associated*	*1.0*
20	360468	7053207	Not associated	4.1
21	361043	7052496	Not associated	4.2
22	358164	7048890	Not associated	0.5
22[3]	361593	7052771	Not associated	4.8
23	360955	7054145	Not associated	4.7
24	361537	7054584	Not associated	5.1
25	354861	7045738	Not associated	2.4
26	357095	7044834	Not associated	3.0
27[3]	362156	7058389	Not associated	4.8
28	360921	7046323	Not associated	2.8
29	361415	7047048	Not associated	3.1
30	361666	7047837	Not associated	3.3
31	362298	7048170	Not associated	4.0
32	361380	7049457	Not associated	3.5
33	361337	7050441	Not associated	3.9
34	361194	7050869	Not associated	4.0
35	362022	7050561	Not associated	4.6
36	362405	7050628	Not associated	5.0
37	361634	7051348	Not associated	4.5
38	361197	7051645	Not associated	4.1
39	362586	7053229	Not associated	5.9
40	361823	7053471	Not associated	5.4
41	361184	7053912	Not associated	5.0
42	361123	7055114	Not associated	4.5
43	361049	7056001	Not associated	4.3
44	361214	7056338	Not associated	4.4

Table 10 Potential dwellings in the vicinity of the proposed Project [7] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest WTG [km]
45	362016	7056910	Not associated	5.1
46	362034	7057017	Not associated	5.2
47	361305	7057765	Not associated	4.2
48	361379	7057845	Not associated	4.2
49	362424	7058080	Not associated	5.1
50	362790	7059247	Not associated	5.2
51	345185	7065765	Not associated	2.8
52	344044	7067709	Not associated	5.0
53	344181	7067739	Not associated	5.0
54	346939	7068582	Not associated	3.7
55	347641	7068732	Not associated	3.3
56	346466	7069964	Not associated	5.0
57	342147	7061956	Not associated	3.7
61	361349	7043442	Not associated	5.1
63	362334	7043452	Not associated	5.7
64	360963	7044135	Not associated	4.3
71	362704	7045140	Not associated	5.0
72	362900	7045408	Not associated	5.0
73	358681	7043634	Not associated	3.9
74	359781	7043989	Not associated	3.8
80	361091	7045178	Not associated	3.6
81	362280	7045679	Not associated	4.3
86	362413	7043475	Not associated	5.7
91	360016	7043449	Not associated	4.4
92	363056	7047559	Not associated	4.7
99	363629	7047931	Not associated	5.3
100	362390	7047474	Not associated	4.0
101	362258	7047717	Not associated	3.9
102	361429	7047054	Not associated	3.1
104	363836	7047136	Not associated	5.5
105	362824	7047800	Not associated	4.5
110	346273	7053106	Not associated	2.6
111	346302	7053163	Not associated	2.5
112	*353733*	*7058476*	*Associated*	*1.0*
113[3]	353714	7058452	Not associated	1.0
114[3]	*357646*	*7062591*	*Associated*	*2.4*
115[3]	355289	7066285	Not associated	4.5
116[3]	352159	7067246	Not associated	2.7
117[3]	345044	7065378	Not associated	2.5
118[3]	352153	7065994	Not associated	2.4
119[3]	354623	7050457	Not associated	0.6
120[3]	344238	7059541	Not associated	2.3
121[3]	352778	7052474	Not associated	0.7
122[3]	352858	7052431	Not associated	0.7
123[3]	346269	7051422	Not associated	2.4

Table 10 Potential dwellings in the vicinity of the proposed Project [7] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest WTG [km]
124[3]	352081	7066111	Not associated	2.4
125[3]	356873	7044544	Not associated	3.4
126[3]	361743	7047293	Not associated	3.4
127[3]	361230	7056104	Not associated	4.4

1. Coordinate system: MGA zone 56, GDA94 datum.
2. Dwelling has been identified by the Customer as uninhabited.
3. Dwelling has been identified by the Customer as a shed.

Associated dwellings are indicated by *underlined italic text.*

Table 11 Details of point-to-point links crossing the proposed Project site

Link no.	Assignment ID	Licence number	Frequency [MHz]	Licence owner
1	687540, 687541	63175/1	413.575	Telstra Corporation Limited Radio, Transport Engineering (Attn Nik Patel) Locked Bag 3501 BRISBANE QLD 4001
	687542, 687543	63175/1	404.125	
2	688024, 688025	63561/1	414.400	
	688026, 688027	63561/1	404.950	

Table 12 Details of point-to-multipoint licences within 75 km of the proposed Project

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
1004766	9023492	1987180/1	-27.0946	150.9417	70	Arrow Energy Ltd GPO Box 5262 BRISBANE QLD 4001
1004769	9023492	1987180/1	-27.0946	150.9417	70	
875255	9009665	1911915/1	-27.0956	150.9411	70	
875258	9009665	1911915/1	-27.0956	150.9411	70	
978884	9009665	1974750/1	-27.0956	150.9411	70	
978887	9009665	1974750/1	-27.0956	150.9411	70	
1346631	9009665	9857064/1	-27.0956	150.9411	70	
1346634	9009665	9857064/1	-27.0956	150.9411	70	
963733	9019273	1967504/1	-27.1687	151.0161	71	
963736	9019273	1967504/1	-27.1687	151.0161	71	
978896	9020873	1974752/1	-27.0723	150.8985	72	
978899	9020873	1974752/1	-27.0723	150.8985	72	
963741	9019322	1967505/1	-27.1248	150.9450	72	
963744	9019322	1967505/1	-27.1248	150.9450	72	
1305626	402542	433911/1	-26.8886	151.6005	22	Bureau of Meteorology GPO Box 1289 MELBOURNE VIC 3001
1305629	402542	433911/1	-26.8886	151.6005	22	
7398049	9026598	11143276/1	-26.5388	151.8366	26	Department of Transport and Main Roads Attention: ITS Enabling Services GPO Box 1412 BRISBANE QLD 4001
7398052	9026598	11143276/1	-26.5388	151.8366	26	
803253	16406	1417242/1	-26.8983	151.6198	23	Ergon Energy Corporation Limited PO Box 264 FORTITUDE VALLEY QLD 4006
803256	16406	1417242/1	-26.8983	151.6198	23	
893760	139042	1923855/1	-26.6951	151.6559	7	Fransfarm Pty Ltd 85 Kumbia Brooklands Road KUMBIA QLD 4610
893763	139042	1923855/1	-26.6951	151.6559	7	
802082	402084	1415361/1	-26.1948	152.0772	65	Gympie Regional Council PO Box 155 (Kilkivan Licence Holders) GYMPIE QLD 4570
802085	402084	1415361/1	-26.1948	152.0772	65	
2624546	9012970	10236814/1	-27.2703	151.6995	65	New Acland Coal Pty Ltd 3/22 Magnolia Dr Att: Jessica Brass BROOKWATER QLD 4300
2624549	9012970	10236814/1	-27.2703	151.6995	65	

Table 12 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
6014306	16378	10774617/1	-26.8344	151.9704	42	Queensland Bulk Water Supply Authority Seqwater PO Box 328 IPSWICH QLD 4305
6014309	16378	10774617/1	-26.8344	151.9704	42	
904977	130697	1932064/1	-26.5244	151.8082	23	South Burnett Regional Council PO Box 336 KINGAROY QLD 4610
904980	130697	1932064/1	-26.5244	151.8082	23	
710339	16335	126104/1	-26.5398	151.8376	26	
710342	16335	126104/1	-26.5398	151.8376	26	
2029224	10002142	10112026/1	-26.1688	151.6065	38	
2029227	10002142	10112026/1	-26.1688	151.6065	38	
904981	9012254	1932065/1	-26.6653	152.0082	42	
904984	9012254	1932065/1	-26.6653	152.0082	42	
1441426	401181	1409253/2	-26.3038	151.8726	42	
1441427	401181	1409253/2	-26.3038	151.8726	42	
904989	16307	1932066/1	-26.2387	151.9324	51	
904992	16307	1932066/1	-26.2387	151.9324	51	
7401816	10018002	11146772/1	-26.8051	151.8923	33	Stanwell Corporation Limited GPO Box 800 BRISBANE QLD 4001
7401819	10018002	11146772/1	-26.8051	151.8923	33	
7401820	10018002	11146773/1	-26.8051	151.8923	33	
7401823	10018002	11146773/1	-26.8051	151.8923	33	
806441	16401	1424224/1	-26.7822	151.9150	34	
806444	16401	1424224/1	-26.7822	151.9150	34	
885518	16401	1919022/1	-26.7822	151.9150	34	
885521	16401	1919022/1	-26.7822	151.9150	34	
847331	16377	1621563/1	-26.8025	151.9099	35	
847334	16377	1621563/1	-26.8025	151.9099	35	
7401812	10017999	11146771/1	-26.8354	151.9076	36	
7401815	10017999	11146771/1	-26.8354	151.9076	36	
693864	16442	76344/1	-25.8656	151.6339	72	Telstra Corporation Limited Radio, Transport Engineering (Attn Nik Patel) Locked Bag 3501 BRISBANE QLD 4001
693865	16442	76344/1	-25.8656	151.6339	72	
10562140	16378	12061325/1	-26.8344	151.9704	42	Toowoomba Regional Council Water Infrastructure Services PO Box 3021 TOOWOOMBA VILLAGE FAIR QLD 4350
10562141	16378	12061325/1	-26.8344	151.9704	42	
922194	400592	1943805/1	-26.8422	151.9865	43	
922197	400592	1943805/1	-26.8422	151.9865	43	
922186	100127	1943804/1	-27.3039	151.8520	73	
922190	100127	1943804/1	-27.3039	151.8520	73	
10352504	9009830	11987458/1	-27.3110	151.8639	74	
10352505	9009830	11987458/1	-27.3110	151.8639	74	
1213891	150556	1420220/1	-26.9346	151.4555	29	Western Downs Regional Council PO Box 551 DALBY QLD 4405
1213894	150556	1420220/1	-26.9346	151.4555	29	
1212791	14714	116874/1	-27.1781	151.2655	59	
1212794	14714	116874/1	-27.1781	151.2655	59	
5068918	14714	10660503/1	-27.1781	151.2655	59	
5068919	14714	10660503/1	-27.1781	151.2655	59	

Table 13 Details of the point-to-multipoint repeater station and remote telemetry sites identified by South Burnett Regional Council [14]

Site name	Latitude [GDA94]	Longitude [GDA94]	Frequency [MHz]	Antenna gain [dB]	Distance to Project [km]
Mount Wooroolin repeater station	-26.524552	151.806564	461.78125 (transmit) 452.28125 (receive)	8.2 (omnidirectional)	21
Kumbia Reservoir remote site	-26.693270	151.653790	452.28125 (transmit) 461.78125 (receive)	9 (directional)	7
Kumbia Reedy Creek Borefield remote site	-26.656325	151.641204	452.28125 (transmit) 461.78125 (receive)	9 (directional)	5
Kumbia Stuart River Borefield remote site	-26.722520	151.665080	452.28125 (transmit) 461.78125 (receive)	9 (directional)	9

Table 14 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	140
2 GHz Band	Spectrum	174
2.3 GHz Band	Spectrum	5310
2.5 GHz Band	Spectrum	91
3.4 GHz Band	Spectrum	3518
700 MHz Band	Spectrum	396
800 MHz Band	Spectrum	197
AWL - FSS Only	Spectrum	93
AWL - Standard	Spectrum	10
Aeronautical Assigned System	Aeronautical	16
Amateur Repeater	Amateur	30
Ambulatory System	Land Mobile	40
CBRS Repeater	Land Mobile	14
Commercial Radio	Broadcasting	4
Commercial Television	Broadcasting	6
Community Broadcasting	Broadcasting	3
Earth Receive	Earth Receive	2
Land Mobile System - > 30MHz	Land Mobile	783
Land Mobile System 0-30MHz	Land Mobile	230
Narrowband Area Service station(s)	Broadcasting	3
Narrowcasting Service (Fixed Tax)	Broadcasting	3
Narrowcasting Service (LPON)	Broadcasting	33
National Broadcasting	Broadcasting	11
PMTS Class B	PTS	168
PMTS Class B (935-960 MHz)	PTS 900 MHz	51
Paging System - Exterior	Land Mobile	14
Paging System - Interior	Land Mobile	2
Radiodetermination	Radiodetermination	28
Retransmission	Broadcasting	20
Retransmission (Out of Area)	Broadcasting	1
Temporary Community Broadcasting	Broadcasting	1

Table 15 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Brisbane Area Wicen Group Inc	Brisbane Area Wicen Group Inc PO Box 2082 KELVIN GROVE QLD 4059	23
Bunya Mts & District AmCom Inc	Bunya Mts & District AmCom Inc PO Box 258 DALBY QLD 4405	16
Citizens Radio Emergency Service Teams Queensland Inc. (CREST Qld)	Citizens Radio Emergency Service Teams Queensland Inc. (CREST QLD) PO Box 49 TAMBORINE QLD 4270	22
Department of Community Safety (Queensland Fire and Rescue Service) – administered by the Public Safety Business Agency (PSBA)	Department of Community Safety (Queensland Fire and Rescue Service) Rural Fire Division Comm QLD Fire Service 20 Pickering St Maintenance Control Services GF ALDERLEY QLD 4051	16
Department of Environment and Science (Queensland Parks and Wildlife Service)	Department of Environment and Science Queensland Parks and Wildlife Service PO Box 15187 CITY EAST QLD 4002	16
Department of Health (Queensland Ambulance Service) – administered by the Public Safety Business Agency (PSBA)	Department of Health (Queensland Ambulance Service) 20 Pickering St Maintenance Control Services GF ALDERLEY QLD 4051	16
Queensland Fire and Emergency Services – administered by the Public Safety Business Agency (PSBA)	Queensland Fire and Emergency Services 20 Pickering St Maintenance Control Services GF ALDERLEY QLD 4r051	16
Queensland Police Service – administered by the Public Safety Business Agency (PSBA)	Queensland Police Service Radio and Electronics Section 20 Pickering Street ALDERLEY QLD 4051	16
St. John Ambulance Australia Incorporated	St. John Ambulance Australia Incorporated Technical Services 601-609 Blackburn Road NOTTING HILL VIC 3168	16

Table 16 Bureau of Meteorology radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
10030632	BOM-Darling Downs Bald Hills Rd WHICHELLO	-27.2740	151.9930	76
16621	Met/Rassonon Site MT KANIGAN	-25.9568	152.5763	121
14367	Meteorology Site The Bluff off Embreys Rd The Bluff	-27.6064	152.5401	139
15794	Telstra Coast Station 881-991 Bribie Island Road NINGI	-27.0685	153.0547	152
10029374	Bureau of Meteorology Radar Pandanus Avenue BRISBANE AIRPORT	-27.3915	153.1301	172
10026504	Met Bureau Radar Site Smiths Road 12 km SE of TAROOM	-25.6961	149.8980	180
13465	Air Sea Rescue Yellowwood Hill BEENLEIGH	-27.7178	153.2400	200
405009	New Radar Tower Radar Hill GLADSTONE	-23.8551	151.2626	294
200244	Met Bureau Office Blueberry Road MOREE	-29.4903	149.8462	350
250466	Dept Agriculture Site Trenayr Rd GRAFTON	-29.6206	152.9633	352
461524	BOM Site Bundalla Roslin Rd DULBYDILLA	-26.4406	147.3492	408
141678	Coffs Harbour Airport Airport Drive COFFS HARBOUR	-30.3194	153.1168	429

Table 17 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
Archookoora	AGD66, AGD84, GDA94	-26.7031	151.7818	20
C 210	AGD66	-26.7171	151.2694	20
C 215	AGD66	-26.4952	151.4913	2
Dangore	AGD66, AGD84, GDA94	-26.4571	151.6057	10
Halys	AGD66	-26.7668	151.5204	9
Halys Round	AGD66	-26.7748	151.6919	14
Kiangarow	AGD66	-26.8294	151.5483	16
NM B 276	AGD66, AGD84	-26.4495	151.5150	6

Table 18 Satellite vectors with potential to be intercepted by the proposed Project

Intercepted satellite	Services provided [65]	Affected dwellings
Eutelsat 70B (E70B, W5A, Eutelsat W5A)	Programs intended for international audiences	30, 126[1]
Intelsat 22 (IS-22)	Programs intended for international audiences	20, 21, 22[1], 30, 32, 33, 35, 36, 37, 38, 42, 43, 44, 45, 47, 48, 49, 50, 92, 100, 101, 104, 105, 126[1], 127[1]
G-Sat 11, G-Sat 14, G-Sat 18, G-Sat 7 (Insat 4F, Rukmini)	Programs intended for international audiences	*19*[2], 20, 30, 31, 33, 37, 41, 49, 50, 92, 101, 104, *112*, 113[1], 118[1], 119[1], 126[1]
ABS 2 (ST 3, Koreasat 8, Condosat 2), ABS 2A (Mongolosat-1)	Programs intended for international audiences	33, *112*, 113[1], 118[1], 119[1], 126[1]
Apstar 7	Programs intended for international audiences	113[1], 118[1], 119[1]
Thaicom 6 (Africom 1), Thaicom 8	Programs intended for international audiences	121[1]
ChinaSat 12 (ZX-15A, Chinasat 15A, ZX-12, Apstar 7B, SupremeSat 1), ChinaSat 2E, ChinaSat 9 (Zhongxing-9, ZX-9), Chinasat 11, Express 103, Express 80, G-Sat 10, G-Sat 12, G-Sat 15, G-Sat 17, G-Sat 30, G-Sat 6 (Insat 4E), G-Sat 9 (South Asia Satellite), JCSat 16, Kazsat 2, Measat 3 (Measat 3, Malaysia East Asia Sat 3), Measat 3A (Measat 1R), Measat 3B (Jabiru 2), SES 12, SES 8, ST 2, Skynet 5A, Thuraya 3, Yamal 401 (Yamal 400 KA-1)90	Programs intended for international audiences	121[1], 122[1]
Horizons 2, Insat 4B, Intelsat 15 (IS-15, JCSat 85)	Programs intended for international audiences	*19*[2], 121[1], 122[1]
Luch 5V (Loutch-5V)	Private communications	121[1], 122[1]
AsiaSat 5, ChinaSat 9A (Zhongxing 9A, ZX 9A, Sinosat 4, Xinnuo 4)	Programs intended for international audiences	22[1], 121[1]
Express AM3 (Ekspress AM3)	Programs intended for international audiences	22[1]
Eutelsat 70B (E70B, W5A, Eutelsat W5A)	Programs intended for international audiences	30, 126[1]

1. Dwelling has been identified by the Customer as a shed.
2. Dwelling has been identified by the Customer as uninhabited.

Associated dwellings are indicated by *underlined italic text*.

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Table 19 Dwellings with increased potential to experience EMI to DTV from television broadcast towers

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone Darling Downs	Wide Bay
1	350033	7048010		X
3	342758	7054371		X
4	347082	7049227		X
7	353829	7065016	X	
8	345309	7065736	X	
10	346952	7049270		X
11	343741	7054626		X
13	351884	7048043		X
14	346268	7053150	X	X
15	*352581*	*7049680*		*X*
16	343622	7055412		X
17	*344450*	*7060814*	*X*	*X*
18	*345283*	*7055357*		*X*
19[2]	*353716*	*7058498*	*X*	*X*
22[3]	358164	7048890	X	
25	354861	7045738		X
26	357095	7044834		X
51	345185	7065765	X	
53	344181	7067739	X	
54	346939	7068582	X	
55	347641	7068732	X	
110	346273	7053106	X	X
111	346302	7053163	X	X
112	*353733*	*7058476*	*X*	*X*
113[3]	353714	7058452	X	X
114[3]	*357646*	*7062591*	*X*	
117[3]	345044	7065378	X	
118[3]	352153	7065994	X	
119[3]	354623	7050457	X	X
120[3]	344238	7059541	X	X
121[3]	352778	7052474	X	X
122[3]	352858	7052431	X	X
123[3]	346269	7051422		X
124[3]	352081	7066111	X	
125[3]	356873	7044544		X

1. Coordinate system: MGA zone 56, GDA94 datum.
2. Dwelling has been identified by the Customer as uninhabited.
3. Dwelling has been identified by the Customer as a shed.

Associated dwellings are indicated by *underlined italic text.*

Table 20 Summary of service operators contacted by DNV and responses received to date

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
1	Fixed point-to-point (including one tower within 2 km of WTG locations) PMTS/spectrum (mobile phone)	Point-to-point #1: no WTGs in diffraction exclusion zone set by DNV, potential reflection/scattering and near-field interference zones not considered; no WTGs in clearance zone requested by Telstra Point-to-point #2: no WTGs in diffraction exclusion zone set by DNV, one WTG in potential reflection/scattering interference zone set by DNV, no WTG in potential near-field interference zone set by DNV; no WTG in clearance zone requested by Telstra PMTS/spectrum: 7 km	Telstra PP319950-AUME-L-01	Response received by email on 11/02/2020, based on preliminary WTG layout and dimensions: *"We don't anticipate any impacts for mobiles [sic] services from this proposal."* Response received by email on 28/02/2020, based on preliminary WTG layout and dimensions: *"…a desk top study was undertaken of the area and nearby telecommunications infrastructure.* *Based on the information provided… results of the rayline analysis investigation reveals that there is a potential for undue interference from the proposed wind farm on or around the Telstra communication tower from four Turbines - T56, T84, T98 & T109.* *In order to analyse the full impact of the windfarm on Telstra's radio telecommunication network, Telstra requests that it be allowed to conduct a detailed feasibility study once detailed design specifications are available.* *This detailed study is required to identify and assess the risk to Telstra's radio telecommunication network. It is important that this risk is identified and assessed prior to a planning application being made to minimise costs and delays to both parties. If Telstra cannot undertake a detailed study and Telstra believes there is a potential risk of interference, Telstra will take the necessary action to ensure its radio telecommunication network is protected from the potential impact of the development.* *Telstra will require the protection of/relocation of its fixed telecommunications infrastructure that may be impacted by activities on this site. To minimise risk of liability due to any damage, the DialBeforeYouDig 1100 Inquiry number should be contacted to obtain location of Telstra plant before commencement of construction work."* Response received by email on 4/03/2020, based on preliminary WTG layout and dimensions: *"…the minimum distance for the turbines should be 200m either side of the expected rayline…"*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			Response received by email on 11/03/2020, based on preliminary WTG layout and dimensions: *"The 200m didn't include the turbine rotor radius. The coordinates that I have been given for the 2 towers is lat/long -26.476810, 121.417008 and -26.600504, 151.554056."* First interim WTG layout and dimensions provided on 18/06/2020 Response received by email on 26/06/2020, based on first interim WTG layout and dimensions: *"I had the revised turbine layout reviewed by the radio design section and they are satisfied that the revise layout shows no turbines within the clearance zone of the radio path and they don't expect that the revised turbine layout will cause any impact to Telstra's services. Attached is a final response letter, the conditions of which from what you have detailed… would be satisfied by this revised layout."* From response letter, based on first interim WTG layout and dimensions: *"To provide a better understanding of potential impacts to the services on the Telstra tower, a detailed simulation analysis was carried out.* *Based on this research and earlier Radio path analysis, in other to minimise potential interference to Telstra's radio telecommunications network Telstra requires RES Australia Pty Ltd to confirm its agreement to the conditions and matters set out below:* *1) No wind turbine, or part thereof, is to be situated closer than 200 m to the existing Telstra tower radio link path, due to concerns with potential impacts on Telstra's radio communications network and the GRN network based on the results of testing.* *2) RES Australia Pty Ltd must consult with Telstra in relation to any new tower to be constructed on [the] Wind Farm for the relocation of affected telecommunication services such as Broadcast Australia [BAI Communications] in order to ensure that the location of the new tower does not hinder telecommunications services on the existing Telstra tower.* *3) RES Australia must ensure that the windfarm does not impede reasonable access by Telstra to the existing tower or communications building, or if this does occur, that alternative access is provided to Telstra's specifications.*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			…If the proposed plans and specifications of the development are altered or amended, Telstra reserves the right to request further conditions and amendments to the development." Second interim WTG layout and dimensions provided on 30/08/2022 Response received by email on 6/09/2022: *"…Earth Potential Rise (EPR) and Low Frequency Induction (LFI) analysis is also required for us to assess for potential impact of proposed windfarms on any existing fixed network.* *In addition to the turbine locations you have already supplied, may I please request power transmission details… to allow our teams to conduct their fixed network assessments…"* Response received by email on 11/10/2022, based on second interim WTG layout and dimensions: *"I can confirm our EMI assessment team have concluded their analysis and have not found any obstruction concerns.* *Please note the EPR and LFI assessments are still outstanding waiting additional information. A formal response will be produced once all factors have been addressed."* Third interim WTG layout and dimensions provided on 8/05/2023 Current WTG layout and dimensions, and details of proposed meteorological masts, provided on 27/10/2023

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
2	Fixed point-to-multipoint Meteorological radar	Point-to-multipoint: 22 km Meteorological radar: 77 km	Bureau of Meteorology 10341169-AUMEL-L-01	Response received by email on 8/09/2022, based on second interim WTG layout and dimensions: *"The proposed wind farm is close to Darling Downs and Gympie radars. Given the number of turbines and their structure height, the first three scans of the Darling Downs [radar] is directly affected by the farm.* *Given the severity of impact, the Bureau agrees with such proposals if the farm developer/owner is willing to sign the legal agreement for shutting down the farm (only problematic turbines) in the event of severe weather condition…* *For your information, figure below shows the simulation result that has been done for normal weather condition. Red shaded areas shows the location the turbines will be visible to radar and hence contaminate the radar signals."* Follow-up response received by email on 15/09/2022: *"...based on our investigation, the PMP stations are not affected by the proposed… WF."* Third interim WTG layout and dimensions provided on 8/05/2023 Current WTG layout and dimensions, and details of proposed meteorological masts, provided on 27/10/2023 Response received by email on 27/10/2023, based on current WTG layout and dimensions: *"I can now confirm that almost 2/3 of all turbines in the new layout are impacting Darling Down S-band radar so the level of risk to that radar remains high.* *Moreover, a few turbines (turbines 127 and 128) are also visible to the Mt Kanigan radar.* *The meteorological masts, temporary and permanent ones, are not of risk for the weather radars as:* *1- They are at lower height than the turbines* *2- They have no or small moving parts so their impact can be filtered out in the radar raw data."*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
3	Fixed point-to-multipoint	26 km	Department of Transport and Main Roads PP319950-AUME-L-03	Response received by email on 6/03/2020, based on preliminary WTG layout and dimensions: *"I can confirm the site and associated licences are for traffic management equipment to receiver in Kingaroy. The transmission is then moved via fibre optics. Transmission is confined to town and across a short, less than 5 km range, therefore do not envisage any interference from the proposed wind farm turbines."* **Further consultation not considered necessary**
4	Fixed point-to-multipoint	23 km	Ergon Energy PP319950-AUME-L-04	Response received by email on 6/04/2020, based on preliminary WTG layout and dimensions: *"Our initial review of this was that since none of our links had a path directly through the wind farm that it would not impact these point to point links.* *There may be some impacts on the point to multipoint licences but we cannot predict what those impacts would be and are expecting that it would be minimal."* **Further consultation not considered necessary**
5	Fixed point-to-multipoint	7 km	Fransfarm Pty Ltd PP319950-AUME-L-05	Response received by email on 7/04/2020, based on preliminary WTG layout and dimensions: *"From all reports interference to our irrigation systems is very unlikely."* **Further consultation not considered necessary**

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
6	Fixed point-to-multipoint	42 km	Seqwater PP319950-AUME-L-06	Response received by email on 27/02/2020, based on preliminary WTG layout and dimensions: *"…it is unlikely your wind farm will have any impact on our signals from our rain gauges in our north west areas."* Response received by email on 28/02/2020, based on preliminary WTG layout and dimensions: *"We have a couple of radio communication assets out that way however they are all east of the wind farm."* Response received by email on 19/02/2020, based on preliminary WTG layout and dimensions: *"I am comfortable with your proposal [that the proposed wind farm is unlikely to have any impact on our operations]."* **Further consultation not considered necessary**
7	Fixed point-to-multipoint	23 km	South Burnett Regional Council PP319950-AUME-L-07	Response received by email on 2/03/2020, based on preliminary WTG layout and dimensions: *"The ICT Department have liaised with the SBRC Microwave Radio equipment providers and confirm that we are unable to see an impact to our equipment [for site IDs 16335, 130697, and 9014230]."* Response received by email on 3/03/2020, based on preliminary WTG layout and dimensions: *"The Base site at Mount Wooroolin (STL Rptr Site Mount Wooroolin, site ID 130697) noted in your correspondence is approximately 21 km from the closest proposed Wind turbine [sic]. However, there are multiple other remote telemetry sites communicating with this site, with several being much closer. Potential sites that may need additional investigation to ensure no impacts are met include:* *- Kumbia Reservoir (7.8km to the nearest proposed wind turbine)* *- Kumbia Reedy Creek Borefield (6.5km to the nearest proposed wind turbine)* *- Kumbia Stuart River Borefield (9.65km to the nearest proposed wind turbine)* *…Council does not consider the blades themselves to be an impedance to these telemetry sites as no turbines are directly in the line of sight for radio communication*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			path. However the main potential impact will be as a result of EMI interference from the turbine itself (via electromagnetic radiation or conduction) or the reflection/scattering from the blades from signals sent to the remote sites from the Repeater Station…. *If DNV-GL or the applicant can provide advice and or approvals to current standards for the Wind Turbines… to achieve regulatory compliance with ACMA for electromagnetic compatibility, this will suffice Council's concerns related to electromagnetic radiation or conduction.* *In regards to radio signal reflection/scattering, Council would require an assessment of this to determine the potential impacts on scattering of radio paths emitted from the Repeater Station (Mount Wooroolin) to the remote sites… and from the remote sites back to the repeater station.* *Without this assessment, Council cannot specify required clearances to avoid or minimise risk of interference, or propose any mitigation measures to resolve potential impacts."* Details of point-to-multipoint links to allow assessment of potential for reflection/scattering of signals received by email on 6/04/2020 DNV assessment of potential for reflection/scattering of signals and radiated or conducted disturbances provided on 19/05/2020 Response received by email on 01/06/2020, based on DNV assessment: *"From the assessment, it has been indicated that interference caused by signal reflection or scattering is not expected. Based on your assessment results, Council will accept the report outcome and have no further requirements for this project.* *Council would request however to be included as a stakeholder in the commissioning or testing phase of the closest wind turbine to ensure no effects actually occur…. In addition, Council would request contact details for the operating authority of the proposed Wind Farm to be able to provide notification should an interface [sic] be identified should the wind farm proceed."* **Further consultation not considered necessary**

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
8	Fixed point-to-multipoint	33 km	Stanwell Corporation PP319950-AUME-L-08	Response received by email on 30/03/2020, based on preliminary WTG layout and dimensions: *"…we can see no issues. From your point of view the concern would be any line-of-sight communications that would be propagating through the path of the turbines.* *We have no equipment requiring transmission beyond the boundaries of our land and therefore we cannot see any issues.* *…The radios within the zone are all directed back towards the Stanwell sites (E/SE) with no requirement to transmit or receive data in the direction of the proposed… Windfarm. The potential for interference to Stanwell's radio telecommunication network will be negligible.* *…Stanwell's radio network should not experience any detrimental effects based on the proposed location for the… Windfarm. The proposed clearances should have negligible impact to Stanwell's radio network.* *…Stanwell's radio network should not experience any detrimental effects based on the proposed location for the… Windfarm, therefore no further mitigations should be required."* **Further consultation not considered necessary**
9	Emergency service	16 km	Public Safety Business Agency (PSBA) (Queensland Ambulance Service, Queensland Fire and Emergency Services, Queensland Fire and Rescue Service, Queensland Police Service) PP319950-AUME-L-09	Response received by email on 6/04/2020, based on preliminary WTG layout and dimensions: *"Radio interference* *Since there are no plans to deploy emergency service radio repeater or linking infrastructure in the near vicinity of the wind farm boundaries the expectation is that no radio interference should be experienced from the planned… wind farm generators during normal operations.* *Electrical interference* *…mid band VHF services (66 – 88 MHZ) can be susceptible to electrical interference typically generated from electrical motors in addition to the EMI effects on VHF/UHF vehicle mounted mobile radios operating inside or adjacent to wind farm locations.*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
				However, PSBA does acknowledge, from previous experience, that electrical interference from the turbines was not noticeably detected under normal circumstances from other wind farm locations. PSBA understands that interference could arise from a fault condition with the generating plant and associated control systems… The expectation is that internal systems would sense and shut down the asset immediately, thus causing minimal interference. *Physical clearances* *With reference to the radiocommunications sites identified within 75km of the windfarm site, neither the supporting structure nor the turbine blades are expected to offer any noticeable impact on the radio services being assessed…* *Electromagnetic radiation (EMR)* *The power levels involved with the base station equipment and links systems employed by the PSA's [public safety agencies] are classified as Category 1… The potential for harmful radiation to personnel is considered negligible unless a worker… is within 1 metre directly in front of the transmitting antenna.* *PSBA considers the turbine structures and associated workers will not be exposed to unsafe levels of EMR from Emergency Services facilities.* *Summary* *…An analysis of the… wind farm location indicates no physical incursion into any current or planned radio link paths or likely interference to PSA services."* **Further consultation not considered necessary**
10	Emergency service	22 km	Citizens Radio Emergency Service Teams Queensland (CREST Qld) PP319950-AUME-L-10	<u>Response received by telephone on 21/02/2020:</u> *No risk of impact – there is no equipment currently active at that site, and no immediate plans to install any equipment.* **Further consultation not considered necessary**

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
11	Emergency service	16 km	Department of Environment and Science (Queensland Parks and Wildlife Service) 10341169-AUMEL-L-02	Response received by email on 6/10/2022, based on second interim WTG layout and dimensions: *"…we had the assessment reviewed and noted the following:* *1. The nearest QPWS repeater site is Bunya Mountains (approx. 16.8km to the nearest turbine)* *a. QPWS has no point-to-point links at this site that might be affected by the proposal* *b. The repeater is located at significantly higher elevation than the proposed wind farm (1100m Elev versus 500m for the proposed turbines using SRTM V3 elevation data)* *c. The Northern edge of the Bunya Mountains NP is just under 10km from the nearest turbines which is an order of magnitude greater than typically recommended clearances, so there is a very low likelihood that any form of reflective interference from the turbine blades will impact on repeater coverage within that estate.* *d. The only repeater coverage area of any concern is Dangore SF (Elev. 500m) as the proposed wind farm sits between it and Bunya Mountains repeater. A path profile at 70MHz is attached showing the elevation profile including 100% First Fresnel Zone (Green) and 60% First Fresnel Zone (Red) with k=1.33. While the repeater is at a considerable elevation, the path already has significant natural foreground obstruction at Dangore SF resulting in some existing patchy coverage within the SF. The planned turbine tip height of 280m at ranges of between 16 and 29km from Bunya Mtns repeater will clearly cause some interference within the 60% F1 zone at the greater ranges i.e. in the western areas of Dangore SF. However, given the relatively small size of obstruction caused by the turbine blades and available reference information on the resulting interference, the impacts to Dangore SF coverage are likely to be very minor.* *2. I can identify no other QPWS sites in the vicinity with point-to-point links or repeater coverage likely to be influenced.* *3. I cannot identify any other QPWS repeater sites in the vicinity where a potential coverage impact appears worthy of mention* *4. Current planning for any potential transition of QPWS to High Band VHF operation does not include any additional repeater sites of relevance.* *5. It is difficult to envision that any QPWS VHF High Band transition would result in a desire to implement any new point-to-point links over the proposed wind farm.*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
				Subsequently, based on the information provided by DNV: *• The risk of impact from the proposed development on QPWS radio assets appears to be low.* *• No variation in currently proposed clearance from QPWS radio assets is suggested.* *• No additional mitigation measures appear indicated.* *• No amendments to [the information obtained from the ACMA RRL database] have been identified."* **Further consultation not considered necessary**
12	Emergency service	16 km	St John Ambulance Australia PP319950-AUME-L-11	Response received by email on 24/06/2020, based on preliminary WTG layout and dimensions: *"In relation to your proposed… Wind Farm in Queensland, St John Ambulance does not have any concerns that the proposed windfarm will impact on our radio link paths or other communication assets."* **Further consultation not considered necessary**
12	Trigonometrical stations	2 km	Geoscience Australia PP319950-AUME-L-12	Response received by email on 24/02/2020, based on preliminary WTG layout and dimensions: *"Geoscience Australia do not foresee any impact to our trigonometric stations, GNSS reference stations, seismic stations or associated assets from the proposed… Wind Farm."* **Further consultation not considered necessary**

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
13	Trigonometrical stations, permanent survey marks	Within site boundaries	Department of Resources PP319950-AUME-L-13	Response received by email on 13/03/2020, based on preliminary WTG layout and dimensions: *"We have investigated the permanent marks in and around the proposed wind farm.* *In response to your email request here are my comments:* *- From the information supplied it appears that none of the existing survey infrastructure will be adversely affected;* *- Based on the dimensions of the turbine installations proposed the minimum clearance should be 150m;* *- Provided the minimum clearance from a survey mark to turbine tower is maintained no further mitigation measures are required.* *From the information provided there would be no turbines within 300m of any existing survey mark and, should the project proceed based on this information, no infrastructure would be adversely affected."* **Further consultation not considered necessary**
14	PMTS/spectrum (mobile phone)	12 km	Optus Mobile PP319950-AUME-L-14	Response received by email on 18/06/2020, based on first interim WTG layout and dimensions: *"As there are no P2P MW [microwave] links passing through the farm, there are no concerns from Microwave perspective.* *I will consult another team from RF perspective for site 10002058."* Response received by email on 30/06/2020, based on first interim WTG layout and dimensions: *"I haven't had any objection from the Optus RAN [radio access network] teams [regarding impacts to mobile phone services and signals from site 10002058]."* **Further consultation not considered necessary**

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
15	PMTS/spectrum (mobile phone)	4 km	Vodafone PP319950-AUME-L-15	Response received by email on 7/04/2020, based on preliminary WTG layout and dimensions: *"The radio access engineers, who manage the coverage are fine with your proposal. I'm just awaiting confirmation from the transmission team to check that our microwave links won't be impacted by the blades. I think it's pretty low risk…"* Response received by email on 8/04/2020, based on preliminary WTG layout and dimensions: *"You are good to go on this one. Our internal advice indicates our use of leased lines (underground) without the use of microwave transmission links in the vicinity of the proposal."* **Further consultation not considered necessary**
16	Wireless internet	6 km	NBN Co PP319950-AUME-L-16	Response received by email on 16/03/2020, based on preliminary WTG layout and dimensions: *"…based on the proposed wind farm location it would appear to have no line of sight (LOS) impact between the nearby nbn LTD-TDD base station sites and premises within the current nbn Wireless Coverage Areas. There are two small areas of nbn wireless coverage inside the wind farm polygon area however these areas contain no known existing or known planned premises requiring a nbn FW (Fixed Wireless) connection.* *A standard nbn response for wind farm applications regarding potential interference impact on nbn FW network is as follows;* *…We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of fixed point-to-point licences within 75 km of the proposed… Wind Farm.* *nbn have strict obligations to provide internet services to the community, and this area has been determined as a FW services area where the footprint of this service is now in place.* *nbn will be forced to consider its position as part of the planning should there an interference issue [sic].* *If the Application is amended before it is lodged we request that we are sent any amended Application so we can determine whether we have any objections to the*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			amended Application. We note that… it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications." First interim WTG layout and dimensions provided on 17/06/2020 Response received by email on 17/06/2020, based on first interim WTG layout and dimensions: *"The revised layout does not change the assessment or my response."* Second interim WTG layout and dimensions provided on 30/08/2022 Response received by email on 1/09/2022, based on second interim WTG layout and dimensions: *"I can see no material change to my previous assessment…* *The key concern, given the proximity of the wind towers to nbn base stations, is the introduction of RF interference to the nbn spectrum. Therefore, once known, please provide information on any RF transmission equipment planned to be used during construction or permanently installed so a potential interference impact can be assessed. This information should include as a minimum the operating transmission frequencies and transmit power, channel bandwidths, antenna types and radiation patterns as well as the exact location with antenna height, boresight azimuth and tilt (mechanical and electrical tilt)."* Third interim WTG layout and dimensions provided on 8/05/2023 Response received by email on 19/05/2023, based on third interim WTG layout and dimensions: *"I have reviewed the data provided based on the proposed wind farm location; The wind farm boundaries are outside existing nbn wireless coverage boundaries and none of the proposed wind tower locations pose any risk of introducing a physical obstruction to the existing RF Path Profiles or boresight paths of existing nbn microwave links. It is also noted no current nbn connected customer premises are within the wind farm boundary so there are no intrusions into their RF path toward their connected nbn eNB at Kumbia.* *Of potential greater concern is any impact from wind farm operated RF transmission equipment impacting nbn licenced spectrum.*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			Therefore, please provide information on any planned RF transmission equipment planned to be installed so a potential interference impact can be assessed. This information should include as a minimum, the operating transmission frequencies and transmit power, channel bandwidths, antenna types and their radiation patterns as well as their exact location with antenna height, boresight azimuth and tilt (either mechanical or electrical tilt). *A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows:* *Potential Impacts of the Proposed Tarong West Wind Farm on NBN Co Spectrum Comunication Assets* *...We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licences within 75 km of the proposed Tarong West Wind Farm.* *nbn has strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place.* *nbn will be forced to consider its position as part of the planning should there be an interference issue.* *If the Application is amended before it is lodged, we request that we are sent any amended Application so we can determine whether we have any objections to the amended Application.* *We note that, as you would be aware, under section 197 of the Radiocommunications Act 1992 (Cth) it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications."* Current WTG layout and dimensions, and details of proposed meteorological masts, provided on 27/10/2023 Response received by email on 31/10/2023, based on current WTG layout and dimensions: *"I have reviewed the data provided based on the proposed wind farm location. Apart from some minor coverage areas with no nbn wireless customers, the wind farm boundaries are outside existing nbn wireless coverage boundaries. None of the proposed wind tower locations pose any risk of introducting a physical obstruction to*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			the RF Path Profiles or boresight paths of existing nbn microwave links. It is also noted no current nbn connected customer premises are within the wind farm boundary so there are no intrusions into their RF path toward their connected nbn eNB. *Of potential greater concern is any impact from wind farm operated RF transmission equipment impacting nbn licenced spectrum.* *Therefore, please provide information on any planned RF transmission equipment planned to be installed so a potential interference impact can be assessed. This information should include as a minimum, the operting transmission frequencies and transmit power, channel bandwidths, antenna types and their radiation patterns as well as their exact location with antenna height, boresight azimuth and tilt (either mechanical or electrical tilt).* *A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows:* *Potential Impacts of the Proposed Tarong West Wind Farm on NBN Co Spectrum Communication Assets* *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 75 km of the proposed Tarong West Wind Farm.* *nbn has strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place.* *nbn will be forced to consider its position as part of the planning should there an interference issue.* *If the Application is amended before it is lodged, we request that we are sent any amended Application so we can determine whether we have any objections to the amended Application.* *We note that, as you would be aware, under section 197 of the Radiocommunications Act 1992 (Cth) it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications."*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
17	Radio and television broadcasting	23 km	BAI Communications PP319950-AUME-L-17	Response received by email on 22/04/2020, based on preliminary WTG layout and dimensions: *"BAI has undertaken a preliminary assessment of potential impacts upon digital television services operating from this facility [Mt Mowbullan]. While modelling suggests that the majority of the area most likely to be impacted is within the wind farm boundary, there is a risk of degradation of television services to dwellings in the region - with a low risk of impacting 17 individuals, and a high risk of impacting 2 individuals…* *While these population numbers are relatively low, BAI recommends a precautionary approach is taken in the design to minimise the risk of any interference to existing or future services at this facility. We would therefore suggest that [the Developer] engage a consultant for a further detailed assessment. In the event that service degradation is experienced for services operating from Mt Mowbullan as a result of the development, BAI would be looking to [the Developer] for solutions to rectify the issues.* *In relation to FM radio transmissions from the BAI site at Mt Mowbullan, these have not been assessed for possible impact from the proposed… Wind Farm as any impact is considered low risk. It is recommended however that appropriate due diligence is undertaken by [the Developer] to address any possible impacts to the FM transmissions associated with the development of this wind farm."* From assessment report, based on preliminary WTG layout and dimensions: *"BA [Broadcast Australia, registered as BAI Communications] have modelled the proposed… Wind Turbines to assess how they will affect DTV services broadcast from Mt Mowbullan Broadcast site… The majority of the impact will be confined to the wind farm boundary. Population analysis was done on the potentially impacted area... and showed 17 people are low risk and 2 people are at high risk of having degraded digital television reception."* Second interim WTG layout and dimensions provided on 30/08/2022 Third interim WTG layout and dimensions provided on 8/05/2023 Response received by email on 15/05/2023, based on third interim WTG layout and dimensions: *"Predictions show low risk up to 6 persons from the interference assessment undertaken from the DTV site, Mt Mowbullan. This is lower than the first iteration studied (then known as Iron Leaf) first in 2020 and revised in 2022.*

Table 20 Summary of service operators contacted by DNV and responses received to date (continued)

Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			Whilst there are minimal persons predicted to be impacted by the wind farm, any degradation of DTV services caused by the wind farm development would be expected to be rectified as part of the project." From assessment report, based on third interim WTG layout and dimensions: *"BAI Communications has done a study on the proposed wind farm located in Ironpot, QLD. The impact on one digital television broadcast facility was studied. The results show that the broadcast facility is impacted (Mt Mowbullan DTV services) and possibly up to 6 persons are predicted to be at low risk of interference to digital television services due to the scatter interference effects of the wind farm. However, if there is any impact, remediation that is required to rectify DTV degradation to viewers, is expected to form part of the wind farm project.* *...The only broadcast site that has been identified to provide coverage around the area of the wind farm [is] Darling Downs (Mt Mowbullan). BAI has conducted field tests on existing wind farms in the past for the impact on FM services. The field test measurements concluded that FM radio had some minor reflections observed but these would not be expected to cause any noticeable effect on reception. Thus, this report will not consider further impacts on FM broadcast.* *...Population analysis was done on the potentially impacted area (ABS Census 2021 Data) and showed 6 people are at low risk... of having degraded digital television reception and no population predicted to be in the high risk area... Upon closer inspection on Google Earth of the predicted interference, no households were observed to be contained within the... interference area.* *BAI have modelled the proposed Tarong West wind turbines to assess how they will affect DTV services broadcast from Mt Mowbullan... Interference analysis concluded that Mt Mowbullan DTV services are affected by the proposed wind farm, and the population analysis was done on the potentially impacted area... and showed 6 people are at low risk of having degraded digital television reception. Whilst there are minimal persons predicted to be impacted by the wind farm, any degradation of DTV services caused by the wind farm development would be expected to be rectified as part of the project."* Current WTG layout and dimensions, and details of proposed meteorological masts, provided on 27/10/2023

LIST OF FIGURES

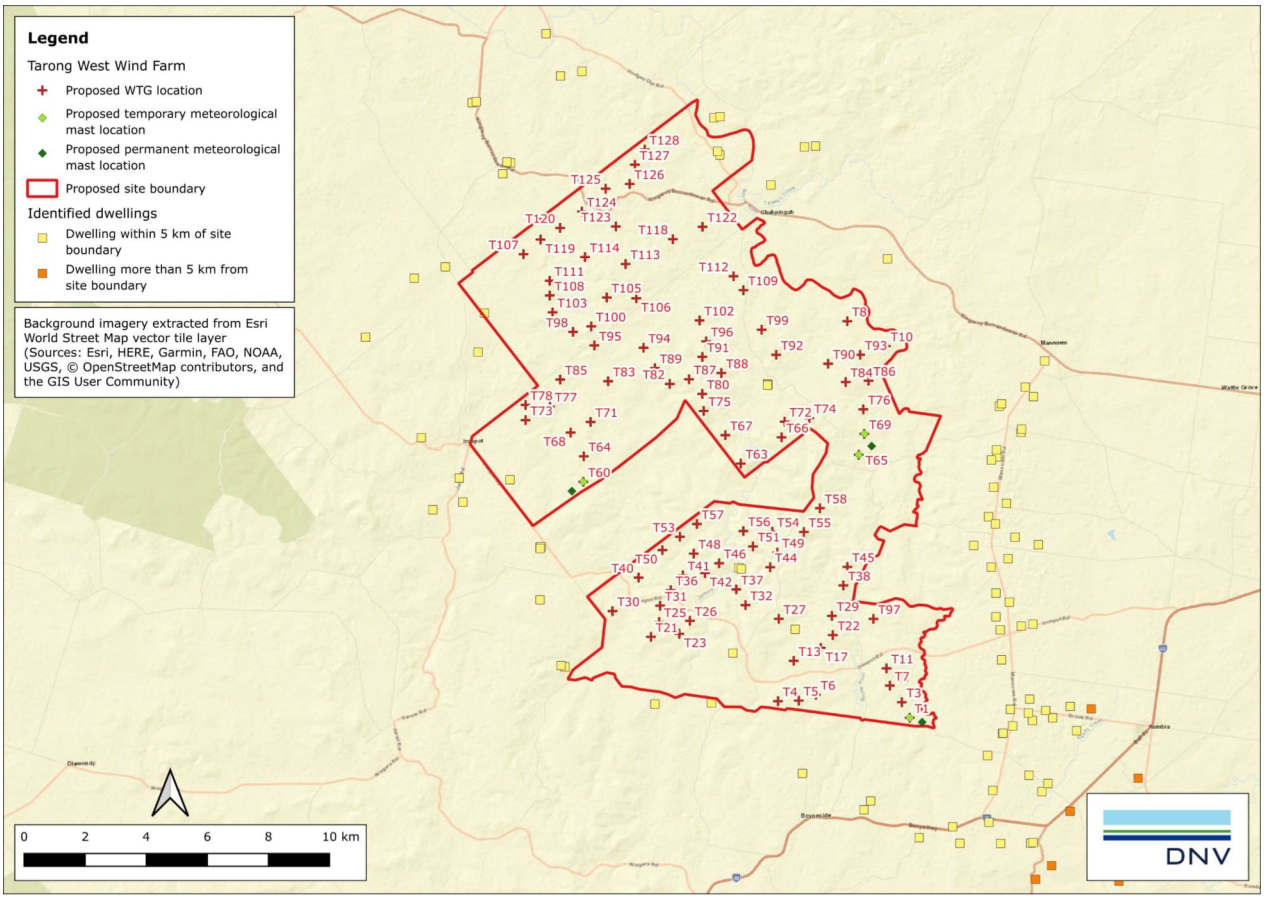

Figure 1 Map of the proposed Project, showing site boundaries, turbine locations, meteorological mast locations, and locations of nearby dwellings

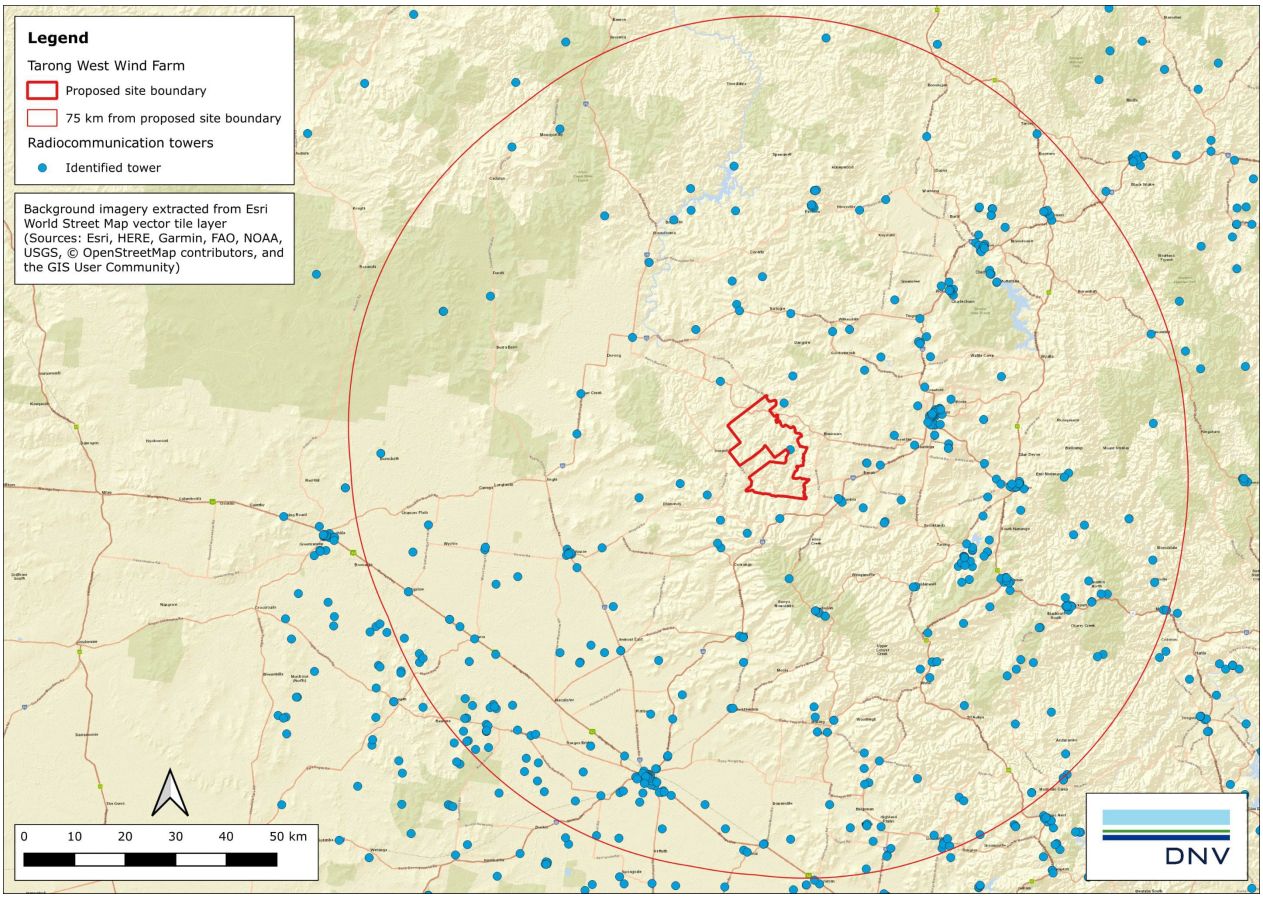

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

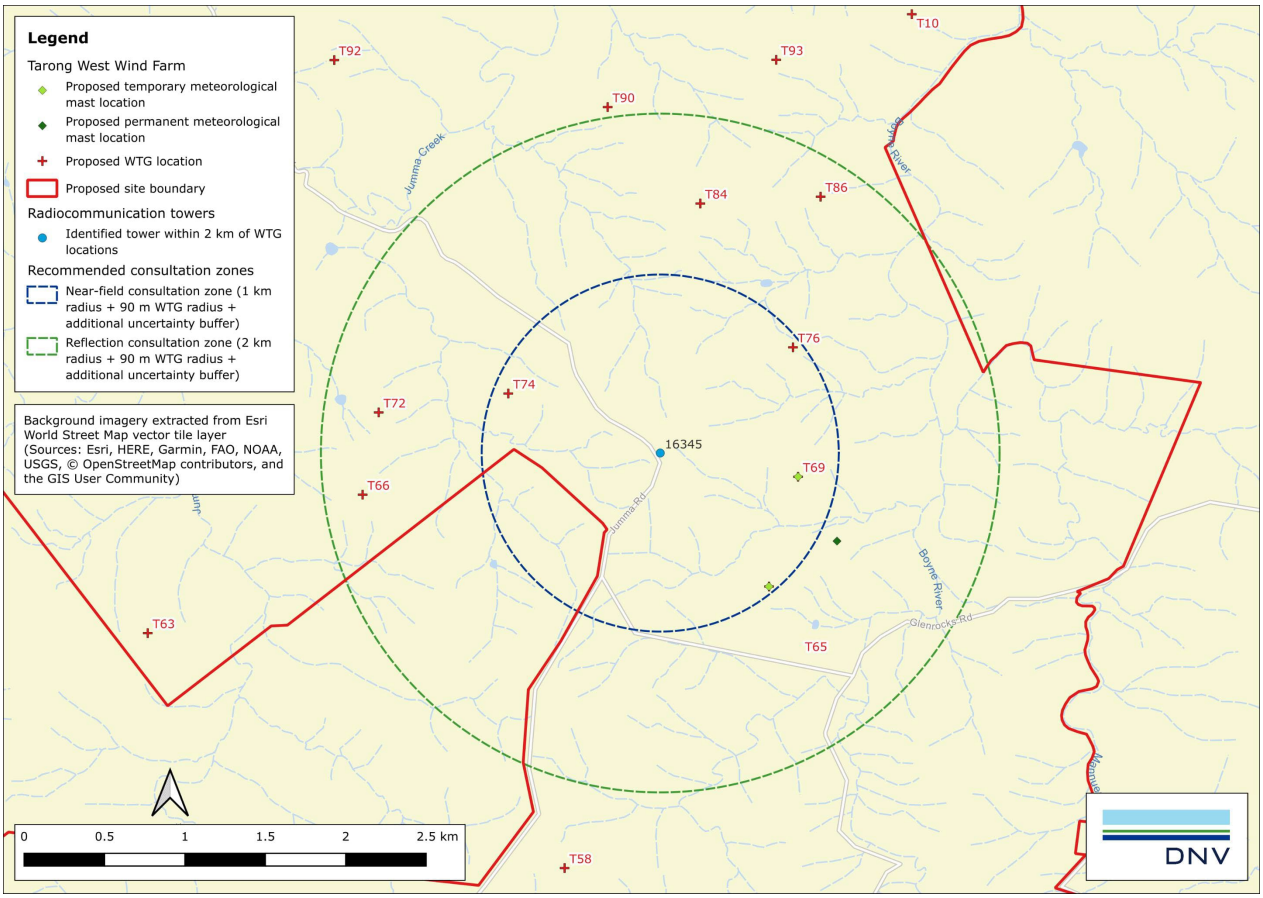

Figure 3 Identified radiocommunication sites within 2 km of the turbine locations for the proposed Project

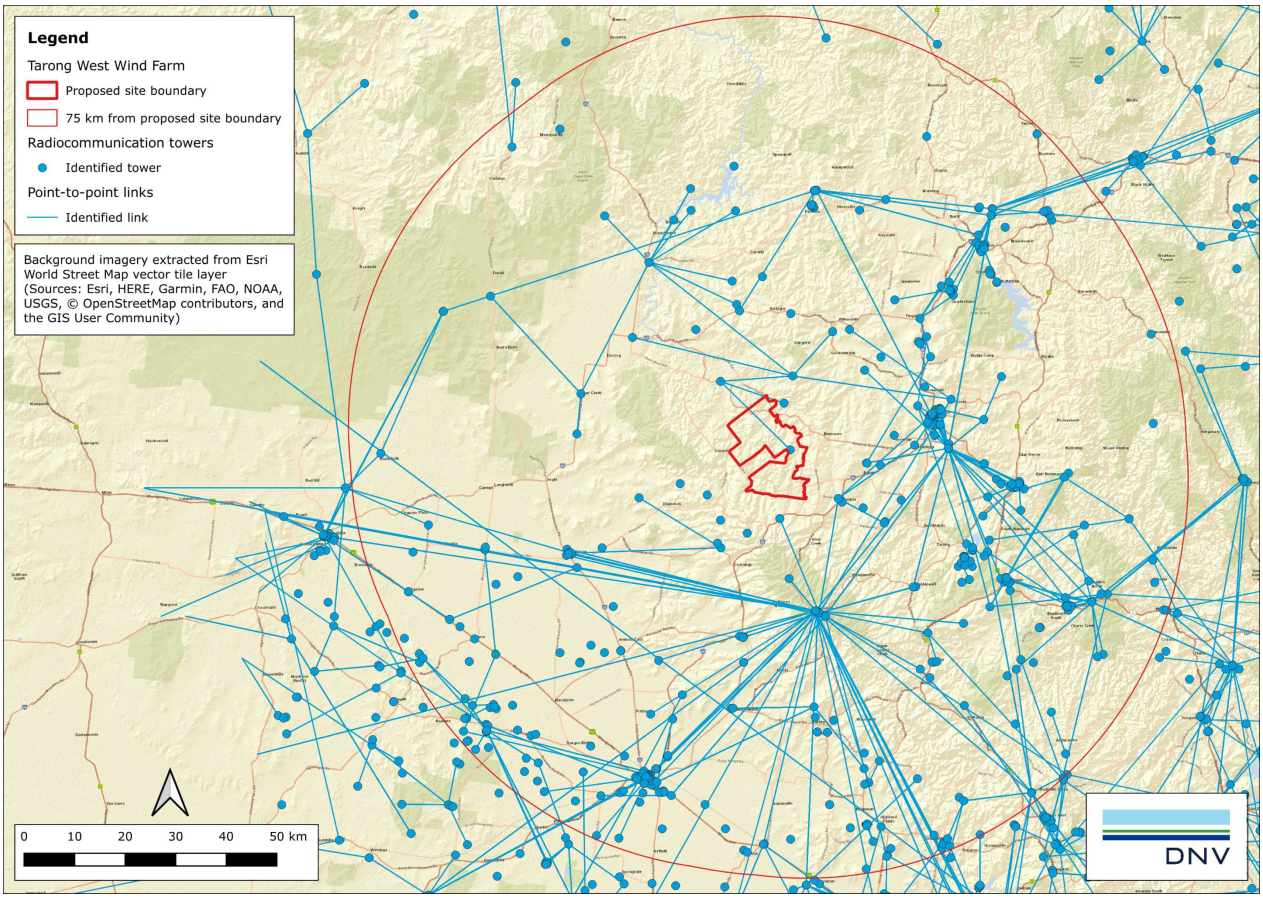

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

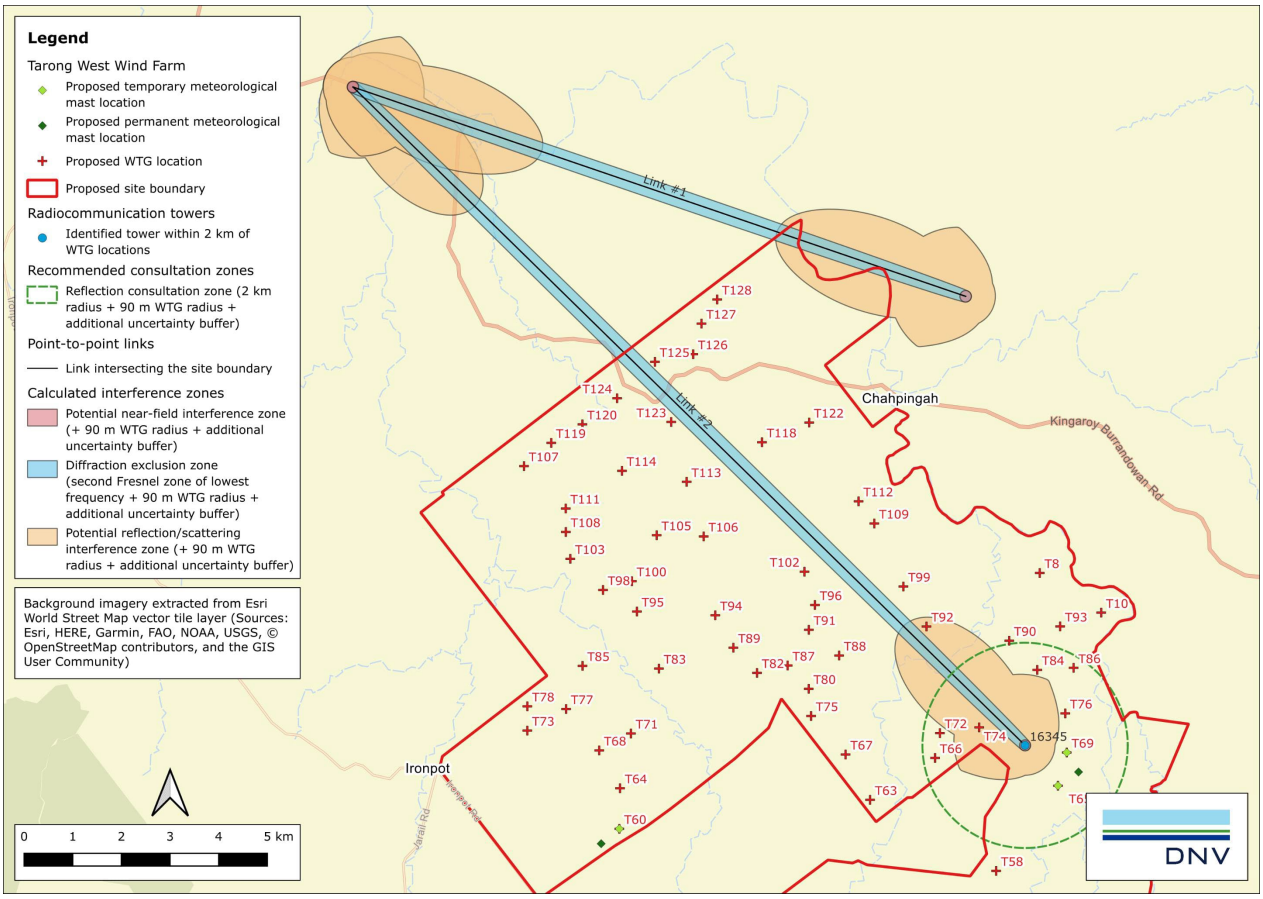

Figure 5 Identified point-to-point radiocommunication vectors and calculated interference zones for the proposed Project

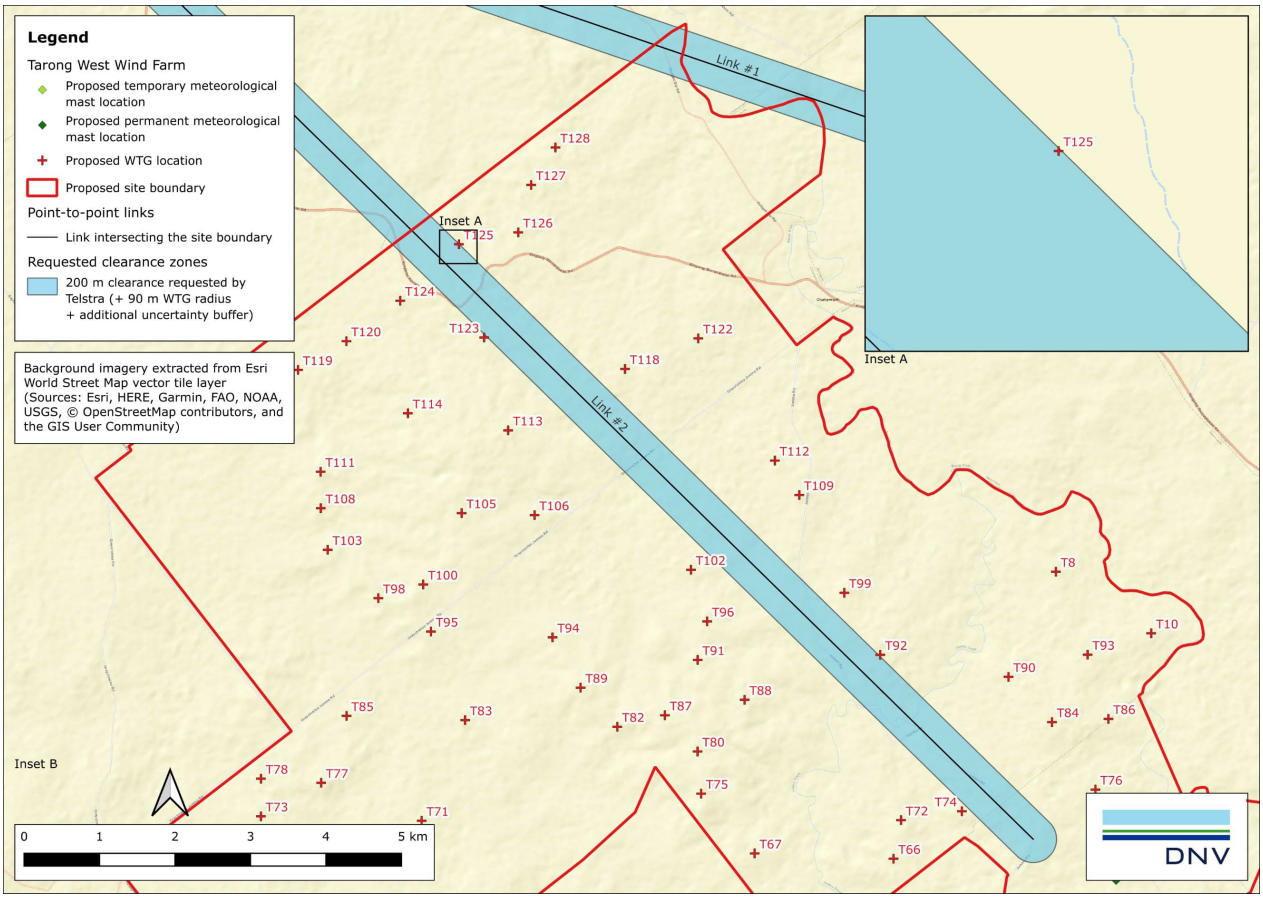

Figure 6 Point-to-point link clearance zones requested by Telstra

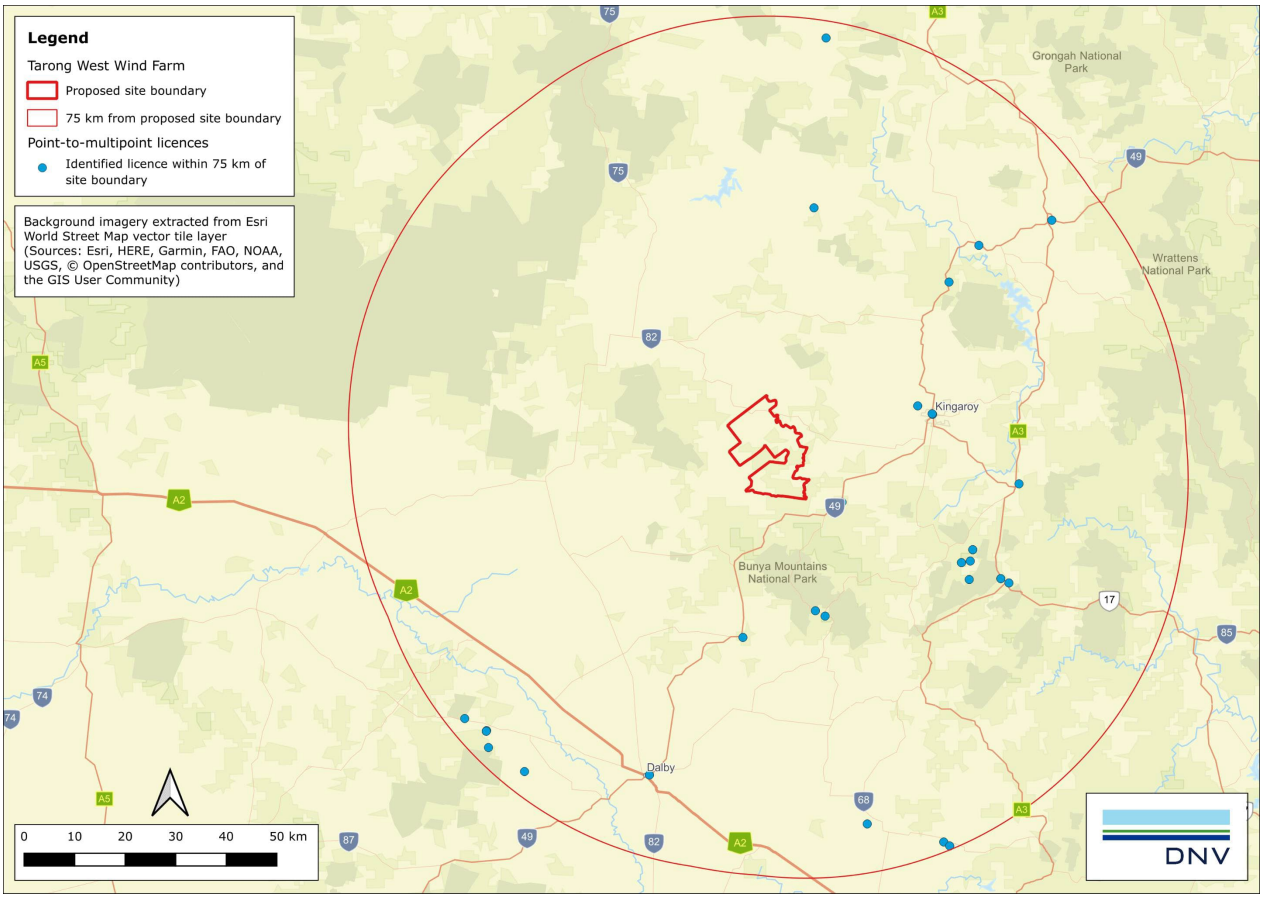

Figure 7 Location of point-to-multipoint licences in the vicinity of the proposed Project

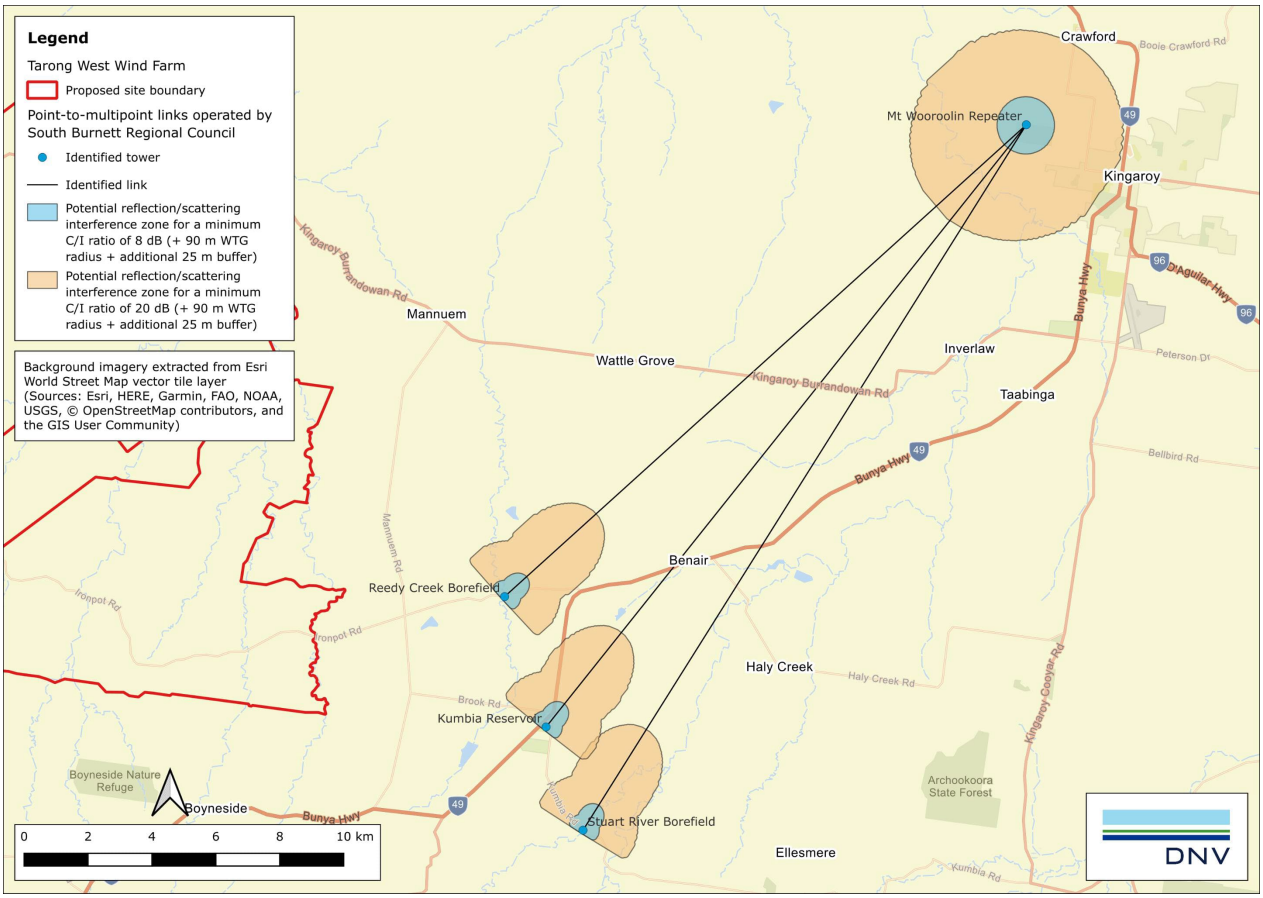

Figure 8 Potential reflection/scattering interference zones for point-to-multipoint links operated by South Burnett Regional Council

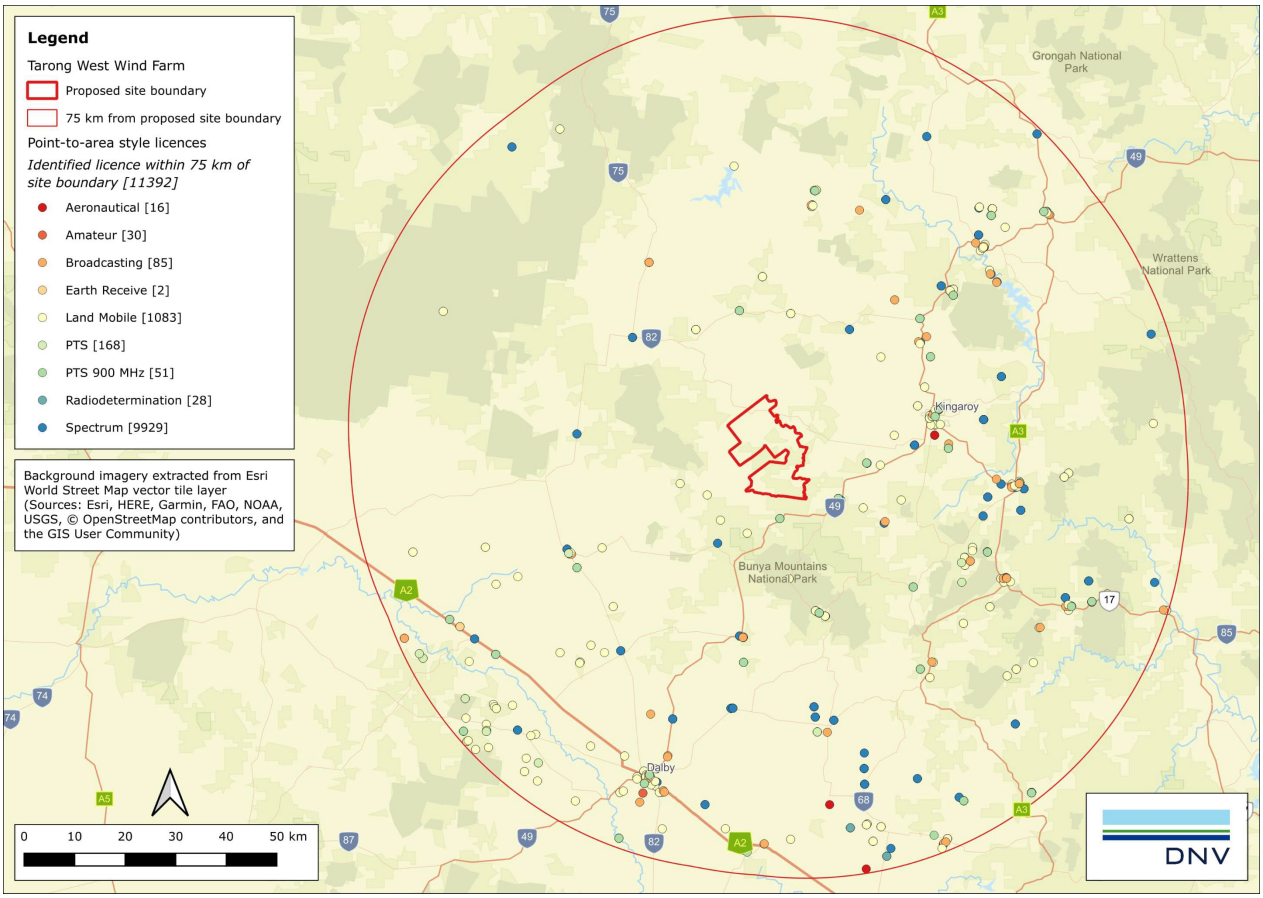

Figure 9 Location of general point-to-area style licences within 75km of the proposed Project

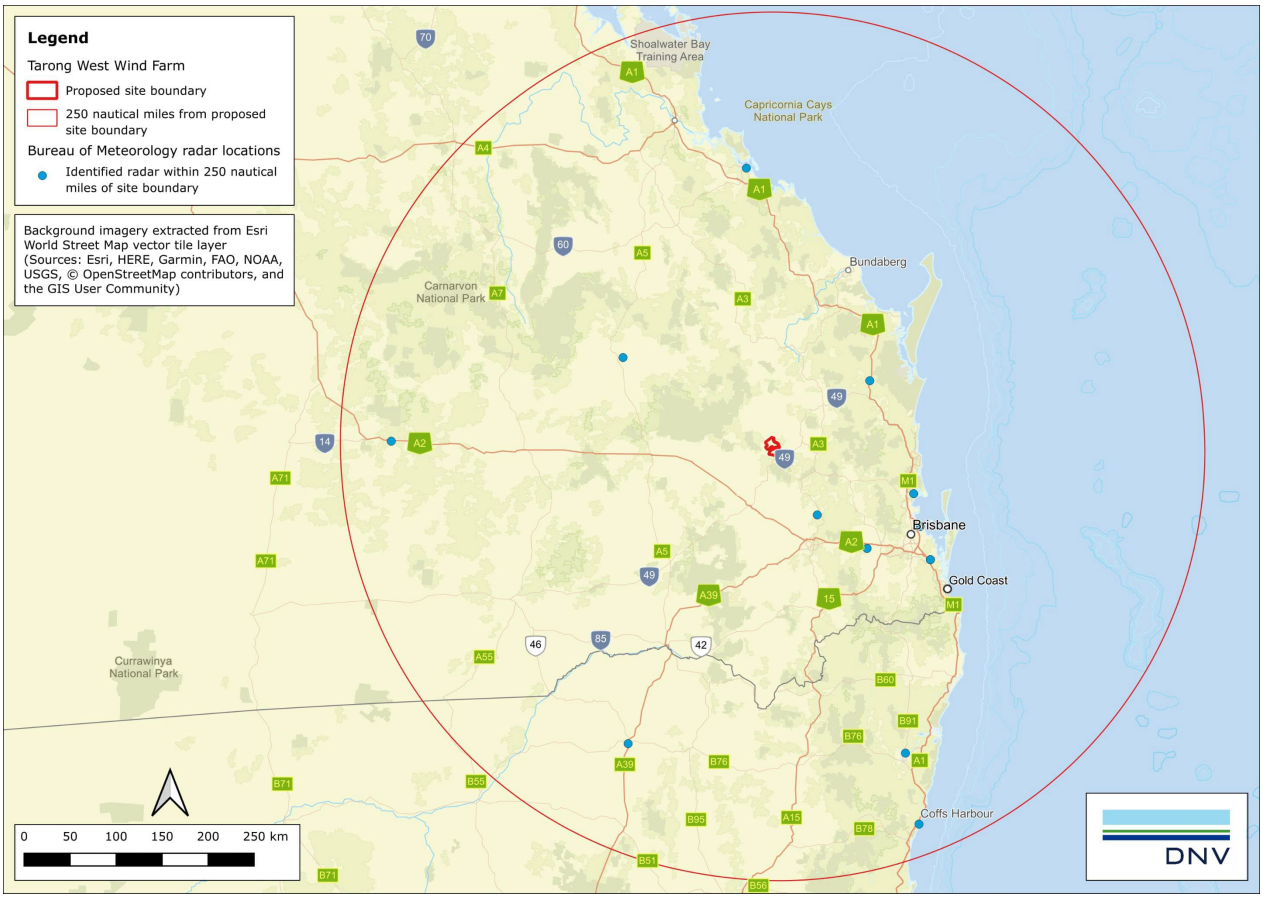

Figure 10 Location of meteorological radar sites within 250 nautical miles of the proposed Project

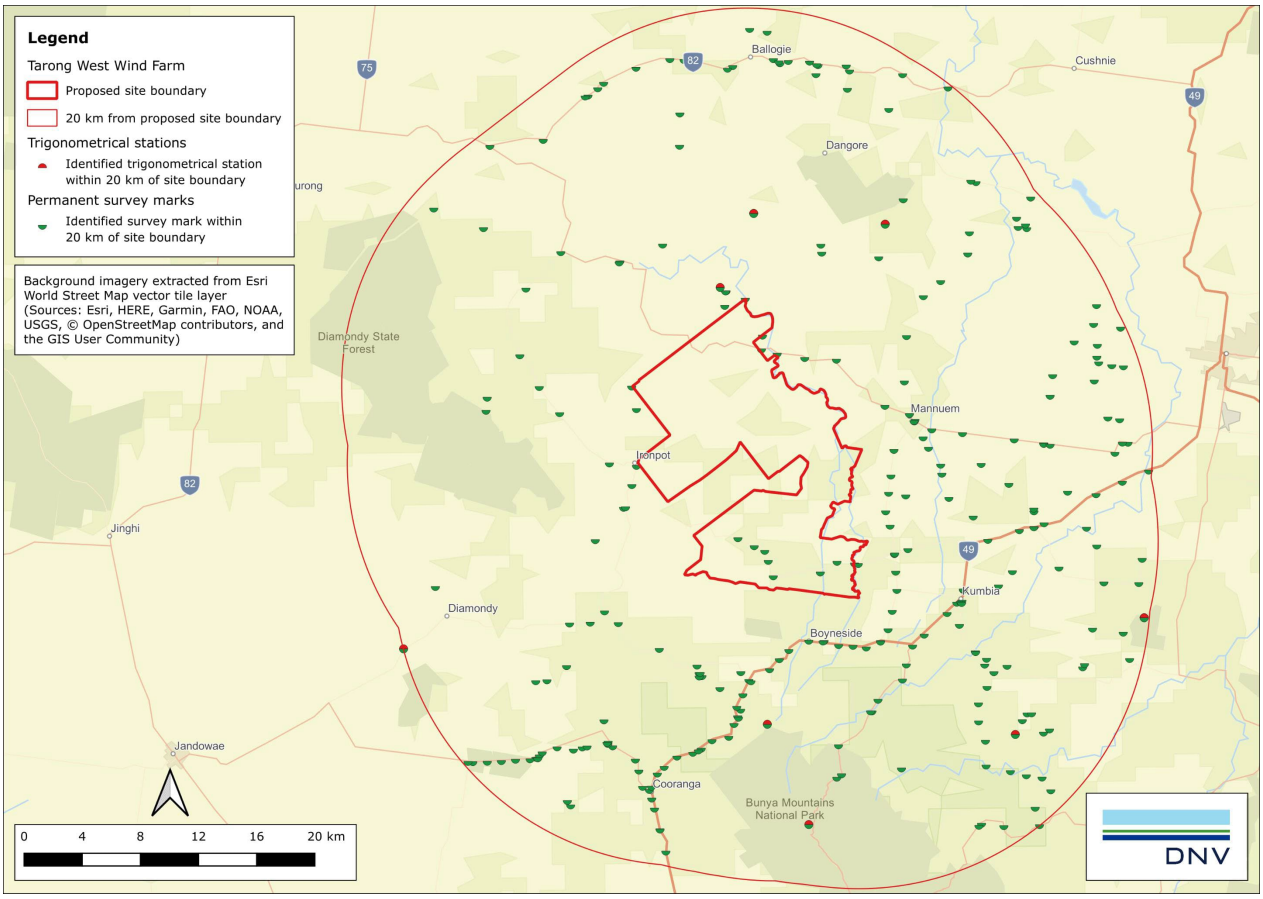

Figure 11 Location of trigonometrical stations within 20 km of the proposed Project

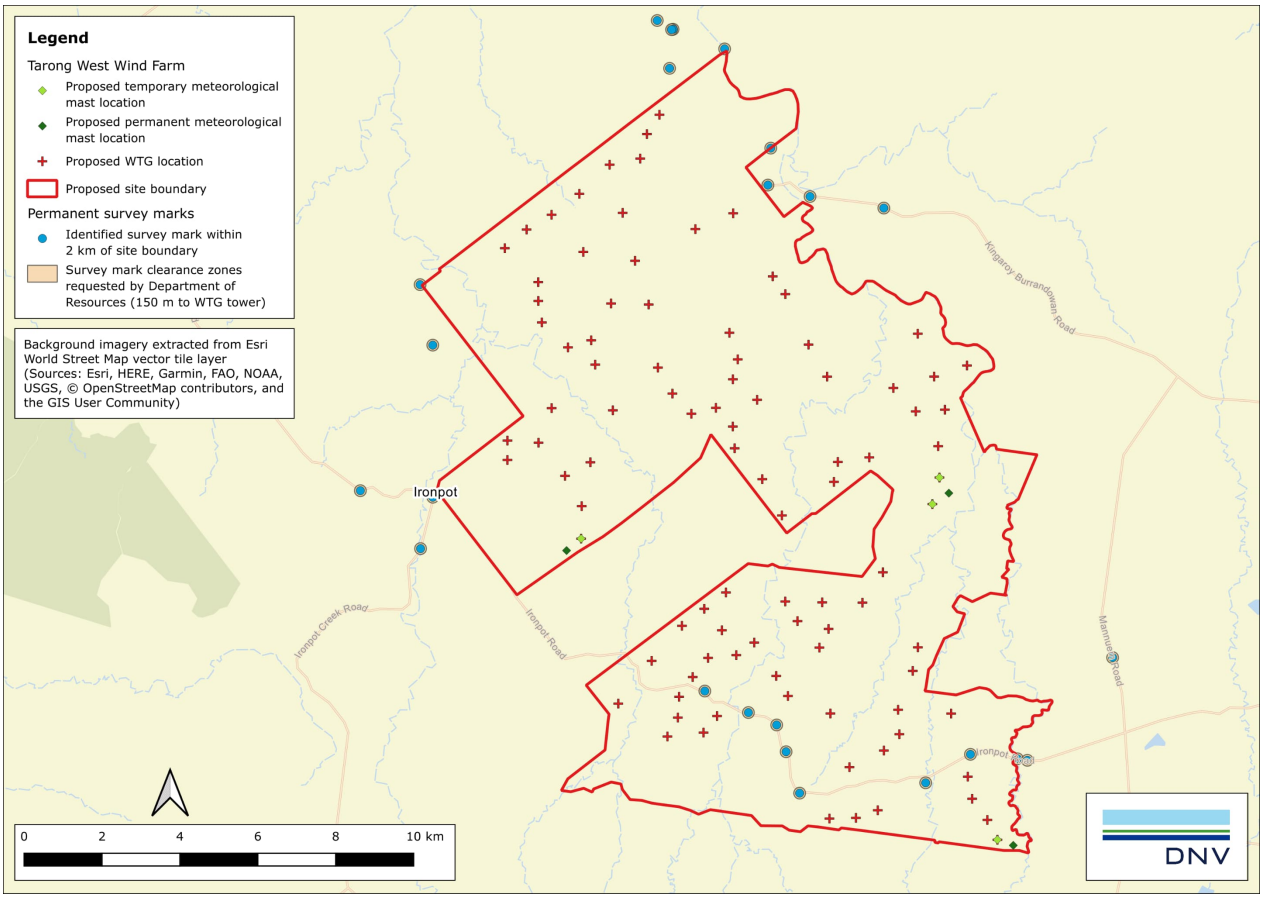

Figure 12 Survey mark clearance zones requested by the Department of Resources

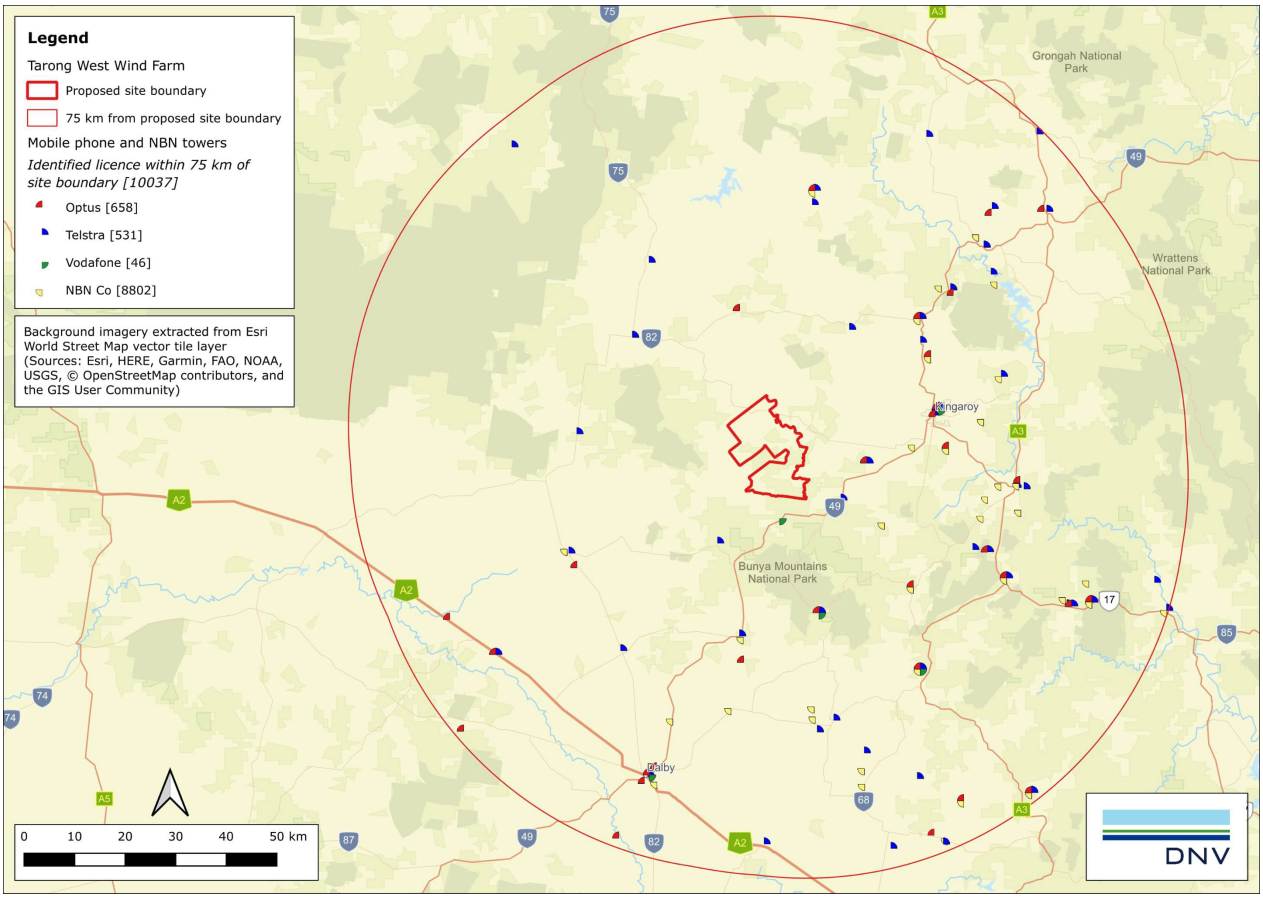

Figure 13 Location of mobile phone and NBN towers within 75 km of the proposed Project

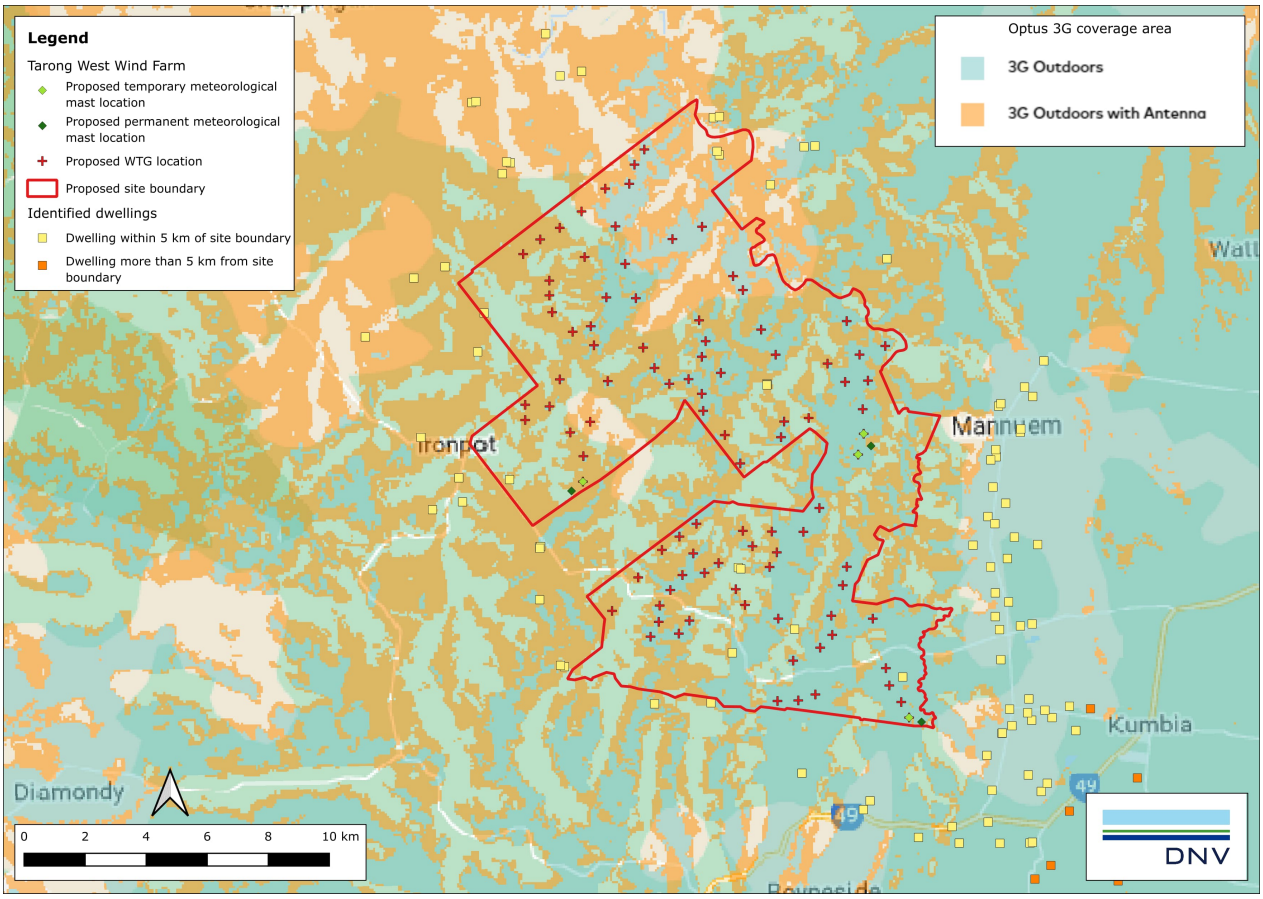

Figure 14 Optus Mobile 3G network coverage for the proposed Project

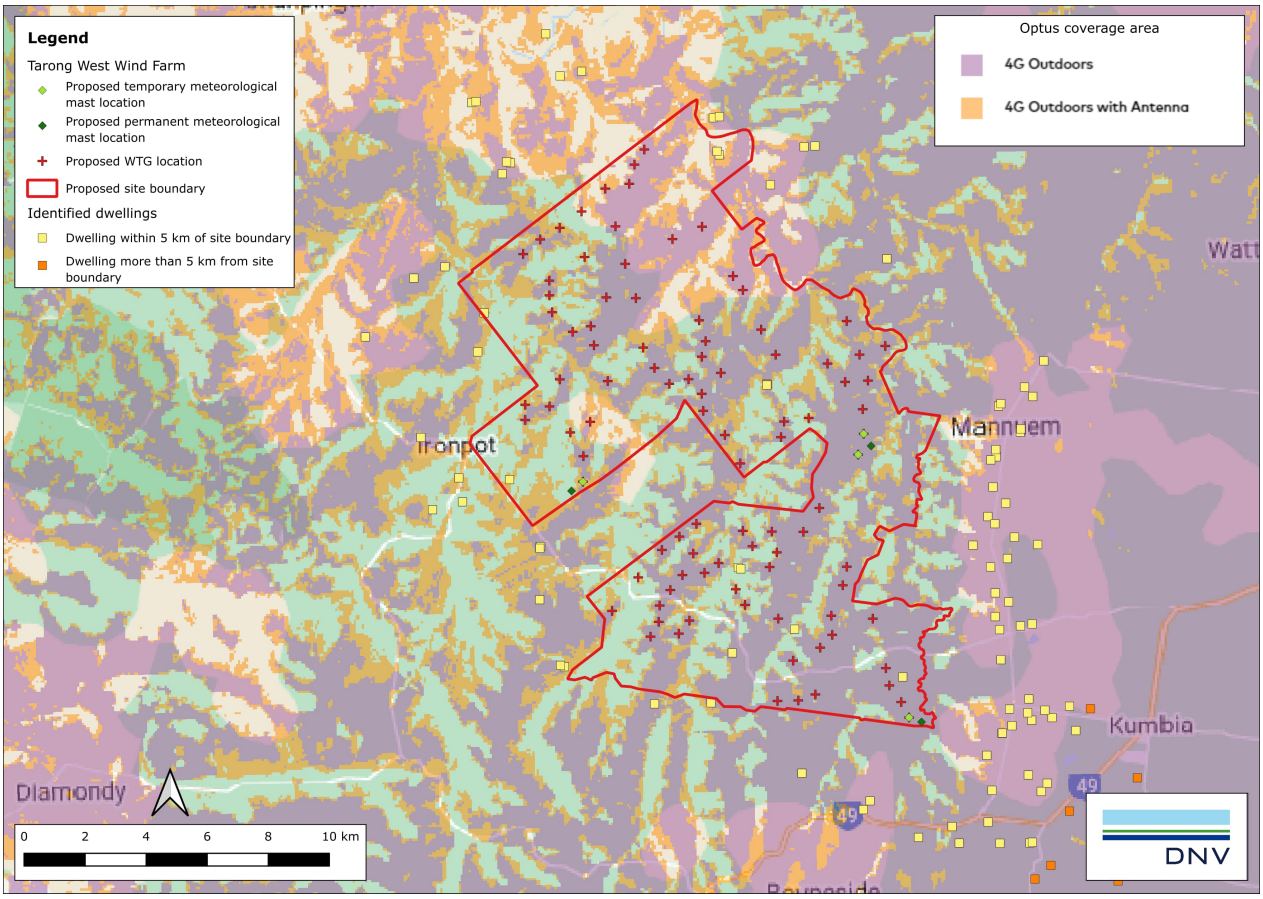

Figure 15 Optus Mobile 4G network coverage for the proposed Project

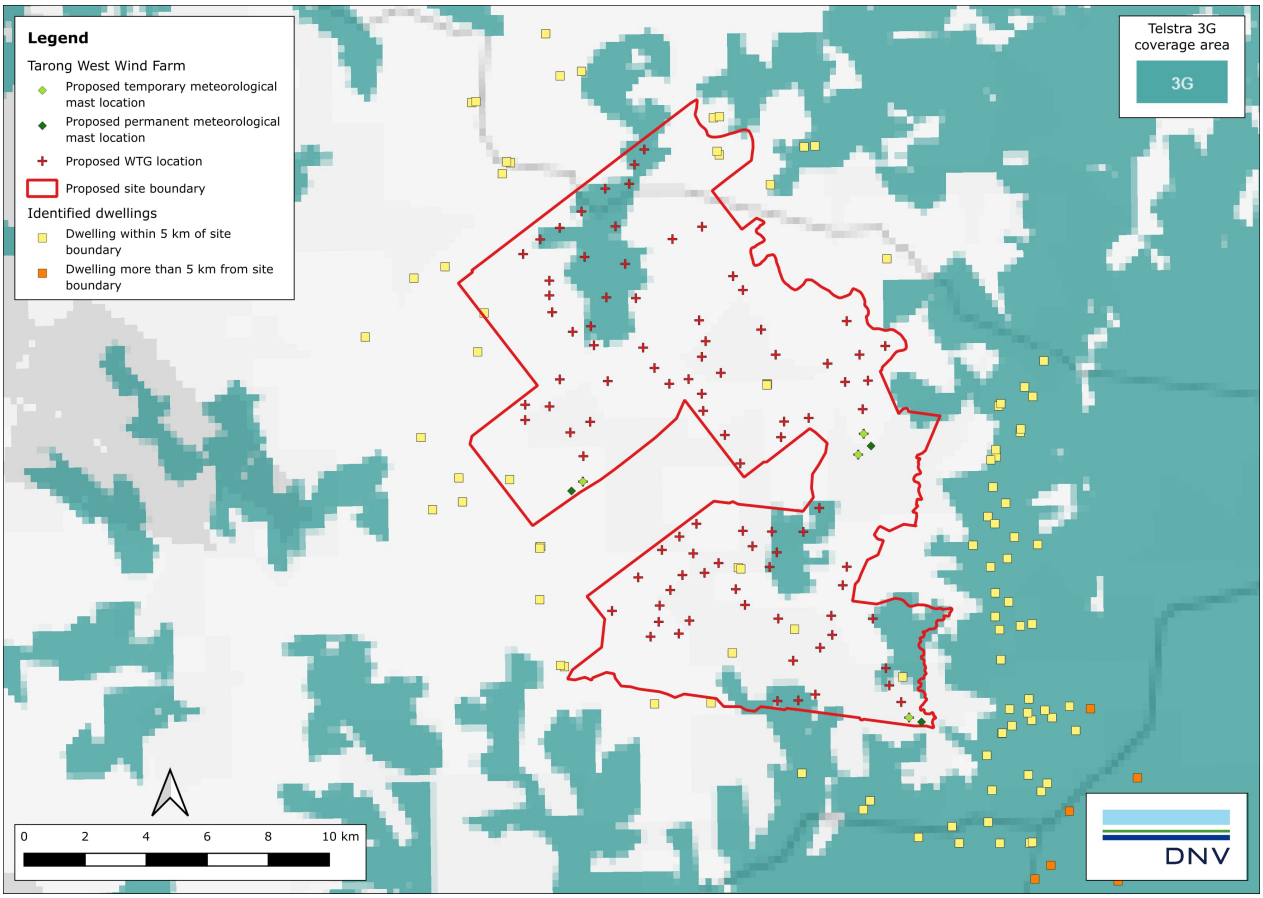

Figure 16 Telstra 3G network coverage for the proposed Project

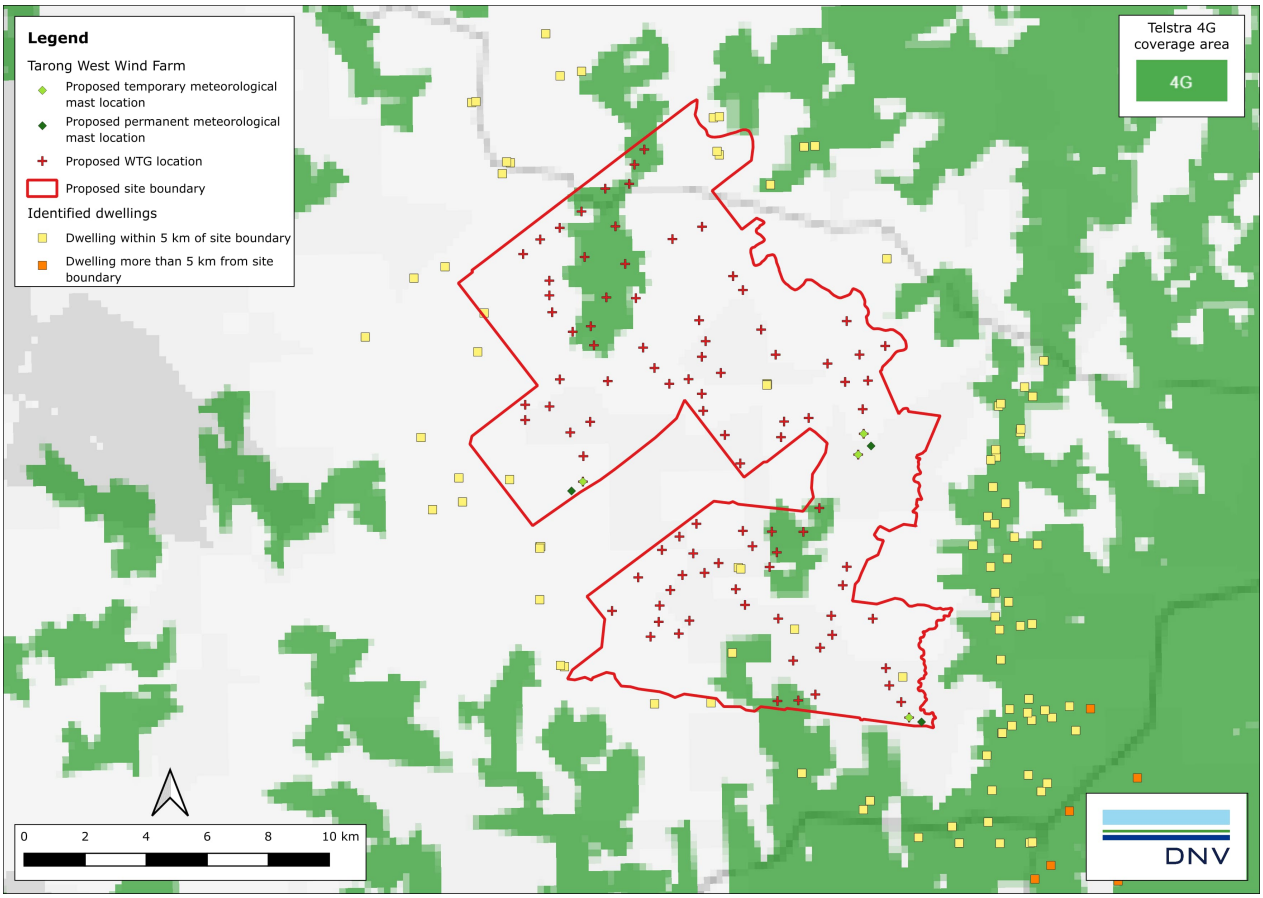

Figure 17 Telstra 4G network coverage for the proposed Project

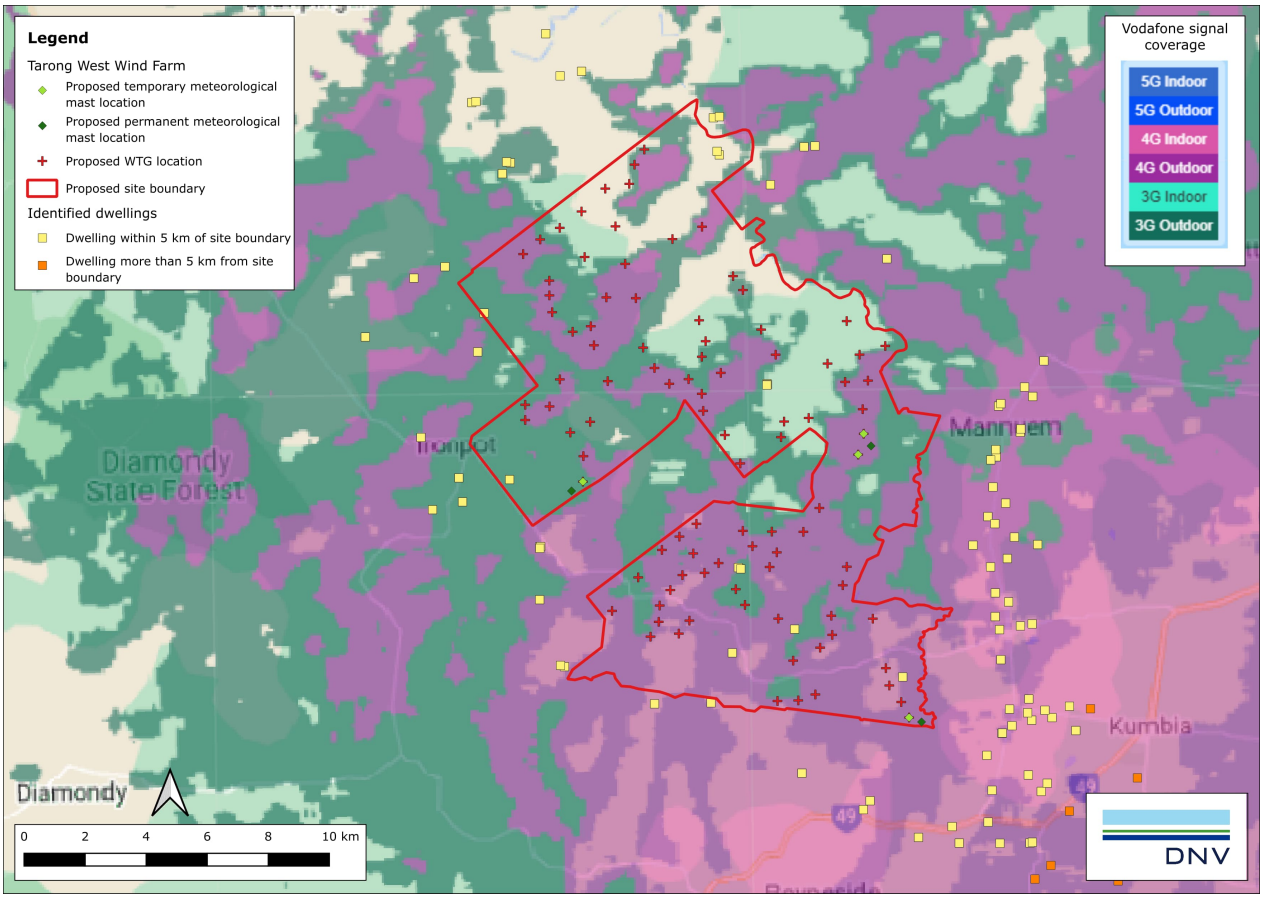

Figure 18 Vodafone network coverage (Apple iPhone 13 handset) for the proposed Project

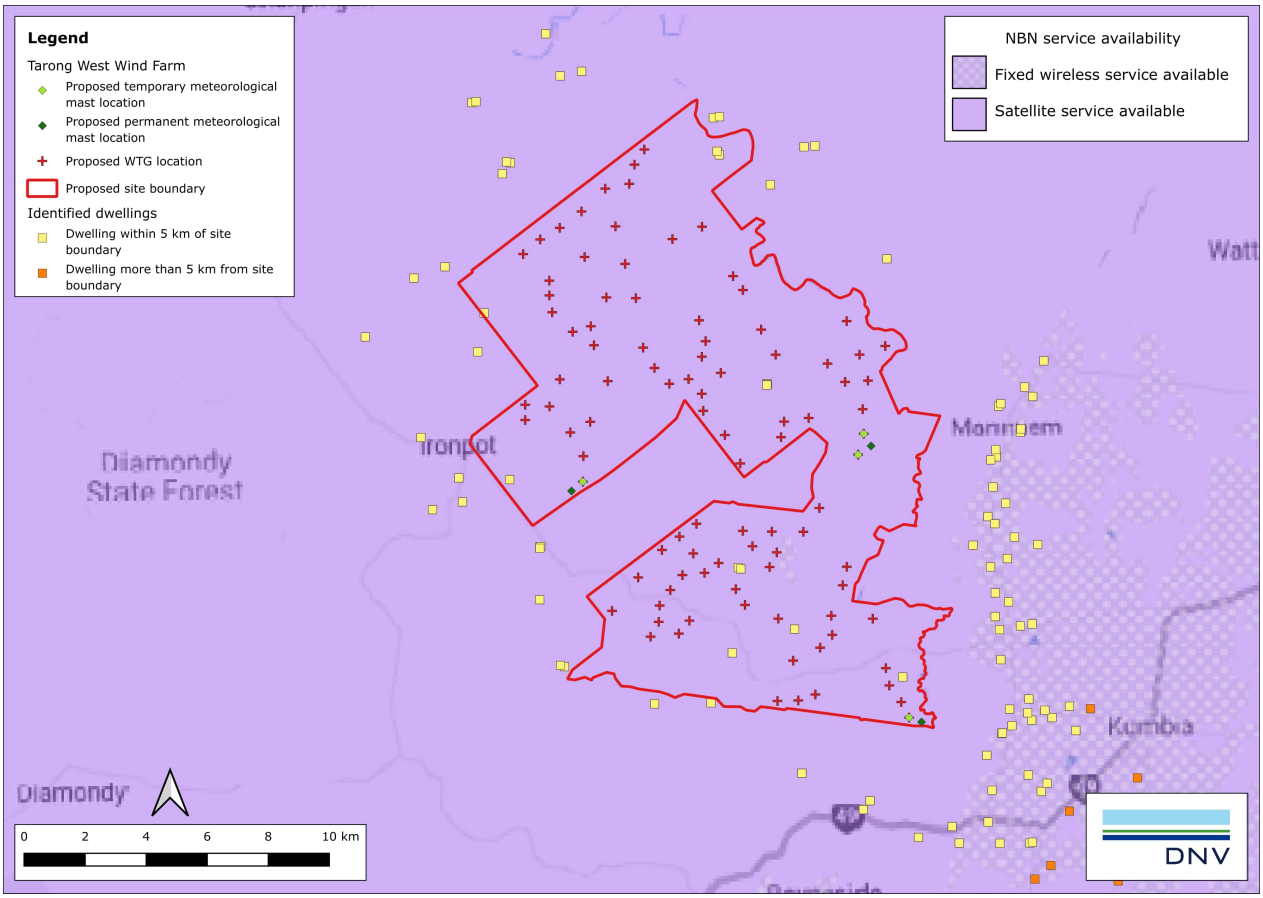

Figure 19 NBN internet coverage in the vicinity of the proposed Project

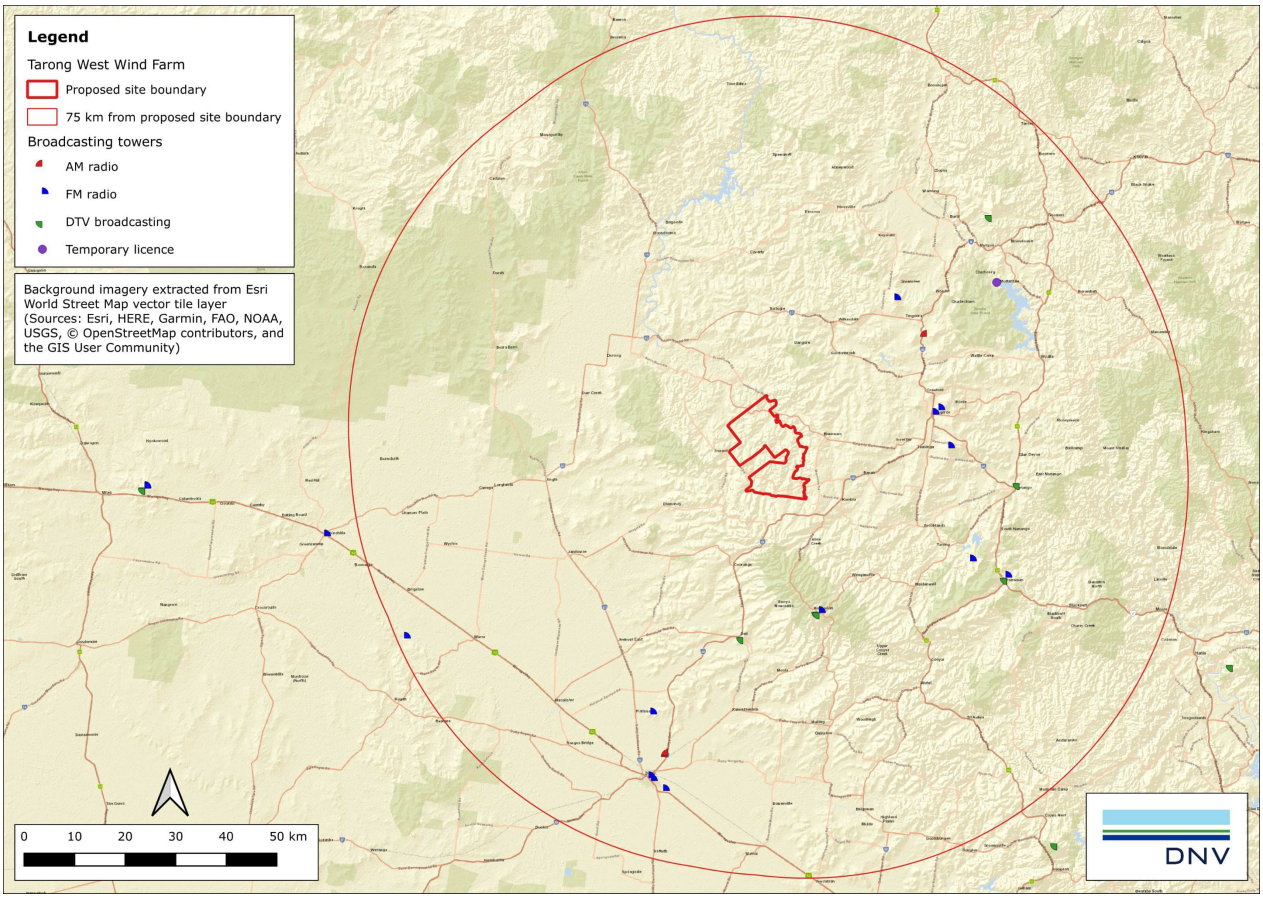

Figure 20 Location of broadcast transmitters in the vicinity of the proposed Project

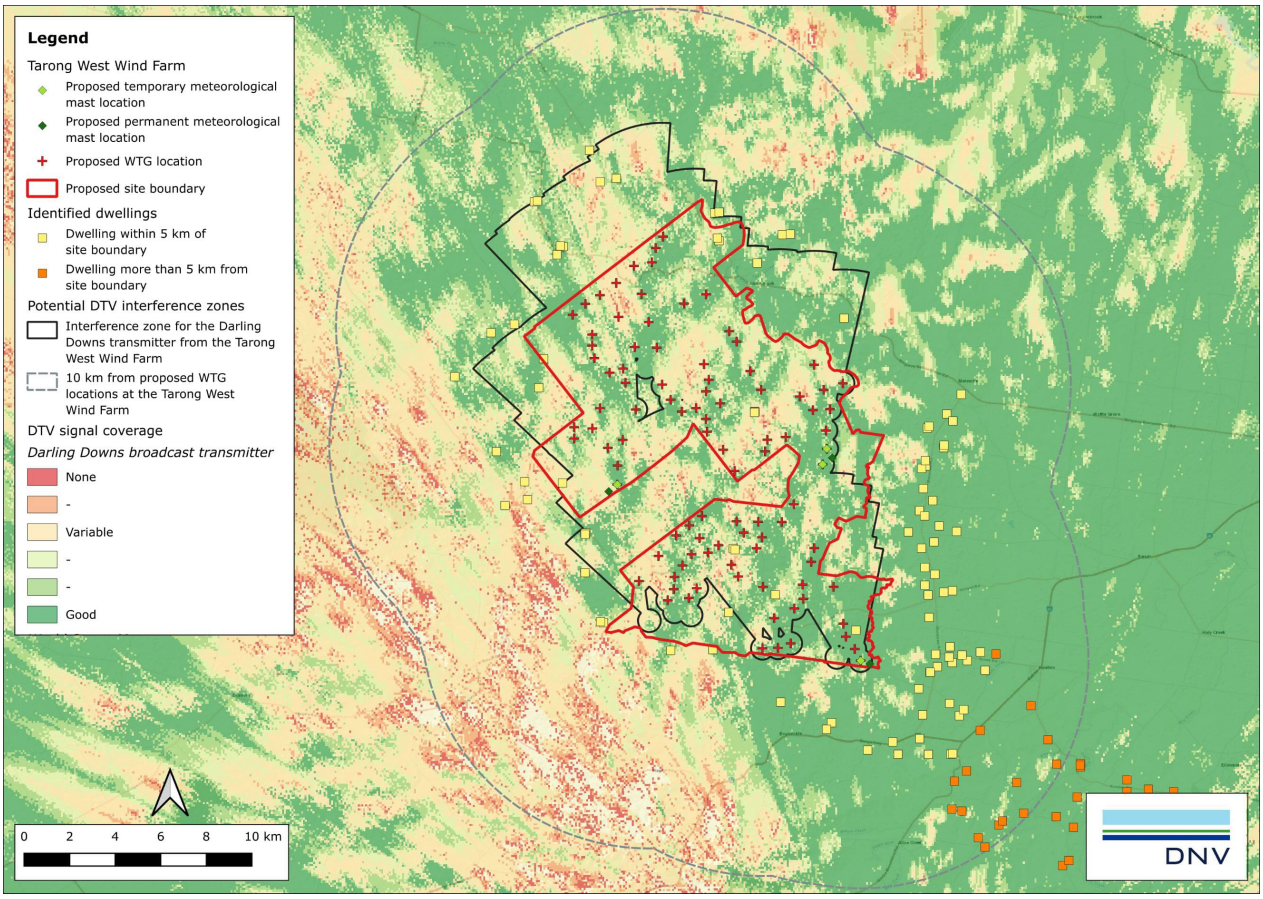

Figure 21 Potential television EMI zones from the Darling Downs broadcast tower for the proposed Project

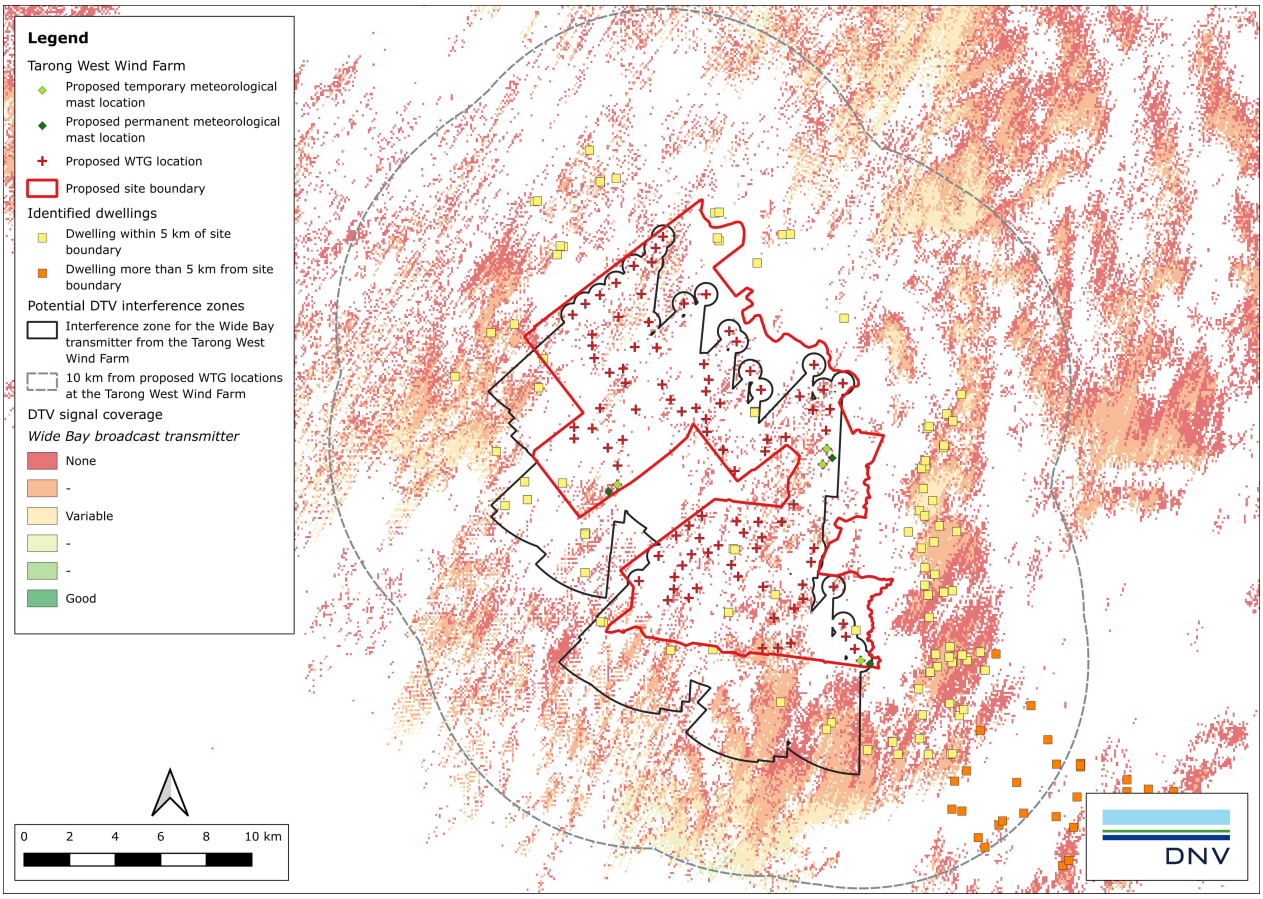

Figure 22 Potential television EMI zones from the Wide Bay broadcast tower for the proposed Project

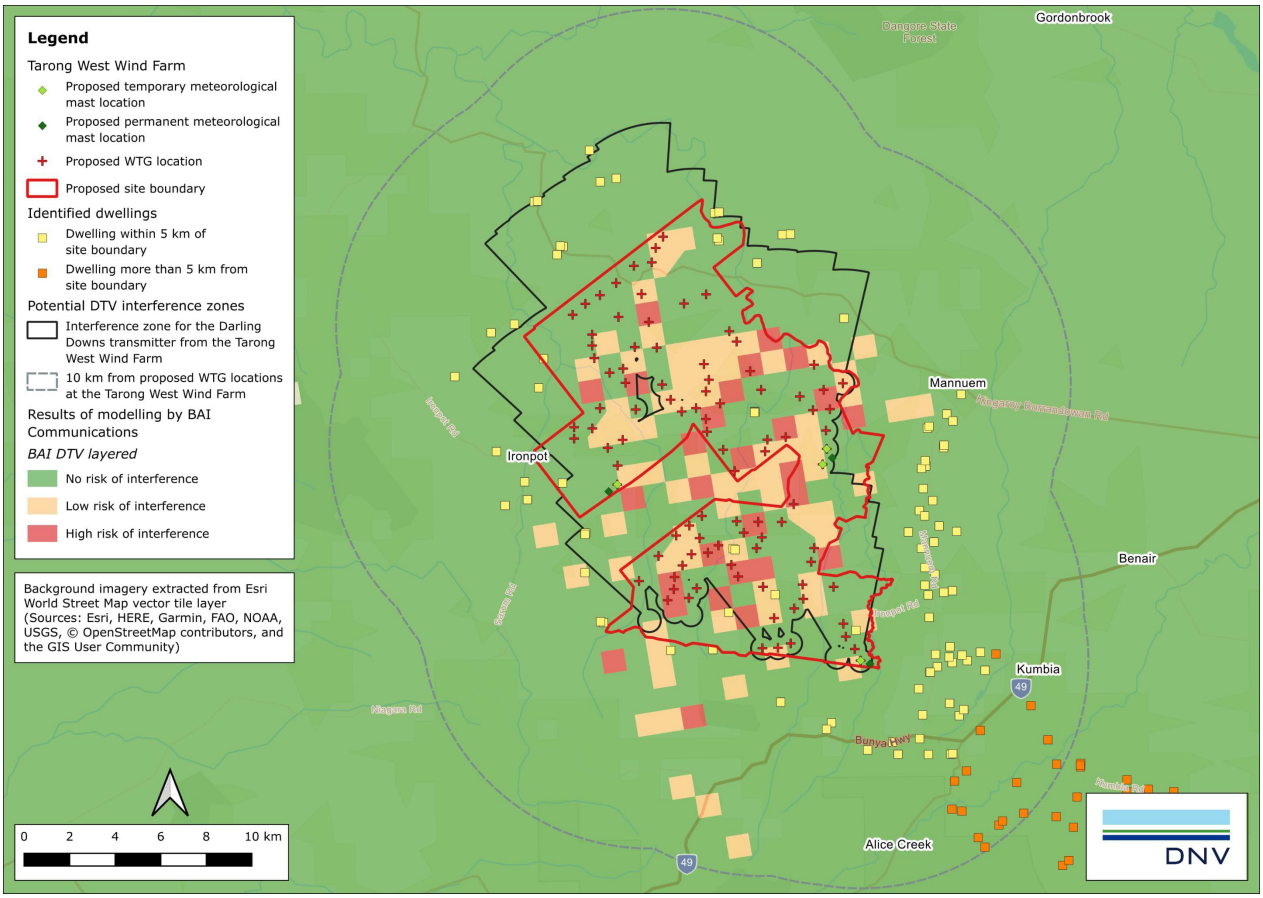

Figure 23 Potential television EMI zones modelled by BAI Communications for the proposed Project

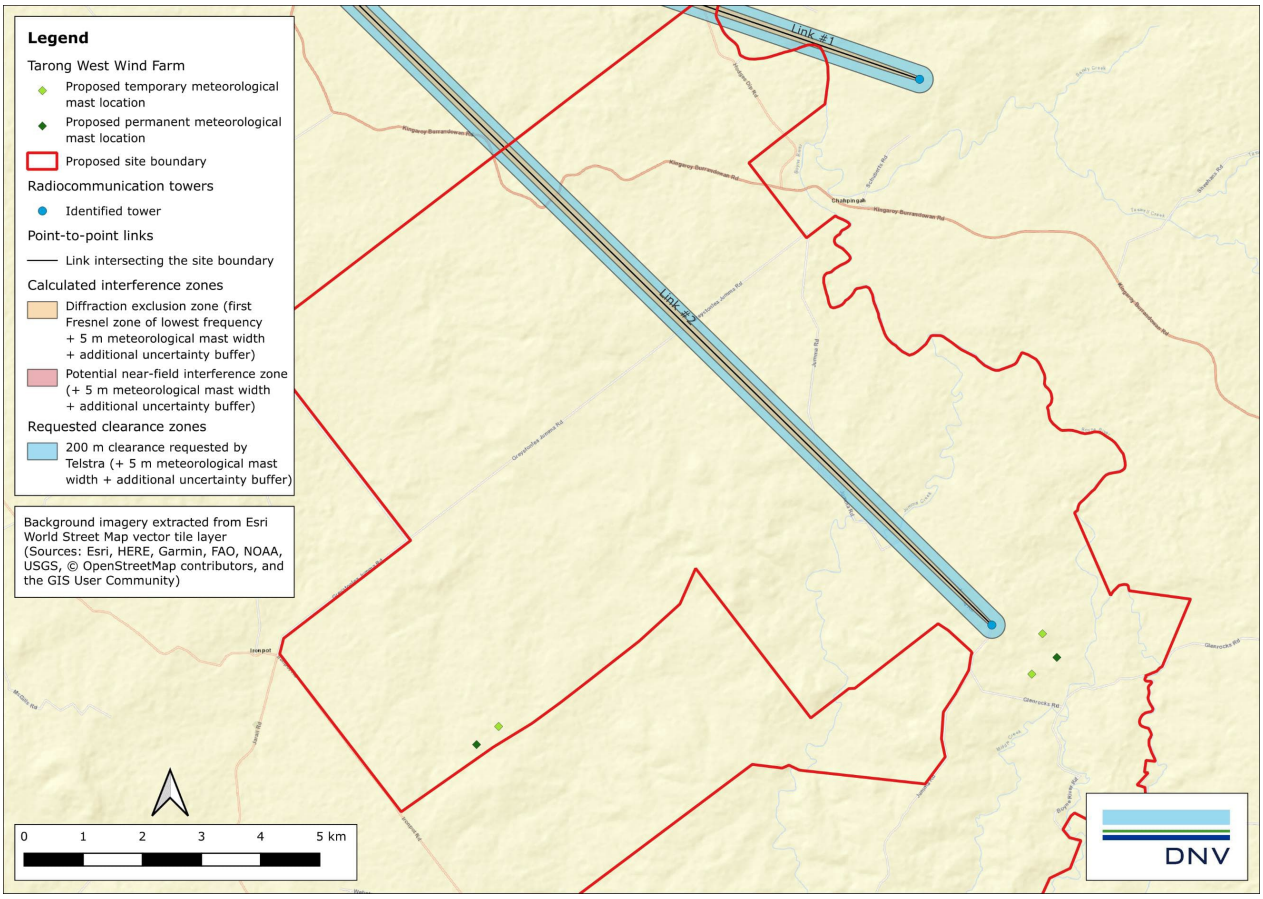

Figure 24 Identified point-to-point radiocommunication vectors, calculated interference zones, and requested clearance zones in relation to the proposed meteorological masts

ABOUT DNV

Driven by our purpose of safeguarding life, property and the environment, DNV enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.