YATHROO WIND FARM

EMI Assessment

Umwelt (Australia) Pty Ltd

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Table of contents

EXECUTIVE SUMMARY

DNV has been commissioned by Umwelt (Australia) Pty Ltd ("Umwelt" or "the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Yathroo Wind Farm ("the Project") in Western Australia. The results of the EMI assessment are described in this document.

Background and methodology

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

A Project layout consisting of 65 wind turbines with a rotor diameter of 182 m, upper tip height of 261 m, and lower tip height of 59 m has been considered. These dimensions represent the maximum and minimum overall tip heights and maximum rotor diameter under consideration for the Project.

There are 48 identified dwellings within 5 km of the Project, 15 of which are involved dwellings.

Outcomes of the assessment

The results of the EMI assessment are summarised in the table at the end of this section.

Through consultation, the Bureau of Meteorology (the Bureau) has raised concerns about the potential for the Project to interfere with their meteorological radar at Watheroo, and the associated impacts to their operations and services. DNV understands that the proponent of the Project is engaging further with the Bureau to understand the nature of the potential impacts and how these might be mitigated.

Electricity Networks Corporation (Western Power) has also advised that turbines at the Project are likely to interfere with a point-to-multipoint link they operate from a nearby base station. However, DNV understands that Western Power has made an internal recommendation to reroute the link to an alternative base station to avoid any potential impacts.

Turbines at the Project may 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 within approximately 5-10 km of the Project that are currently receiving weak signals from the Moora, Lancelin, and Perth television broadcast transmitters may experience interference to those services, although coverage maps suggest that most dwellings in the vicinity of the Project are unlikely to be receiving signals from these transmitters. If interference to these services is experienced, a range of options are available to rectify difficulties.

Since it is not possible to determine the potential EMI impacts on nearby point-to-area style communications, point-to-multipoint links, emergency services, and wireless internet services without obtaining further information from the relevant operators, DNV has consulted with a number of organisations operating these services. Apart from the feedback received from the Bureau and Western Power, as outlined above, no concerns have been raised to date. Consultation with other organisations operating services that may be affected by the Project is ongoing.

Potential EMI impacts on other services considered in this assessment, including fixed point-to-point links, trigonometrical stations and survey marks, satellite internet and television services, and CB radio, are not expected or are considered to be minor.

DNV notes that the Project is located in an area of high wind farm development activity, with several other proposed, approved, and operating wind farms located nearby. The potential cumulative impacts of the Project in conjunction with the nearby wind farms have not been considered in detail in this assessment. However, for services where impact from the Project itself is considered either unlikely or non-existent, it is generally expected that cumulative impacts will be minimal or non-existent.

Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	5 towers within 2 km of proposed turbine locations, operated by: DBNGP (WA) Nominees Pty Ltd (DBGNP) Electricity Networks Corporation (Western Power) Optus Mobile Pty Limited (Optus) Starlink Australia Pty Ltd (Starlink) Telstra Limited (Telstra) The Trustee for John Brown Family Trust TPG Internet Pty Ltd (TPG) Western Australia Police (WA Police)	**DBNGP, Western Power, Optus, John Brown Family Trust, WA Police:** No concerns raised **Starlink, Telstra:** No response received **TPG:** Consultation yet to commence	**Point-to-point links:** See findings for point-to-point links **TPG mobile phone services:** Potential for interference **Other services:** Unlikely to cause interference	**Point-to-point links:** As for point-to-point links **Starlink satellite services:** None required **Other services:** If required - – increase signal strength from affected tower or alternative towers, relocate tower, install signal repeater, install additional tower
Fixed point-to-point links	12 links within 300 m of the Project boundary, operated by: DBGNP Western Power Iluka Resources Limited (Iluka Resources) Optus St John Ambulance Western Australia Ltd. (St John Ambulance) Telstra WA Police **DBNGP and Western Power links:** no turbines in diffraction zones, 2 turbines in potential reflection/scattering zones, no turbines in potential near-field zones **Optus links:** no turbines in diffraction zones, 4 turbines in potential reflection/scattering zones, no turbines in potential near-field zones **WA Police links:** no turbines in diffraction zones, 5 turbines in potential reflection/scattering zone for 1 link, no turbines in potential near-field zones **Other links:** no turbines in any interference zones	**DBNGP, Western Power, Optus, WA Police:** No concerns raised **St John Ambulance, Telstra:** No response received **Iluka Resources:** Consultation not considered necessary	**DBNGP, Western Power, Optus, and WA Police links:** Low likelihood of interference through reflection or scattering of signals **Other links:** Unlikely to cause interference	If required - reroute affected links, install additional towers, replace affected links with alternative technologies

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Fixed point-to-multipoint links	102 assignments within 75 km of Project boundary 7 base stations within 20 km of Project boundary, operated by: Iluka Resources Karakin Wind Pty Ltd and North East Equity Pty Ltd (Karakin Wind) Water Corporation West Hills Farm Pty Ltd	**Western Power:** Likely to cause interference to 1 point-to-multipoint link **Bureau of Meteorology, Karakin Wind, Water Corporation:** No concerns raised **Department of Defence, Iluka Resources:** Consultation yet to commence **Other operators:** Consultation not considered necessary	**Western Power:** Likely to cause interference to 1 point-to-multipoint link **Bureau of Meteorology, Karakin Wind, Water Corporation:** None **Other operators:** Potential for interference if link paths cross the Project near turbines	**Western Power point-to-multipoint link:** Reroute link to an alternative base station **Other point-to-multipoint networks:** If required – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	**Point-to-area style communications:** see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	-	-	-
Emergency services	**Point-to-point links:** 3 WA Police links crossing boundary (see above) **Point-to-area style communications:** unlikely to be affected	**WA Police:** No concerns raised **St John Ambulance:** No response received **Other operators:** Consultation yet to commence	**Point-to-point links:** See findings for point-to-point links **Point-to-area style communications:** Unlikely to cause interference	**Point-to-point links:** As for point-to-point links **Point-to-area style communications:** If required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest radar: 68 km from Project	Likely to cause interference to Watheroo radar	Likely to cause interference to Watheroo radar	To be determined through consultation with the Bureau of Meteorology
Trigonometrical stations	**Trigonometrical stations:** unlikely to be affected **Survey marks:** unlikely to be affected	No concerns raised	Unlikely to cause interference	None required
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Optus:** No concerns raised **Telstra:** No response received **Vodafone/TPG:** Consultation yet to commence	Low likelihood of interference	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	**Wireless broadband service providers:** Field Solutions Group Pty Ltd, Mobile JV Pty Limited, mobile phone networks, NBN Co **NBN:** available as a fixed wireless and satellite service	**Optus, NBN Co:** No concerns raised **Telstra:** No response received **Vodafone/TPG (including Mobile JV), Field Solutions Group:** Consultation yet to commence	**Wireless broadband services**: See findings for mobile phones **NBN:** Unlikely to cause interference	**Wireless broadband services:** As for mobile phones **NBN:** If required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install new tower
Satellite television and internet	**Geostationary satellites:** no signals intercepted by turbines **Low Earth orbit (LEO) satellites:** unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	Consultation not considered necessary	**AM and FM signals:** Low likelihood of interference **Digital radio signals:** None	**AM and FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** None required

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Moora transmitter:** Good to variable coverage to the northeast and east; patchy coverage to the north and within the Project boundary; no coverage elsewhere 12 dwellings (5 involved dwellings) in potential interference zone – most are unlikely to be receiving signals from this transmitter	Consultation yet to commence	Low likelihood of interference, as dwellings may not be currently receiving a signal	If required – re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	Lancelin transmitter: Variable to poor coverage to the west and southwest; patchy coverage within the Project boundary; no coverage elsewhere 20 dwellings (7 involved dwellings) in potential interference zone - most are unlikely to be receiving signals from this transmitter		Low likelihood of interference, as dwellings may not be currently receiving a signal	
	Perth transmitter: Variable coverage to the south and in isolated areas to the north and within the Project boundary; poor to no coverage elsewhere 10 dwellings (7 involved dwellings) in potential interference zone - most are unlikely to be receiving signals from this transmitter		Low likelihood of interference, as dwellings may not be currently receiving a signal	

1 INTRODUCTION

Umwelt (Australia) Pty Ltd ("Umwelt" or "the Customer") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Yathroo Wind Farm ("the Project") in Western Australia. The results of this work are reported here.

In accordance with the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [1], this assessment investigates the potential EMI impact of the Project on:

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

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

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The Project site is located approximately 10 km south of Dandaragan in Western Australia.

The site is mainly comprised of areas of open agricultural land, areas of scattered native trees, and a few small pockets of densely treed bushland.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 65 wind turbines [2]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 6.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Customer [3]. There are 48 dwellings located within 5 km of the Project boundary, 15 of which are involved dwellings. The coordinates of these dwellings are presented in Table 7, and the dwellings and Project boundary considered in this assessment are shown in Figure 1.

For the purposes of this assessment, DNV has evaluated the potential for EMI-related impacts at identified dwellings within 5 km of the Project boundary. The locations of identified dwellings more than 5 km from the Project boundary have also been shown, where available, but impacts at these dwellings have not been considered in detail.

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 assumed that all considered dwellings are inhabited and has not considered two existing involved dwellings that the Customer has advised will not be inhabited once the Project commences operation.

3 REGULATORY REQUIREMENTS

The development of wind farms in Western Australia is governed by the Western Australian Planning Commission's Position Statement on renewable energy facilities ("the WA Position Statement"), published in March 2020 [4]. However, the WA Position Statement does not address the potential for wind farms to cause EMI-related impacts on nearby radiocommunication services.

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) [1]. 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.

Since the WA Position Statement does not provide any guidance on the assessment of EMI-related impacts, DNV considers that the recommendations of the Draft National Guidelines are relevant to the assessment of EMI impacts for wind farms in Western Australia. Therefore, the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 EMI CAUSED BY THE PHYSICAL PRESENCE OF WIND TURBINES

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 65 wind turbines, as outlined in Table 6.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 182 m, an upper tip height of 261 m, and a lower tip height of 59 m has been considered. These dimensions represent the maximum tip height and rotor diameter under consideration for the Project. The results generated based on this turbine configuration will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying all of the following criteria:

- a rotor diameter of 182 m or less
- an upper tip height of 261 m or less
- a lower tip height of 59 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, and then assess the radiocommunication licences attached to these towers. This reduces the likelihood that radiocommunication links crossing the Project 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 Communications and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 2 June 2025 [5].

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

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a radiocommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV has consulted with, or is intending to consult 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. The organisations that have been contacted and all responses received to date are summarised in Table 15. DNV has undertaken an initial round of consultation with selected operators based on a

previous turbine layout consisting of 69 turbines with a rotor diameter of 182 m and an upper tip height of 261 m ("the preliminary turbine layout"). Further consultation based on the turbine layout considered in this assessment ("the current turbine layout", consisting of 65 turbines with a rotor diameter of 182 m and an upper tip height of 261 m) is ongoing.

The radiocommunication licences and services with potential to experience EMI-related impacts from the proposed Project are considered in the following sections. Each section contains a brief overview of the relevant technology, followed by an assessment of the identified licences and services in the area around the Project and the expected potential for interference. Details of any feedback obtained from the service operators and potential mitigation options are also included where appropriate.

DNV notes that the Project is located in an area of high wind farm development activity, with several other proposed, approved, and operating wind farms located nearby. The potential cumulative impacts of the Project in conjunction with the nearby wind farms have not been considered in detail in this assessment. However, for services where impact from the Project itself is considered either unlikely or non-existent, it is generally expected that cumulative impacts will be minimal or non-existent.

4.2 Radiocommunication towers

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

4.2.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 308 radiocommunication towers within a nominal 75 km of the Project boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 2.

There are nine radiocommunication towers located within 2 km of the proposed Project boundary, five of which are within 2 km of the proposed turbine locations. These five towers and the consultation zones recommended by the Draft National Guidelines [1] are shown in Figure 3 based on information obtained from the ACMA RRL database and extracted from aerial or satellite imagery. Each consultation zone includes the rotor radius for turbines with a 182 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. Where appropriate, the size of the uncertainty buffer in each case has been informed by the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

Details of the licences associated with these radiocommunication towers are given in Table 1**.** These licences and services include:

- fixed point-to-point links
- point-to-area style communications, comprising land mobile licences used for private mobile telephony (mobile radio and paging systems), spectrum licences used for commercial public mobile phone networks, and a Citizen's band radio repeater (CBRS) licence
- fixed satellite services.

Table 1 Details of radiocommunication towers located within 2 km of the proposed turbine locations

Site ID	Operator	Licence/service types	Distance to nearest turbine [m]
30554	Telstra Limited (Telstra)	Point-to-point links Point-to-area (mobile phone)	1125
	Western Australia Police (WA Police)	Point-to-point links Point-to-area (land mobile)	
36736	Electricity Networks Corporation (Western Power)	Point-to-point links Point-to-area (land mobile)	1794
	DBNGP (WA) Nominees Pty Ltd (DBNGP)	Point-to-point links Point-to-area (land mobile)	
601222	The Trustee for John Brown Family Trust	Point-to-area (CBRS repeater)	512
10025044	Starlink Australia Pty Ltd (Starlink)	Area-wide fixed satellite service	1906
10033038	Optus Mobile Pty Limited (Optus)	Point-to-point links Point-to-area (mobile phone)	712
	TPG Internet Pty Ltd (TPG)	Point-to-area (mobile phone)	

The potential for the Project to interfere with point-to-point links through reflection or scattering of signals or near-field effects is discussed further in Section 4.3. For the point-to-point links associated with the radiocommunication towers shown in Table 1, DNV has established potential reflection/scattering and near-field interference zones as described in Sections 4.3.1.2 and 4.3.1.3. Based on these interference zones, it is not expected that the Project will cause interference to the point-to-point links through near-field effects. However, there may be potential for the Project to cause interference to the point-to-point links operated by DBNGP, Western Power, Optus and WA Police through reflection or scattering of the signals.

Point-to-area style radiocommunications such as mobile radio and paging systems are typically designed to operate in a range of environments and are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation, and other forms of signal obstruction. However, interference caused by reflection or scattering of signals or near-field effects can be a problem if the turbines are located close to the transmission tower. Reference [6] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts due to reflection or scattering of signals. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for these types of

services [7]. Previous advice received from mobile phone network operators in Australia has suggested that clearances of between 500 m and 1000 m from their towers may be required to avoid the potential for impacts to mobile phone signals.

Given the proximity of the proposed wind turbine locations to the towers at site IDs 30554, 601222, and 10033038, there is a potential for the Project to interfere with the associated point-to-area style communications and mobile phone services operated by WA Police, the John Brown Family Trust, Optus, and TPG from these towers through reflection or scattering of the signals. Near-field zones for these types of systems are typically only a few metres in radius, and so it is considered unlikely that the Project will cause interference to the services associated with these towers through near-field effects.

Fixed satellite services involve the transmission of signals between two or more fixed locations via a satellite or network of satellites. For these services, the signal paths between the ground-based stations and the corresponding satellites are directed away from the earth's surface. Although satellite signals can be intercepted by structures such as wind turbines, interference is only likely to be a problem if turbines are located within approximately 1000 m of the ground station. Since there are no proposed wind turbine locations within 1000 m of the tower at site ID 10025044, it is not expected that turbines at the Project will obstruct the fixed satellite service signals to or from this tower.

4.2.2 Stakeholder consultation

DNV has contacted DBNGP, Western Power, Telstra, Optus, Starlink, and WA Police to determine the likelihood that the proposed Project will cause interference to their services associated with the towers shown in Table 1 through near-field effects or reflection or scattering of signals. Responses have been received from DBGNP, Western Power and WA Police, based on the preliminary turbine layout, and no concerns have been raised. No response has been received to date from Telstra or Starlink. Further consultation with these operators based on the current turbine layout is ongoing. Responses have been received from Optus based on both the preliminary and current turbine layouts, and no concerns have been raised.

The Customer has provided advice from the John Brown Family Trust regarding the land mobile licence operated from the tower at site ID 601222. Based on this feedback, DNV understands that this tower is a base station for an agricultural navigation system used by the landowner and the owners of neighbouring properties for farming operations. Agricultural navigation systems use satellite-based radionavigation services such as the Global Positioning System (GPS) network to provide precision positioning, guidance, and control for tractors and other farming equipment and activities [8]. In many of these systems, a satellite receiver is installed on a base station at a fixed location [9, 10]. A computer processor at the base station calculates the difference between the known location of the station and the location determined from the navigational satellite signals. The base station then transmits this information to a roaming satellite receiver, such as a handheld unit or a receiver installed on a tractor, using mobile radio signals. There may be potential for interference to the signals from the base station at site ID 601222 if they pass through the Project in the vicinity of turbines. However, any interference caused by turbines is expected to be similar to that caused by existing obstacles such as buildings, vegetation, or terrain that may temporarily obstruct the line of sight between the base station and the moving receiver. The John Brown Family Trust has confirmed that interference to the signals from the tower at site ID 601222 operations is not expected, and there is no required clearance distance or need for mitigation.

DNV is also intending to contact TPG to seek feedback regarding the potential for the Project to cause interference to their services associated with the tower at site ID 10033038 through near-field effects or reflection or scattering of signals.

4.2.3 Mitigation options

Potential mitigation options for impacts to the point-to-point links operated by DBNGP, Western Power, Optus, Telstra, and WA Police are discussed in Section 4.3.3.

In the event that impacts to point-to-area style communications are experienced after the Project is operational, mitigation measures would need to be determined in consultation with the relevant operators but may include increasing the signal strength from the affected tower or alternative towers, relocating the tower to a position where the signals will not be affected by the Project, installing a signal repeater, or installing additional towers in the vicinity of the Project.

4.3 Fixed licences of point-to-point type

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

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

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

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

Each individual link identified in this assessment 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 12 point-to-point links recorded in the ACMA RRL database that pass over or within 300 m of the proposed Project boundary, operated by DBNGP, Western Power, Iluka Resources Limited (Iluka Resources), Optus, St John Ambulance Western Australia Ltd. (St John Ambulance), Telstra, and WA Police. The details of the links are provided in Table 8, and the link paths are shown in greater detail in Figure 5 based on information obtained from the ACMA RRL database and extracted from aerial or satellite imagery. To simplify reporting, each link has been assigned a unique identifier (e.g. Link #1) so that it can be easily distinguished.

The potential interference mechanisms and interference zones established by DNV for these links are described in Sections 4.3.1.1, 4.3.1.2, and 4.3.1.3, and summarised in Section 4.3.1.4. Feedback obtained from the operators of the links, including their recommended clearance zones to reduce the potential for interference, is summarised in Section 4.3.2.

4.3.1.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [1, 11, 12], typically defined in terms of the Fresnel zones for the link. The *n*th Fresnel zone is comprised of all points for which, if the signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n-\lambda}{2}$, where λ = wavelength.

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

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

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

To avoid interference to point-to-point links caused by signal diffraction, wind turbines, including the blades, should be kept outside of an exclusion zone based on either the second Fresnel zone as recommended in [11], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [6] (although DNV understands that this zone is under review by the authors of that document). For each of the links crossing the proposed Project boundary, 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.

The potential diffraction exclusion zones in the horizontal plane are shown in Figure 5. Each exclusion zone includes the rotor radius for turbines with a 182 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. Where appropriate, the size of the uncertainty buffer in each case has been informed by the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

The results of this analysis are summarised in Table 2.

There are no turbines located within the diffraction exclusion zones for the point-to-point links passing over or within 300 m of the proposed Project site. Therefore, it is not expected that the Project will cause interference to these links through diffraction of the signals.

4.3.1.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-

interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a wind turbine will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [11].

Reference [11] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a wind turbine at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and wind turbine, and comparing this to the required C/I ratio, a potential interference zone can be defined.

For each of the identified links with a transmission tower near the proposed turbine 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 turbine calculated according to the equation proposed in [13], and an assumed minimum C/I ratio of 20 dB [13]. The radiation patterns for the antennas were approximated using the reference radiation patterns given in the International Telecommunication Union (ITU) Recommendation F.699-8 [14].

The potential reflection/scattering interference zones are shown in Figure 5. Each interference zone includes the rotor radius for turbines with a 182 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. Where appropriate, the size of the uncertainty buffer in each case has been informed by the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery. For comparison, Figure 5 also shows the 2 km radius consultation zones for reflection or scattering effects as recommended by the Draft National Guidelines, centred on the transmission towers for the point-to-point links crossing the Project boundary.

The results of this analysis are summarised in Table 2.

There are two turbines located within the potential reflection/scattering interference zones for the point-to-point links operated by DBNGP and Western Power, four turbines located within the potential reflection/scattering interference zones for the point-to-point links operated by Optus, and five turbines located within the potential reflection/scattering interference zones for one link operated by WA Police.

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 turbine and from the turbine to the receiver also have a clear line of sight with respect to terrain [11]. 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 wind turbine 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 [6].

Nevertheless, DNV notes that the reflection/scattering interference zones shown in Figure 5 are approximations only and may be overly conservative [1]. This is especially true for high frequency links where increased antenna directionality (or gain) and narrower scatter regions can make the signal less susceptible to interference caused by reflection or scattering [6]. The turbine 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 [13], 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, DNV has contacted the operators of the point-to-point links crossing the proposed Project boundary, as described in Section 4.3.2, to seek their feedback on the potential for the Project to cause interference to those links through reflection or scattering of the signals.

4.3.1.3 Interference caused by near-field effects

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

Reference [11] 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 turbine locations, DNV has established a near-field interference zone based on the operating frequency and antenna gain for that link.

The potential near-field interference zones are shown in Figure 5. Each interference zone includes the rotor radius for turbines with a 182 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. Where appropriate, the size of the uncertainty buffer in each case has been informed by the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

The results of this analysis are summarised in Table 2.

There are no turbines located within the near-field interference zones for any of the point-to-point links passing over or within 300 m of the proposed Project boundary. Therefore, it is not expected that the Project will cause interference to the point-to-point links through near-field effects.

4.3.1.4 Summary of point-to-point interference effects

Table 2 summarises the turbines located within the calculated diffraction, reflection/scattering, and near-field interference zones for each of the point-to-point links crossing the Project boundary.

Table 2 Details of turbines located within the interference zones established by DNV for point-to-point links crossing the proposed Project boundary

Link no.	Operator	Turbines within potential interference zone		
		Diffraction	Reflection/ scattering	Near-field
1	DBGNP	None	2 turbines (63, 64)	None
2	DBGNP	None	2 turbines (63, 64)	None
3	Western Power	None	2 turbines (63, 64)	None
4	Western Power	None	2 turbines (63, 64)	None
5	Iluka Resources	None	None	None
6	Optus	None	4 turbines (22, 25, 29, 34)	None
7	Optus	None	4 turbines (22, 25, 29, 34)	None
8	St John Ambulance	None	Not assessed[1]	Not assessed[1]
9	Telstra	None	None	None
10	WA Police	None	None	None
11	WA Police	None	5 turbines (42, 43, 44, 55, 56)	None
12	WA Police	None	None	None

1. Transmission towers are located more than 5 km from the proposed turbine locations. Interference caused by reflection or scattering of signals or near-field effects is not expected for this link.

4.3.2 Stakeholder consultation

DNV has contacted the operators of the point-to-point links crossing the proposed Project boundary 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.

Responses have been received from DBNGP, Western Power, and WA Police, based on the preliminary turbine layout, and no concerns have been raised. No response has been received to date from St John Ambulance or Telstra. Further consultation with these operators based on the current turbine layout is ongoing.

Based on advice received from the Customer, DNV understands that the Optus point-to-point links crossing the Project boundary (links #6 and #7) are currently under development and may not yet be operational. Responses have been received from Optus based on both the preliminary and current turbine layouts, and no concerns have been raised. At the request of the Customer, DNV has also contacted CPS Technology & Infrastructure (CPS), who are involved in the design and implementation of the Optus point-to-point links, to seek their feedback on the potential for the Project to interfere with these links. CPS referred the enquiry to Optus, who confirmed that the proposed turbine locations are sufficiently clear of the link paths and they do not expect either the Project to impact on these links.

Consultation with Iluka Resources regarding the potential for impacts to their point-to-point link passing within 300 m of the Project boundary is not considered necessary.

4.3.3 Mitigation options

In the event that interference to point-to-point links is experienced after the Project is operational, mitigation options would need to be confirmed through consultation with the relevant operators but may include upgrading the equipment for the affected links, re-routing links via an existing or new tower, or replacing links with alternative communication technologies.

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 ACMA RRL database. A point-to-multipoint licence allows communication between one or more static sites and multiple points or between the points, and is usually 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 but does not include the remote stations that communicate with the static station. Hence, the paths of the transmission vectors are not readily identifiable.

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

From the ACMA RRL database, DNV has identified 102 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 6. The details of the licence holders as given in the ACMA RRL database are provided in Table 9.

There are seven point-to-multipoint base stations within 20 km of the Project boundary, operated by Illuka Resources, Karakin Wind Pty Ltd and North East Equity Pty Ltd (Karakin Wind), Water Corporation, and West Hills Farm Pty Ltd. There are also several point-to-multipoint base stations located more than 20 km from the Project.

Wind turbines can cause interference to point-to-multipoint links through the same mechanisms as described for point-to-point links in Section 4.3.1. As such, there may be potential for interference to point-to-multipoint links if those links cross the Project near the turbines. However, as it is not possible to know the link paths in a point-to-multipoint network without obtaining further information about the locations of each station in the network, consultation with the relevant operators is needed to determine the potential for interference.

4.4.2 Stakeholder consultation

DNV has contacted the Bureau of Meteorology, Western Power, Karakin Wind, and Water Corporation to determine the likelihood that the proposed Project will cause interference to their point-to-multipoint networks. No concerns have been raised by the Bureau of Meteorology, Karakin Wind, or Water Corporation.

The feedback received from Western Power based on the preliminary turbine layout indicated that the Project is likely to interfere with a point-to-multipoint link from the tower at site ID 36736 to a remote station located to the west of the Project. DNV notes that there are no point-to-multipoint licences currently associated with site ID 36736 in the ACMA RRL database, and so this site has not been identified in Figure 6 or Table 9. However, the advice provided by Western Power suggests that this link is being operated under the point-to-area style licence associated with site ID 36736 and identified in Section 4.2.1. To avoid the potential for impacts to this link, DNV understands that Western Power has made an internal recommendation to reroute the link to an existing alternative

base station. Further consultation with Western Power based on the current turbine layout is ongoing.

DNV is also intending to contact the operators of other potentially affected base stations identified within approximately 60 km of the Project, namely the Department of Defence and Iluka Resources, to determine the likelihood that the proposed Project will cause interference to their operations and services.

Consultation with Tronox Management Pty Ltd and West Hills Farm regarding the potential for impacts to their point-to-multipoint licences is not considered necessary.

4.4.3 Mitigation options

Western Power has advised that impacts to their point-to-multipoint link associated with the tower at site ID 36736 could be mitigated by rerouting the link to an alternative base station.

In the event that interference to other point-to-multipoint links is experienced after the Project is operational, mitigation options would need to be confirmed through consultation with the relevant operators but may include re-routing the affected links via an existing or new tower, installing additional towers, or replacing the links with alternative communications technologies.

4.5 Other licence types

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

4.5.1 Locations of other licences and potential for interference

DNV has identified a number of other licences in the ACMA RRL database within 75 km of the proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 7 and Table 10.

Most of the licences identified can be broadly described as base to mobile station or point-to-area style communications, including commercial and private mobile telephony and radio and television broadcasting. These licence types are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation, and other forms of signal obstruction.

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

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

4.6 Emergency services

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

4.6.1 Locations of emergency services licences and potential for interference

DNV has reviewed the ACMA RRL database to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 11 along with their contact details. The nearest licence is associated with a tower located within the Project boundary, approximately 1.1 km from the nearest wind turbine.

The potential for the turbines at the Project to interfere with emergency services point-to-point links crossing the proposed Project site is discussed in Section 4.3.

All other licences operated by emergency services in the vicinity of the Project are mobile telephony licences used for mobile radio and paging systems, or maritime radiocommunication licences that are restricted to coastal areas. As discussed in Section 4.5, mobile telephony systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction. Reference [6] provides general guidance regarding the potential for interference with mobile radio systems and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts to these systems. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for point-to-area style services [7].

The potential for interference to mobile telephony services operated by WA Police from a tower within 2 km of the proposed turbine locations is discussed in Section 4.2.1.

Given the distance of the other emergency services mobile telephony and maritime licences from the Project, DNV considers it unlikely that the Project will cause interference to other mobile radio and paging systems and maritime radiocommunications operated by emergency services.

4.6.2 Stakeholder consultation

DNV has contacted St John Ambulance and WA Police, to seek feedback on any potential impact that the Project could have on their operations and services. A response has been received from WA Police based on the preliminary turbine layout and no concerns have been raised. No response has been received from St John Ambulance to date. Further consultation with these operators based on the current turbine layout is ongoing.

DNV is also intending to contact the operators of other potentially affected licences identified within approximately 60 km of the Project, namely the Department of Biodiversity Conservation and Attractions and the Department of Fire and Emergency Services of WA, to seek feedback on any potential impact that the Project could have on their operations and services.

4.6.3 Mitigation options

Potential mitigation options for impacts to emergency services point-to-point links crossing the Project boundary are discussed in Section 4.3.3.

Potential mitigation options for impacts to the mobile telephony services operated by WA Police from the tower within 2 km of the proposed turbine locations are discussed in Section 4.2.3.

As noted above, interference with mobile telephony services operated by other emergency services is considered unlikely. If localised interference to mobile radio or paging system signals is experienced, this can often be mitigated by the user moving a short distance to a new or higher location to receive a clearer signal or by using an external antenna to improve the signal reception. Other mitigation options may include increasing the signal strength from the affected tower or

alternative towers or installing a signal repeater or additional tower on the opposite side of the Project.

4.7 Aircraft navigation systems and radar

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

4.8 Meteorological radar

The Bureau of Meteorology ("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 [15].

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 [16, 17].

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 [18, 19], and approximately 100 km at a height of 1000 m [19]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high potential for complete or partial blockage of the radar signal and subsequent loss of weather data [20, 21]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of turbines 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 turbine will be 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 [1].

4.8.1 Locations of meteorological radars and potential for interference

DNV has identified that the Bureau operates seven weather radars within 250 nautical miles of the proposed Project, with the closest radar located approximately 68 km northeast of the Project at Watheroo. The locations of these radars are shown in Figure 8 and the details of each radar are given in Table 12.

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.

4.8.2 Stakeholder consultation

DNV has contacted the Bureau regarding the Project, as recommended by the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely.

The feedback received from the Bureau based on the preliminary turbine layout indicated that the Project is likely to interfere with signals from the Watheroo radar and may therefore impact on the Bureau's operations and services. To address this potential for impact, the Bureau has advised that they require a detailed assessment of the likely impacts on their services and possible mitigation measures. DNV understands that the proponent of the Project is engaging further with the Bureau based on the current turbine layout to understand the nature of the potential impacts and how these might be mitigated.

4.8.3 Mitigation options

Mitigation options to address the impacts of interference to the Watheroo radar will need to be determined through consultation with the Bureau but may include the installation of additional weather monitoring equipment, such as rain gauges, automatic weather stations, wind profiling devices, or a new meteorological radar.

4.9 Trigonometrical stations

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

Some trig points may host surveying equipment such as Global Positioning System (GPS) antennas and electronic distance measuring (EDM) devices. EDM devices measure the distance from the trig point to the target object by means of a beam of known velocity which is reflected back to the unit from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed.

The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 km to 5 km, and could be intercepted or obstructed by the presence of turbines. However, the potential for 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 [22].

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 [23]. 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) [24], 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.

4.9.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [25], there are 42 trig points within 20 km of the Project boundary. One trig point, Walyer Walyer, is located inside the Project boundary approximately 1.1 km from the nearest proposed turbine location. The details of these trig points are provided in Table 13 and their locations are illustrated in Figure 9.

There are also 28 permanent survey marks within 2 km of the Project boundary [26] as shown in Figure 10. The closest survey mark is located 296 m from the nearest turbine.

DNV has reviewed the primary geodetic network of Australia [27] and observed that the Project is located within the high-density trilateration region. Trilateration depends on distances measured from trigonometrical stations of known positions, baselines and heights, with a high degree of accuracy, to determine the location of the site being surveyed.

The closest GNSS station is located approximately 29 km southeast of the Project, at Lancelin [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.

4.9.2 Stakeholder consultation

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 to inform them of the Project, and seek feedback regarding whether interference to their systems is possible. A response has been received from Geoscience Australia and no concerns have been raised.

4.10 Citizen's band radio

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

The CB radio service can be used for voice communication activities, telemetry, and telecommand applications. The radio service operates on two frequency bands, namely the high frequency (HF)

band between 26.965 MHz and 27.405 MHz and the ultra-high frequency (UHF) band between 476.425 MHz and 477.400 MHz.

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

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

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

4.10.1 Locations of CB radio devices and potential for interference

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

4.10.2 Mitigation options

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

4.11 Mobile phones

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

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is

theoretically possible that wind turbines could cause some interference to the signal. However, there is little evidence in the literature of wind turbines interfering with mobile phone signals, and DNV notes that previous advice received from mobile phone network operators in Australia has generally indicated that they do not expect wind farm developments to interfere with their services provided that appropriate clearances from the mobile phone towers are maintained.

4.11.1 Availability of mobile phone services and potential for interference

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 11. The nearest mobile phone tower is located within the Project boundary, approximately 700 m from the nearest wind turbine.

Mobile phone network coverage maps have been obtained for Optus, Telstra, and Vodafone/TPG 4G services. 5G services are not available in the immediate vicinity of the Project.

Figure 12 shows the Optus Mobile network coverage for the Project area [29]. Optus 4G coverage is generally available to the west of the Project site along the Brand Highway, but is otherwise patchy across the Project area and surroundings.

Figure 13 shows the Telstra network coverage for the Project area [30]. Telstra 4G coverage is available through the centre of the Project site and in areas to the south and west. Coverage is not available in the northeast of the Project site and is patchy in areas beyond the Project boundary to the northeast and east.

Figure 14 shows the Vodafone/TPG network coverage for the Project area [31]. Vodafone/TPG 4G coverage is generally available to the west and northwest of the Project site along the Brand Highway, but is otherwise patchy across the Project area and surroundings.

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 the possibility for interference exists if a wind turbine intercepts the signal between a mobile phone and the tower.

4.11.2 Stakeholder consultation

DNV has contacted Optus and Telstra to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. Responses have been received from Optus based on both the preliminary and current layouts, and no concerns have been raised. No response has been received from Telstra to date.

DNV is also intending to contact Vodafone/TPG to seek feedback on any potential impact that the Project could have on their services.

4.11.3 Mitigation options

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

4.12 Wireless internet

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

4.12.1 Wireless broadband services

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

4.12.1.1 Availability of wireless broadband services and potential for interference

Field Solutions Group Pty Ltd and Mobile JV Pty Limited (a joint venture between Vodafone and TPG) hold point-to-area style licences in the vicinity of the Project, with base stations located 33 km and 52 km direction of the Project respectively. As the locations of Field Solutions Group and Mobile JV customers are not known, it is not possible to determine whether there is the potential for interference to their services. However, given the distance of these stations from the proposed Project, there is a low likelihood that they will be servicing customers in the vicinity of the Project.

Additionally, residents in the vicinity of the Project may use wireless broadband services provided by Optus, Telstra, and Vodafone/TPG. These wireless broadband services use the same networks as mobile phone services, and therefore the comments made in Section 4.11.1 are applicable here. Specifically, there is a low theoretical potential for interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower.

4.12.1.2 Stakeholder consultation

DNV has contacted Optus and Telstra, as discussed in Section 4.11.2, to seek feedback on any potential impact that the Project could have on their services. Responses have been received from Optus based on both the preliminary and current turbine layouts, and no concerns have been raised. No response has been received from Telstra to date.

DNV is also intending to contact Vodafone/TPG and Field Solutions Group to seek feedback regarding the potential for interference to their services any potential impact that the Project could have on their services.

4.12.1.3 Mitigation options

As noted above, interference with wireless broadband services is considered unlikely. If interference to the wireless broadband services provided by mobile phone networks occurs, the mitigation options given in Section 4.11.3 may be applicable. Specifically, localised interference can often be rectified by the user moving a short distance or using an external antenna to improve signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower on the opposite side of the Project.

4.12.2 National Broadband Network

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

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

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a range between 14 km and 29 km [32, 33]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [34].

For rural and remote users in areas that are not able to receive fixed line or fixed wireless services, NBN satellite internet signals are available from the NBN Sky Muster I and II satellites.

4.12.2.1 Availability of NBN services and potential for interference

The NBN website [35] indicates that the network is currently available as a fixed wireless and satellite internet service in the area surrounding the Project. 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 internet towers within 75 km of the Project boundaries are shown in Figure 11, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 15.

The NBN fixed wireless towers servicing the Project area are located at Nilgen and Karakin. Based on the relative positions of these towers and the nearby dwellings, and the fixed wireless coverage areas shown in Figure 15, it is considered unlikely that turbines at the Project will intercept the line of sight between these towers and nearby dwellings.

The potential for interference to satellite internet signals from the NBN Sky Muster I and II satellites is considered in Section 4.13.

4.12.2.2 Stakeholder consultation

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 responses received from NBN Co based on the preliminary and current turbine layouts indicate that interference to NBN fixed wireless services is not expected.

4.12.2.3 Mitigation options

As noted above, interference with NBN fixed wireless internet services is considered unlikely. If interference to NBN fixed wireless signals is experienced at nearby dwellings as a result of the Project, several mitigation options may be available to improve the signal reception. NBN Co has previously advised that in most instances where the signal line of sight from a given tower is obstructed an alternative tower can be used to service the affected dwelling. If an alternative tower is not available, interference can usually be rectified by moving the outdoor antenna at the affected dwelling a short distance from the building, to a location where the signal is not impacted by the turbines, and connecting that antenna to the dwelling via a cable (described by NBN Co as a "non-standard install process" [32]). It may also be possible to avoid impact by micro-siting the turbines in some cases, or by installing a new NBN tower to service the affected dwellings. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

4.13 Satellite television and internet

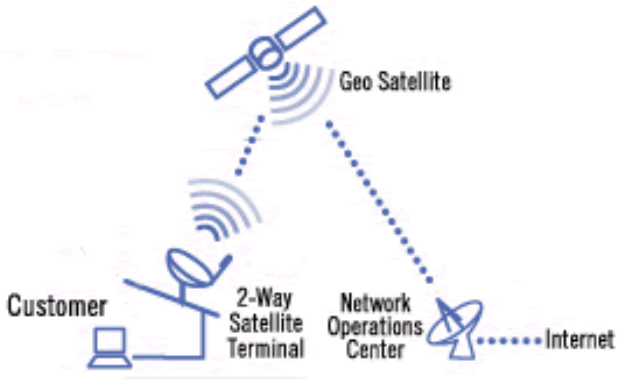
In some rural or remote areas, television and internet access can only be provided through satellite signals. There are two types of satellite that are typically used to provide commercial telecommunication services: geostationary satellites and low Earth orbit (LEO) satellites.

4.13.1 Geostationary satellite communication services

Geostationary satellites orbit the earth directly above the equator, at a height of 35,786 km above the Earth's surface [36]. At this altitude, the satellites travel at the same rate as the Earth's rotational speed and therefore appear to remain stationary at the same point in the sky relative to an observer at a fixed location. Additionally, due to their high altitude, each satellite can view (and therefore provide coverage to) a large portion of the Earth's surface. Geostationary orbits are typically used for weather monitoring satellites that continually observe a specific area of the Earth and for satellites that provide telecommunication services, since the satellite dish or antenna used on Earth to receive and transmit signals can be permanently pointed to the correct location in the sky. Both satellite television and satellite internet services are currently available in Australia via geostationary satellites.

Satellite television signals are delivered via a geostationary 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 geostationary satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [37, 38].

In the case of internet services provided by geostationary satellites, 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 geostationary satellites for providing satellite internet in Australia are the IPSTAR (THAICOM-4) and Optus D2 satellites, and the NBN Sky Muster I and II satellites.



Two-way connection to the internet via satellite [39]

4.13.1.1 Locations of geostationary satellite vectors and potential for interference

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

A number of satellites transmit television and internet signals that can be received in Australia. 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 analysis has shown that satellite signals to dwellings in the vicinity of the Project are not expected to be intercepted by turbines.

4.13.2 Low Earth orbit satellite communication services

Satellites in LEO occupy heights between 160 km and 1000 km above the Earth's surface [36]. At these altitudes, the satellites travel significantly faster than the Earth's rotational speed and typically compete a full orbit in approximately 90 minutes. Unlike geostationary satellites, LEO satellites do not have to follow a particular path around the Earth and their orbits are usually tilted with respect to the equator. However, due to their low altitude, each satellite can only observe or communicate with a small portion of the Earth's surface at a time and this, together with their fast movement across the sky, can limit the usefulness of LEO satellites in some situations.

For telecommunication applications, satellites in LEO offer lower latency and better performance than geostationary satellites, due to the reduced distance for the signal to travel. However, using a single LEO satellite to provide telecommunication services is often impractical due to the relatively small coverage area and significant effort required to track the satellite from the ground. To compensate for this, LOE satellites used for telecommunications usually operate as part of a large network or "constellation" of multiple satellites that work together to provide continuous coverage to large areas simultaneously. As satellites within the constellation move through the field of view of a satellite dish on Earth, the dish detects and connects to the satellite with the strongest signal and then automatically switches over to another satellite as the first moves out of view. Nevertheless, these services may be sensitive to physical obstructions such as terrain, vegetation, buildings, and other structures such as wind turbines, which can unexpectedly interrupt the signal from the connected satellite and cause the service to temporarily drop out until a new satellite can be found.

4.13.2.1 Availability of low Earth orbit services and potential for interference

Starlink is the only LEO satellite internet service currently available to customers in Australia. The current Starlink LEO constellation consists of several thousand satellites orbiting the Earth at a height of approximately 550 km [40], although this may increase to tens of thousands of satellites in the future. Starlink offers two classes of satellite dish to users of their services: a standard dish that is considered suitable for most residential applications, and a high performance dish that has a wider field of view (enabling it to connect to more satellites, even in the presence of obstructions), a higher gain antenna, and improved performance under extreme environmental conditions [41, 42].

In the southern hemisphere, Starlink satellite dishes currently require a relatively clear view of the sky within a field of view of 100° tilted towards the south, with a minimum elevation angle of 25° above the southern horizon [43]. Although some obstructions can be tolerated, the impact of these obstacles will depend on their apparent size, their distance and direction relative to the satellite dish, and the proportion of the sky already obstructed. Obstacles below an elevation angle of 25° in the south, 40° in the east and west, and 40° in the north (allowing for locations where no tilt of the satellite dish is required) will not pose any obstruction to the field of view. However, as more satellites are launched and join the Starlink constellation, it is expected that the required angle of tilt towards the south will reduce until dishes can be pointed directly upwards, with elevation angles above the horizon of 40° in all directions [44], and the service will become less sensitive to obstructions due to the increased number of visible satellites at each location.

DNV has considered the potential for turbines at the Project to obstruct Starlink signals received at nearby dwellings, based on the relative locations of the dwellings and the nearby turbines, the elevations of the dwellings and turbines, and a turbine tip height of 261 m.

At all dwellings in the vicinity of the Project, the turbines are expected to be below an angle of 25° above the horizon in all directions. Therefore, based on this analysis, it is not expected that turbines at the Project will obstruct Starlink signals for any nearby dwellings.

4.14 Radio broadcasting

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

4.14.1 AM radio

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

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

However, as noted above, the presence of physical obstructions such as turbines is unlikely to cause significant interference to AM radio signals. Due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [45].

4.14.1.1 Locations of AM transmitters and potential for interference

The locations of AM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [46], and are shown in Figure 16.

It is unlikely that any permanent AM radio receivers will be located sufficiently close to the Project to be affected by interference to the radio signals from the turbines.

4.14.1.2 Mitigation options

In the event that localised interference to AM radio signals is experienced, this can potentially be rectified by installing a high-quality antenna or amplifier at the affected residence.

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. Instead, the waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon. However, FM radio signals may be blocked by significant terrain features. FM radio stations therefore tend to have only local coverage, which means that signals are less susceptible to interference from distant FM broadcasters. FM signals are also less susceptible to interference from changes in atmospheric conditions and electrical equipment than AM signals.

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

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [47]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [45, 48].

Wind turbines located close to an FM transmitter may also present a physical obstruction to the radio signal. If the line-of-sight between the transmitter and a radio receiver is blocked by a turbine, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [47]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmitter [49].

4.14.2.1 Locations of FM transmitters and potential for interference

The locations of FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [46], and are shown in Figure 16.

The closest FM broadcast transmitter is located approximately 22 km from the proposed Project boundary. Therefore, it is considered unlikely that the Project will cause interference to the FM radio signals from this transmitter.

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

4.14.2.2 Mitigation options

In the event that localised interference to FM radio signals is experienced, this can potentially be rectified by installing a high-quality antenna or amplifier at the affected residence.

4.14.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne, and Sydney [50]. 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.

The UK telecommunications regulator Ofcom [47] states that *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*. DNV has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

4.14.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [51], 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 [52]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV 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 susceptibility of DTV signals to interference from wind turbines is discussed further in Section A.1 of Appendix A.

4.15.1 Availability of DTV broadcasting and potential for interference

The locations of DTV broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [52], and are shown in Figure 16. The main DTV transmitter used by residents in the vicinity of the Project is the Moora transmitter at Berkshire Valley. However, according to the Australian Government mySwitch website [53], it is also possible that

residents in the vicinity of the Project are able to receive DTV signals from other nearby transmitters.

The DTV broadcast transmitters likely to be servicing the area around the Project are summarised in Table 3 below. Coverage maps for these broadcast transmitters are reproduced in Figure 17 to Figure 19.

Table 3 DTV broadcast transmitters servicing the Project area

DTV broadcast transmitter	Signal coverage in the vicinity of the Project	Figure containing coverage map
Moora (Berkshire Valley)	Good to variable coverage to the northeast and east of the Project site; patchy coverage to the north and within the Project boundary; no coverage elsewhere	Figure 17
Lancelin (Nilgen)	Variable to poor coverage to the west and southwest of the Project site; patches of poor coverage within the Project boundary; no coverage elsewhere	Figure 18
Perth (Bickley/Carmel)	Variable coverage to the south of the Project site and in isolated areas to the north and within the Project boundary; poor to no coverage elsewhere	Figure 19

4.15.1.1 Interference caused by large scale effects

For broadcast signals, large scale interference can generally be avoided by placing the wind turbines at some distance from the transmitter. Broadcast transmitters may be either relay or primary transmitters. Relay transmitters are more commonly found in rural areas. Primary transmitters are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay transmitters, while a clearance of at least 6 km is recommended for primary transmitters [12].

The closest DTV transmitter to the Project is the Lancelin relay transmitter at Nilgen, which is approximately 22 km away. Therefore, it is considered unlikely that the Project will cause large scale interference to signals from this transmitter.

4.15.1.2 Interference caused by reflection or scattering

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

Due to the lack of an accurate theoretical scattering model, DNV has not performed detailed scatter calculations to predict DTV interference. Instead, dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine at 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 in Section A.3 of Appendix A, with a forward-scatter distance of 5 km and a back-scatter distance of 500 m.

The results of the analysis can be seen in Table 14 and Figure 17 to Figure 19. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 4. However, as noted in Table 4, many of the dwellings in the potential interference zones are in locations that, according to the coverage maps, are unlikely to be receiving signals from the corresponding transmitter.

Table 4 Number of dwellings located within potential interference zones for digital television broadcast transmitters in the vicinity of the Project

DTV broadcast transmitter	Number of dwellings in potential interference zone	Signal coverage in potential interference zone
Moora (Berkshire Valley)	12 (5 involved dwellings)	Limited to none – dwellings in the potential interference zone may not be receiving signals from this transmitter
Lancelin (Nilgen)	20 (7 involved dwellings)	Limited to none – dwellings in the potential interference zone are unlikely to be receiving signals from this transmitter
Perth (Bickley/Carmel)	10 (7 involved dwellings)	Limited to none – dwellings in the potential interference zone are unlikely to be receiving signals from this transmitter

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 at dwellings outside of the identified interference zones. Circumstances under which interference may occur outside the interference zones typically established using the 'keyhole' approach are discussed further in Section A.2 of Appendix A. In particular, although DNV has considered the potential for interference to DTV signals at dwellings within 5 km of the proposed turbine 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 turbines. For comparison, Figure 17 and Figure 19 also shows the area within 10 km of the proposed turbine locations. DNV recommends contacting BAI Communications, as discussed in Section 4.15.2 to confirm the potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

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

4.15.2 Stakeholder consultation

DNV is intending to contact 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.

4.15.3 Mitigation options

In the event that DTV interference is experienced at nearby dwellings as a result of the Project, potential mitigation options may include:

1. Realigning the user's television antenna more directly towards their existing transmitter.

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

In the event of significant interference in the backscatter region, realigning the antenna or installing a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. However, the effectiveness of this mitigation may be reduced if there is no clear line of sight from the antenna to the transmitter. In these cases, it may be more effective to move the antenna to a location where there is a clearer line of sight to the transmitter or to tune the antenna into an alternative or substitute signal (if one is available).

In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more aligned or directional antenna may not alleviate a forward scatter issue. Alternative mitigation measures to resolve issues caused by forward scatter could include tuning the antenna into an alternative signal (if one is available) or installing cable or satellite television at the affected dwelling. However, as noted in [54], DVB-T reception quality may not be substantially affected in the forward scatter region.

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

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription-based broadcasts. Residents in areas which are unable to receive DTV through their normal television antenna due to local interference, terrain, or distance from the transmitter in their area may be eligible to access the Australian Government funded Viewer Access Satellite Television (VAST) service [56].

5 CONCLUSIONS

Broadcast towers and transmission paths around the Project were investigated to determine if EMI would be experienced as a result of the development and operation of the Project. The Project will involve the installation of 65 wind turbine generators. DNV has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 182 m or less, an upper tip height of 261 m or less, and a lower tip height of 59 m or more.

The results of this assessment, including feedback obtained from relevant stakeholders, are summarised in Table 5.

The Bureau of Meteorology has raised concerns about the potential for the Project to interfere with their meteorological radar at Watheroo, and the associated impacts to their operations and services. DNV understands that the proponent of the Project is engaging further with the Bureau to understand the nature of the potential impacts and how these might be mitigated.

Western Power has also advised that turbines at the Project are likely to interfere with a point-to-multipoint link they operate from a nearby base station. However, DNV understands that Western Power has made an internal recommendation to reroute the link to an alternative base station to avoid any potential impacts.

Turbines at the Project may 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 within approximately 5-10 km of the Project that are currently receiving weak signals from the Moora, Lancelin, and Perth television broadcast transmitters may experience interference to those services, although coverage maps suggest that most dwellings in the vicinity of the Project are unlikely to be receiving signals from these transmitters. If interference to these services is experienced, a range of options are available to rectify difficulties.

Since it is not possible to determine the potential EMI impacts on nearby point-to-area style communications, point-to-multipoint links, emergency services, and wireless internet services without obtaining further information from the relevant operators, DNV has consulted with a number of organisations operating these services. Apart from the feedback received from the Bureau and Western Power, as outlined above, no concerns have been raised to date. Consultation with other organisations operating services that may be affected by the Project is ongoing.

Potential EMI impacts on other services considered in this assessment, including fixed point-to-point links, trigonometrical stations and survey marks, satellite internet and television services, and CB radio, are not expected or are considered to be minor.

Table 5 Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	5 towers within 2 km of proposed turbine locations, operated by: DBGNP Western Power Optus Starlink Telstra The Trustee for John Brown Family Trust TPG WA Police	**DBNGP, Western Power, Optus, John Brown Family Trust, WA Police:** No concerns raised **Starlink, Telstra:** No response received **TPG:** Consultation yet to commence	**Point-to-point links:** See findings for point-to-point links **TPG mobile phone services:** Potential for interference **Other services:** Unlikely to cause interference	**Point-to-point links:** As for point-to-point links **Starlink satellite services:** None required **Other services:** If required - – increase signal strength from affected tower or alternative towers, relocate tower, install signal repeater, install additional tower
Fixed point-to-point links	12 links within 300 m of the Project boundary, operated by: DBGNP Western Power Iluka Resources Optus St John Ambulance Telstra WA Police **DBNGP and Western Power links:** no turbines in diffraction zones, 2 turbines in potential reflection/scattering zones, no turbines in potential near-field zones **Optus links:** no turbines in diffraction zones, 4 turbines in potential reflection/scattering zones, no turbines in potential near-field zones **WA Police links:** no turbines in diffraction zones, 5 turbines in potential reflection/scattering zone for 1 link, no turbines in potential near-field zones **Other links:** no turbines in any interference zones	**DBNGP, Western Power, Optus, WA Police:** No concerns raised **St John Ambulance, Telstra:** No response received **Iluka Resources:** Consultation not considered necessary	**DBNGP, Western Power, Optus, and WA Police links:** Low likelihood of interference through reflection or scattering of signals **Other links:** Unlikely to cause interference	If required - reroute affected links, install additional towers, replace affected links with alternative technologies

Table 5 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Fixed point-to-multipoint links	102 assignments within 75 km of Project boundary 7 base stations within 20 km of Project boundary, operated by: Iluka Resources Karakin Wind Water Corporation West Hills Farm Pty Ltd	**Western Power:** Likely to cause interference to 1 point-to-multipoint link **Bureau of Meteorology, Karakin Wind, Water Corporation:** No concerns raised **Department of Defence, Iluka Resources:** Consultation yet to commence **Other operators:** Consultation not considered necessary	**Western Power:** Likely to cause interference to 1 point-to-multipoint link **Bureau of Meteorology, Karakin Wind, Water Corporation:** None **Other operators:** Potential for interference if link paths cross the Project near turbines	**Western Power point-to-multipoint link:** Reroute link to an alternative base station **Other point-to-multipoint networks:** If required – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	**Point-to-area style communications:** see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting **Aeronautical and radiodetermination:** to be considered as part of an aviation impact assessment	-	-	-
Emergency services	**Point-to-point links:** 3 WA Police links crossing boundary (see above) **Point-to-area style communications:** unlikely to be affected	**WA Police:** No concerns raised **St John Ambulance:** No response received **Other operators:** Consultation yet to commence	**Point-to-point links:** See findings for point-to-point links **Point-to-area style communications:** Unlikely to cause interference	**Point-to-point links:** As for point-to-point links **Point-to-area style communications:** If required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest radar: 68 km from Project	Likely to cause interference to Watheroo radar	Likely to cause interference to Watheroo radar	To be determined through consultation with the Bureau of Meteorology
Trigonometrical stations	**Trigonometrical stations:** unlikely to be affected **Survey marks:** unlikely to be affected	No concerns raised	Unlikely to cause interference	None required

Table 5 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Optus:** No concerns raised **Telstra:** No response received **Vodafone/TPG:** Consultation yet to commence	Low likelihood of interference	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	**Wireless broadband service providers:** Field Solutions Group Pty Ltd, Mobile JV Pty Limited, mobile phone networks, NBN Co **NBN:** available as a fixed wireless and satellite service	**Optus, NBN Co:** No concerns raised **Telstra:** No response received **Vodafone/TPG (including Mobile JV), Field Solutions Group:** Consultation yet to commence	**Wireless broadband services**: See findings for mobile phones **NBN:** Unlikely to cause interference	**Wireless broadband services:** As for mobile phones **NBN:** If required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install new tower
Satellite television and internet	**Geostationary satellites:** no signals intercepted by turbines **Low Earth orbit (LEO) satellites:** unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	Consultation not considered necessary	**AM and FM signals:** Low likelihood of interference **Digital radio signals:** None	**AM and FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** None required

Table 5 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Moora transmitter:** Good to variable coverage to the northeast and east; patchy coverage to the north and within the Project boundary; no coverage elsewhere 12 dwellings (5 involved dwellings) in potential interference zone – most are unlikely to be receiving signals from this transmitter	Consultation yet to commence	Low likelihood of interference, as dwellings may not be currently receiving a signal	If required – re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	Lancelin transmitter: Variable to poor coverage to the west and southwest; patchy coverage within the Project boundary; no coverage elsewhere 20 dwellings (7 involved dwellings) in potential interference zone - most are unlikely to be receiving signals from this transmitter		Low likelihood of interference, as dwellings may not be currently receiving a signal	
	Perth transmitter: Variable coverage to the south and in isolated areas to the north and within the Project boundary; poor to no coverage elsewhere 10 dwellings (7 involved dwellings) in potential interference zone - most are unlikely to be receiving signals from this transmitter		Low likelihood of interference, as dwellings may not be currently receiving a signal	

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APPENDIX A – TELEVISION INTERFERENCE CAUSED BY REFLECTION OR SCATTERING OF SIGNALS

A.1 Susceptibility of DTV signals to reflection or scattering

The United Kingdom telecommunications regulator Ofcom [47] 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 wind turbines.

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

- the proximity of turbines to the television broadcast transmitter
- the proximity of turbines to receivers (dwellings)
- the location of turbines in relation to dwellings and television broadcast transmitters
- 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.

A.2 Forward and back scatter of DTV signals

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

Forward scatter can occur when the transmitter, one or more turbines, and receiver are almost aligned as shown in Figure A.1. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [54]. Both of these effects can potentially degrade the DTV signal quality.

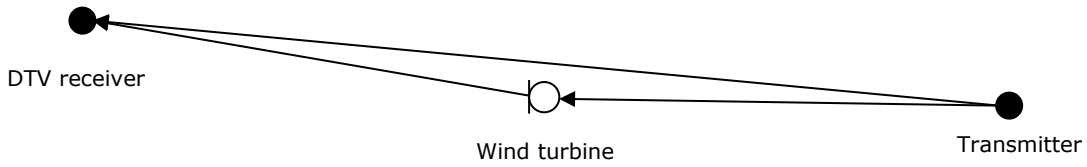

Figure A.1 Forward scatter signal path for DTV signals

Back scatter from wind turbines occurs when DTV signals are reflected from turbine towers and blades onto a receiver as shown in Figure A.2. 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).

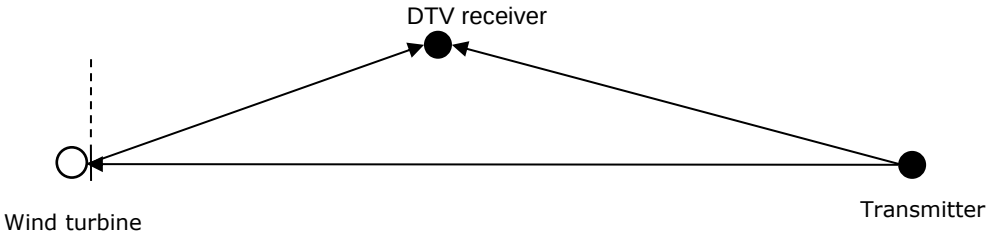

Figure A.2 Back scatter signal path for DTV signals

Interference to DTV signals from wind turbines can potentially occur in both the forward and backward scatter region. The effect of a turbine on a DTV signal can be different depending on the scattering region where the receiver is located [54].

According to Ofcom [47], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [12, 57]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the turbines [47]. 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 transmitter. The back scatter region generally does not extend further than 500 m [12, 47], 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 Figure A.3, resembles a keyhole.

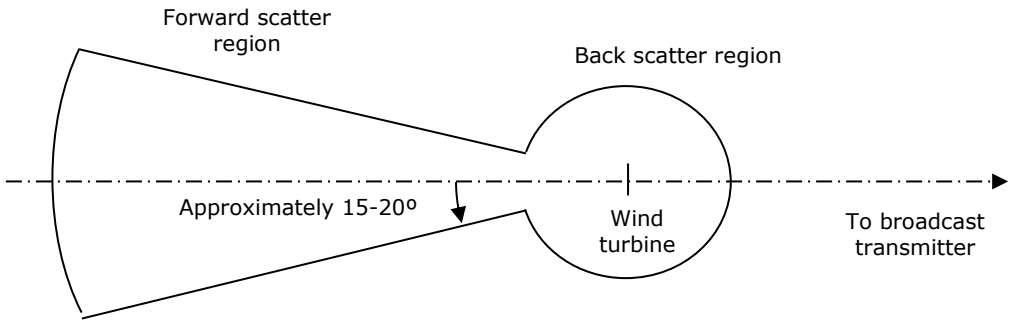

Figure A.3 Potential television interference zones around a wind turbine

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, DTV signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [58] 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, wind turbines are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [55] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more turbines, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [55].

With regards to back scattering, the ITU states:

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

In other words, the C/N ratio needs to be higher in the presence of significant back scatter to achieve the same QEF condition as is the case without the presence of turbines, which effectively means that interference is more likely to occur as coverage quality decreases.

A.3 Theoretical models for wind turbine scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [59]. 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 [58], 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 wind turbine rather than a wind farm as a whole.

As an alternative to signal scattering models, 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 and shown in Figure A.3, this is often referred to as the 'keyhole' approach and is an established technique for predicting where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [47]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

LIST OF TABLES

Table 6 Proposed turbine layout for the Project [2]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]
1	376711	6588269	255	34	380072	6593865	158
2	377121	6587897	255	35	379366	6594265	170
3	377844	6587488	239	36	378694	6594615	215
4	378427	6587185	247	37	379690	6583500	237
5	378824	6586687	227	38	380206	6583033	238
6	379130	6586015	233	39	377683	6583366	189
7	377850	6585055	196	40	378488	6583096	220
8	379093	6584946	211	41	378941	6582664	207
9	379855	6584642	228	42	377277	6582603	167
10	380265	6585269	197	43	377063	6581578	177
11	380591	6586091	214	44	377421	6580886	201
12	379881	6587660	231	45	376726	6579896	231
13	379532	6588299	205	46	377259	6579506	240
14	379259	6589213	173	47	371754	6583441	158
15	377296	6589335	251	48	372314	6583238	182
16	377017	6590261	191	49	370130	6583422	128
17	376673	6590974	165	50	370794	6582979	110
18	376456	6591931	148	51	371235	6582526	121
19	378313	6590284	177	52	371161	6582044	135
20	378005	6591011	163	53	369474	6582553	116
21	377727	6591889	146	54	369931	6582109	112
22	380156	6589935	174	55	370492	6586362	166
23	379523	6590701	143	56	369868	6586835	192
24	379255	6591701	160	57	371047	6587239	177
25	380670	6591231	173	58	370851	6587751	187
26	377576	6592969	169	59	370201	6588032	226
27	377284	6593559	180	60	369607	6588242	221
28	377184	6594607	227	61	369174	6588630	211
29	380141	6592179	187	62	370215	6589436	190
30	379620	6592815	170	63	370823	6590088	185
31	378789	6593483	165	64	371141	6589343	171
32	380972	6592510	245	65	371605	6588942	142
33	381115	6593682	202				

1. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Base elevations have been determined by DNV based on publicly available SRTM1 data.

Table 7 Dwellings within 5 km of the proposed Project boundary [3]

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
1	*372941*	*6587196*	*Involved*	*1.9*
2	*375235*	*6594717*	*Involved*	*2.0*
3	*381763*	*6588980*	*Involved*	*1.9*
7	*375432*	*6594610*	*Involved*	*1.8*
8	*375112*	*6595186*	*Involved*	*2.2*
9	*368350*	*6586805*	*Involved*	*1.5*
11	*375102*	*6595251*	*Involved*	*2.2*
13	*376418*	*6586164*	*Involved*	*1.8*
17	*381769*	*6588946*	*Involved*	*1.9*
41	*375211*	*6594801*	*Involved*	*2.0*
81	*372505*	*6585617*	*Involved*	*2.1*
150	*382485*	*6588827*	*Involved*	*2.6*
153	372200	6579163	Non-involved	3.1
154	376668	6574935	Non-involved	4.6
155	*383134*	*6589269*	*Involved*	*3.1*
156	*382738*	*6590081*	*Involved*	*2.4*
167	385213	6588526	Non-involved	5.2
195	379575	6578152	Non-involved	2.7
213	374152	6597576	Non-involved	4.2
214	383597	6588157	Non-involved	3.6
240	382288	6584481	Non-involved	2.2
243	*360940*	*6591794*	*Involved*	*8.8*
248	379467	6577412	Non-involved	3.0
250	381331	6581815	Non-involved	1.7
268	382484	6596508	Non-involved	3.1
277	382461	6594955	Non-involved	1.9
286	372078	6577114	Non-involved	5.0
295	376222	6576592	Non-involved	3.1
299	371809	6594873	Non-involved	4.9
308	360359	6594047	Non-involved	10.3
312	366663	6590272	Non-involved	3.0
322	364161	6581460	Non-involved	5.4
331	366787	6583923	Non-involved	3.0
339	370011	6597081	Non-involved	7.0
342	373993	6588254	Non-involved	2.5
351	385990	6583769	Non-involved	5.8
356	373767	6589266	Non-involved	2.2
367	374922	6597855	Non-involved	4.0
369	382462	6586883	Non-involved	2.0
400	384386	6594495	Non-involved	3.4
418	367353	6581207	Non-involved	2.5
419	385028	6591387	Non-involved	4.2
426	382804	6596788	Non-involved	3.5
427	366268	6594459	Non-involved	6.3
440	375038	6583549	Non-involved	2.4
455	373928	6588049	Non-involved	2.5
463	374934	6597959	Non-involved	4.0
504	373570	6585092	Non-involved	2.2

1. Involved dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.

Table 8 Details of point-to-point links crossing the proposed Project

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
1	1192998/1	1194381	6880000000	DBNGP (WA) Nominees Pty Ltd Dampier Bunbury Pipeline Att: Dane Coetzee PO Box Z5267 SAINT GEORGES TERRACE WA 6831
		1194382	6880000000	
		1194383	6540000000	
		1194384	6540000000	
2	1192999/1	1194385	7040000000	
		1194386	7040000000	
		1194387	6700000000	
		1194388	6700000000	
3	1191263/1	1234549	7704500000	Electricity Networks Corporation Western Power GPO Box L921 Attn: Comms Operations & Maintenance PERTH WA 6842
		1234550	7704500000	
		1234551	7543500000	
		1234552	7543500000	
4	12309844/1	11777525	6271365000	
		11777526	6271365000	
		11777527	6019325000	
		11777528	6019325000	
5	12013754/1	10441043	11645000000	Iluka Resources Limited GPO Box U 1988 PERTH WA 6845
		10441044	11645000000	
		10441045	11155000000	
		10441046	11155000000	
6	12820382/1	13389474	11645000000	Optus Mobile Pty Limited 4G TXN 1 Lyonpark Road MACQUARIE PARK NSW 2113
		13389475	11645000000	
		13389476	11155000000	
		13389477	11155000000	
7	12820383/1	13389478	11645000000	
		13389479	11645000000	
		13389480	11155000000	
		13389481	11155000000	
8	284717/1	719482	413518750	ST JOHN AMBULANCE WESTERN AUSTRALIA LTD. ST JOHN AMBULANCE AUSTRALIA (WESTERN AUSTRALIA) INC. PO Box 183 BELMONT WA 6104
		719483	413518750	
		719484	404068750	
		719485	404068750	
9	10209405/1	2468046	11225000000	TELSTRA LIMITED Telstra - Radio Transport Engineering Locked Bag 3501 BRISBANE QLD 4001
		2468047	11225000000	
		2468048	10735000000	
		2468049	10735000000	

Table 8 Details of point-to-point links crossing the proposed Project (continued)

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
10	10678058/1	5227850	8044195000	WESTERN AUSTRALIA POLICE Radio & Electronic Services Unit 21 Swanbank Road Att: Phillip Manna MAYLANDS WA 6051
		5227851	8044195000	
		5227852	7732875000	
		5227853	7732875000	
11	1976436/1	982074	7704500000	
		982075	7704500000	
		982076	7543500000	
		982077	7543500000	
12	1976446/1	982154	8133145000	
		982155	8133145000	
		982156	7821825000	
		982157	7821825000	

Table 9 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
1480186	9027817	9967451/1	-30.7547	116.1303	35	BUREAU OF METEOROLOGY Bureau of Meteorology 700 Collins Street Docklands VIC 3008
1480189	9027817	9967451/1	-30.7547	116.1303	35	
1480202	9027813	9967453/1	-31.0008	116.2314	46	
1480205	9027813	9967453/1	-31.0008	116.2314	46	
1480170	9027814	9967456/1	-31.2614	116.1260	54	
1480173	9027814	9967456/1	-31.2614	116.1260	54	
1480130	9027819	9967452/1	-30.6219	116.3794	61	
1480133	9027819	9967452/1	-30.6219	116.3794	61	
1480174	9027815	9967455/1	-30.5097	116.3728	65	
1480177	9027815	9967455/1	-30.5097	116.3728	65	
1480182	9027816	9967450/1	-30.3625	116.2808	68	
1480185	9027816	9967450/1	-30.3625	116.2808	68	
1255276	600783	1990617/1	-31.2723	115.8306	41	Department of Defence Director Defence Spectrum Office D DSO APW-GF-173 Anzac Park West PO Box 7953 CANBERRA BC ACT 2610
1255279	600783	1990617/1	-31.2723	115.8306	41	
1268477	26689	494815/1	-31.4996	115.9506	68	
1268480	26689	494815/1	-31.4996	115.9506	68	
1268485	26689	494818/1	-31.4996	115.9506	68	
1268488	26689	494818/1	-31.4996	115.9506	68	
1235618	30549	1939591/1	-30.5812	115.7551	21	Electricity Networks Corporation Western Power GPO Box L921 Attn: Comms Operations & Maintenance PERTH WA 6842
1235621	30549	1939591/1	-30.5812	115.7551	21	
1235532	30603	1924996/1	-30.6324	116.0225	29	
1235535	30603	1924996/1	-30.6324	116.0225	29	
1234880	30508	1607427/1	-31.2734	115.8901	43	
1234883	30508	1607427/1	-31.2734	115.8901	43	
1234884	30508	1607427/1	-31.2734	115.8901	43	
1234887	30508	1607427/1	-31.2734	115.8901	43	
1235875	30508	1963822/1	-31.2734	115.8901	43	
1235878	30508	1963822/1	-31.2734	115.8901	43	
1235879	30508	1963823/1	-31.2734	115.8901	43	
1235882	30508	1963823/1	-31.2734	115.8901	43	
1236373	30508	1986534/1	-31.2734	115.8901	43	
1236376	30508	1986534/1	-31.2734	115.8901	43	
12896948	30508	12722256/1	-31.2734	115.8901	43	
12896951	30508	12722256/1	-31.2734	115.8901	43	
1236077	132419	1971924/1	-30.2760	116.0903	64	
1236080	132419	1971924/1	-30.2760	116.0903	64	
4361234	10010562	10546352/1	-30.7654	115.5426	6	Iluka Resources Limited GPO Box U 1988 PERTH WA 6845
4361237	10010562	10546352/1	-30.7654	115.5426	6	
6336542	10010562	10896557/1	-30.7654	115.5426	6	
6336545	10010562	10896557/1	-30.7654	115.5426	6	
4361238	10012495	10546353/1	-30.7506	115.5356	8	
4361241	10012495	10546353/1	-30.7506	115.5356	8	
932826	601960	1951167/1	-31.0105	115.7138	11	Karakin Wind Pty Ltd and North East Equity Pty Ltd att Nicola Tana Family Trust No 18 37 Clarkson Road MAYLANDS WA 6051
932829	601960	1951167/1	-31.0105	115.7138	11	

Table 9 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
1009545	9020135	1989768/1	-30.6601	115.4402	21	
1009548	9020135	1989768/1	-30.6601	115.4402	21	
723523	600876	405810/1	-30.6528	115.4486	21	TRONOX MANAGEMENT PTY LTD TIWEST JOINT VENTURE PO Box 305 KWINANA WA 6966
723526	600876	405810/1	-30.6528	115.4486	21	
841153	600876	1607269/1	-30.6528	115.4486	21	
841156	600876	1607269/1	-30.6528	115.4486	21	
841457	600876	1607820/1	-30.6528	115.4486	21	
841460	600876	1607820/1	-30.6528	115.4486	21	
981270	9021122	1976044/1	-30.6119	115.3945	28	
981273	9021122	1976044/1	-30.6119	115.3945	28	
1249592	9001039	1146203/1	-30.6668	115.7075	11	
1249595	9001039	1146203/1	-30.6668	115.7075	11	
12332317	9001039	12449014/1	-30.6668	115.7075	11	
12332320	9001039	12449014/1	-30.6668	115.7075	11	
7818548	10024848	11228002/1	-30.9694	115.4134	19	
7818551	10024848	11228002/1	-30.9694	115.4134	19	
1249653	9001631	1181123/1	-30.6123	115.8807	21	
1249654	9001631	1181123/1	-30.6123	115.8807	21	
12688038	10039867	12655311/1	-31.0132	115.3389	28	
12688041	10039867	12655311/1	-31.0132	115.3389	28	
10522268	600557	12043235/1	-31.2876	115.5361	44	
10522271	600557	12043235/1	-31.2876	115.5361	44	
1250380	602353	1617786/1	-30.5564	116.1564	45	
1250383	602353	1617786/1	-30.5564	116.1564	45	
7999199	602353	11248183/1	-30.5564	116.1564	45	
7999200	602353	11248183/1	-30.5564	116.1564	45	
1249576	9000980	1145821/1	-31.3402	115.5877	48	
1249579	9000980	1145821/1	-31.3402	115.5877	48	
1250885	9009776	1912454/1	-31.3347	115.8976	49	Water Corporation PO Box 100 (Dinesh Raghu) LEEDERVILLE WA 6902
1250888	9009776	1912454/1	-31.3347	115.8976	49	
12394137	9009776	12464169/1	-31.3347	115.8976	49	
12394138	9009776	12464169/1	-31.3347	115.8976	49	
1250873	9009751	1912450/1	-30.5031	115.0718	59	
1250876	9009751	1912450/1	-30.5031	115.0718	59	
12688046	9009751	12655313/1	-30.5031	115.0718	59	
12688049	9009751	12655313/1	-30.5031	115.0718	59	
1250881	9009773	1912453/1	-30.2847	116.0170	60	
1250884	9009773	1912453/1	-30.2847	116.0170	60	
12688031	9009773	12655310/1	-30.2847	116.0170	60	
12688032	9009773	12655310/1	-30.2847	116.0170	60	
1249584	26294	1145823/1	-31.4800	115.6030	63	
1249587	26294	1145823/1	-31.4800	115.6030	63	
1249672	9002847	1187105/1	-31.1074	116.3876	64	
1249675	9002847	1187105/1	-31.1074	116.3876	64	
10434106	9002847	12009701/1	-31.1074	116.3876	64	
10434107	9002847	12009701/1	-31.1074	116.3876	64	
1249852	9003499	1191430/1	-30.8955	116.4598	66	
1249855	9003499	1191430/1	-30.8955	116.4598	66	
12688042	9003499	12655312/1	-30.8955	116.4598	66	
12688045	9003499	12655312/1	-30.8955	116.4598	66	
1249580	9000979	1145822/1	-31.5564	115.6458	71	

Table 9 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
1249583	9000979	1145822/1	-31.5564	115.6458	71	
6549021	601452	10922125/1	-30.7488	116.5470	75	
6549024	601452	10922125/1	-30.7488	116.5470	75	
848783	603212	1622808/1	-30.8787	115.4088	15	West Hills Farm Pty Ltd PO Box 63 TUART HILL WA 6060
848786	603212	1622808/1	-30.8787	115.4088	15	
887934	138793	1920602/1	-30.8996	115.4148	15	
887937	138793	1920602/1	-30.8996	115.4148	15	

Table 10 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	364
2 GHz Band	Spectrum	180
2.3 GHz Band	Spectrum	1238
2.5 GHz Band	Spectrum	115
3.4 GHz Band	Spectrum	1588
700 MHz Band	Spectrum	678
800 MHz Band	Spectrum	358
850/900 MHz Band	Spectrum	270
AWL - FSS Only	Spectrum	8
AWL - Standard	Spectrum	16
Aeronautical Assigned System	Aeronautical	8
Amateur Repeater	Amateur	20
Ambulatory - Copy	Land Mobile	4
Ambulatory System	Land Mobile	10
CBRS Repeater	Land Mobile	4
Commercial Radio	Broadcasting	3
Commercial Television	Broadcasting	3
Earth Receive	Earth Receive	18
Fixed Earth	Earth	8
Land Mobile System - > 30MHz	Land Mobile	470
Land Mobile System 0-30MHz	Land Mobile	48
Limited Coast Assigned System	Maritime Coast	6
Narrowcasting Service (LPON)	Broadcasting	14
National Broadcasting	Broadcasting	3
PMTS Class B	PTS	62
Paging System - Interior	Land Mobile	1
Radiodetermination	Radiodetermination	28
Retransmission	Broadcasting	26

Table 11 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Australian Maritime Safety Authority	Australian Maritime Safety Authority GPO Box 2181 Attn: Response Division Administration, Client ID 20000768 Canberra ACT 2601	51
Bindoon Volunteer Bush Fire Brigade	Bindoon Volunteer Bush Fire Brigade PO BOX 113 Bindoon WA 6502	63
Department of Biodiversity Conservation and Attractions	Department of Biodiversity Conservation and Attractions Att: Coordinator, Telecommunications Systems Locked Bag 104 Office of Information Management BENTLEY DC WA 6983	28
Department of Fire and Emergency Services of WA	Department of Fire and Emergency Services of WA Attn Manager Radio Communications PO Box P1174 PERTH WA 6844	21
St John Ambulance Australia (N.S.W.)	St John Ambulance Australia (N.S.W.) 12 Lyonpark Macquarie Park NSW 2113	33
St John Ambulance Western Australia Ltd.	St John Ambulance Western Australia Ltd. PO Box 183 BELMONT WA 6104	7
St. John Ambulance Australia Incorporated	St. John Ambulance Australia Incorporated Technical Services 601-609 Blackburn Road NOTTING HILL VIC 3168	7
Surf Life Saving Western Australia Inc	Surf Life Saving Western Australia Inc PO Box 700 Balcatta WA 6021	22
Western Australia Police	Western Australia Police Radio & Electronic Services Unit 21 Swanbank Road Att: Phillip Manna MAYLANDS WA 6051	Within Project boundary

Table 12 Bureau of Meteorology radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
10000636	Off Edawa Road	-30.3600	116.2896	68
601351	Bureau of Meteorology Office Northern Perimeter Road PERTH AIRPORT	-31.9274	115.9765	115
44829	Walnut Rd BICKLEY	-32.0077	116.1349	127
138152	Bureau of Meteorlogy across the road from runway Lot 164 (286) Yangedi Rd HOPELAND	-32.3917	115.8670	164
10000627	BOM Station Approximately 1.2km South of Fire Road SOUTH DOODLAKINE	-31.7770	117.9529	230
139890	Geraldton Met Bureau Radar Arthur Road GERALDTON	-28.8047	114.6973	238
10000625	Off Lake Grace-Newdegate Road NEWDEGATE	-33.0970	119.0087	392

Table 13 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
GH	AGD66, AGD84, GDA94	-31.0234	115.8055	14
Gt	AGD66, AGD84, GDA94	-30.9773	115.5101	12
Hill River 1a	AGD84, GDA94	-30.9190	115.4789	11
Hill River 46	AGD66, GDA94	-30.9058	115.3634	20
Hill River 47	AGD66, GDA94	-30.8625	115.3599	19
Hill River 53	AGD66	-30.8375	115.3999	16
Hill River 54	AGD66	-30.7953	115.4609	10
Hill River 55	AGD66	-30.8227	115.4134	14
Hill River 75	AGD66, AGD84, GDA94	-30.9706	115.4120	19
KH	AGD84, GDA94	-30.9503	115.7469	4
LT	AGD66, AGD84, GDA94	-30.9063	115.8917	12
Moora 26	AGD66, GDA94	-30.7556	115.5699	7
Moora 27	AGD66, GDA94	-30.7359	115.5370	9
Moora 51	AGD84, GDA94	-30.7459	115.9441	18
Moora 52	AGD84, GDA94	-30.7172	115.8110	8
Moora 53	AGD84, GDA94	-30.6251	115.6405	17
Moora 56	GDA94	-30.6592	115.7036	12
Moora 56t	GDA94	-30.6586	115.7037	12
Moora 57	GDA94	-30.6784	115.7026	10
Perth 163	GDA94	-31.0287	115.7332	13
Perth 164	GDA94	-31.0611	115.7508	16
Perth 187	AGD66, AGD84, GDA94	-31.0286	115.8375	17
Perth 292	AGD66, AGD84, GDA94	-31.0296	115.6316	14
S 147	AGD66, AGD84	-30.6555	115.4963	19
S 148	AGD66, AGD84	-30.7248	115.4953	12
S 149	AGD66, AGD84	-30.7361	115.5372	9
S 150	AGD66, AGD84	-30.7725	115.5026	8
S 151	AGD66, AGD84	-30.8374	115.4950	6
S 152	AGD66, AGD84	-30.8444	115.4950	6
S 153	AGD66, AGD84	-30.8821	115.4948	7
S 154	AGD66, AGD84	-30.8967	115.4948	8
S 155	AGD66, AGD84	-30.9388	115.4938	11
S 156	AGD66, AGD84	-30.9417	115.5049	10
S 157	AGD66, AGD84	-30.9418	115.4547	14
S 158	AGD66, AGD84	-30.9808	115.4959	14
S 159	AGD66, AGD84	-31.0002	115.4918	16
SS	AGD66, AGD84, GDA94	-31.0511	115.7548	15
Walyer Walyer	AGD66, AGD84, GDA94	-30.8448	115.6255	Within Project boundary
Walyering	AGD66, AGD84, GDA94	-30.6718	115.5107	17

Table 13 Trigonometrical stations in the vicinity of the proposed Project (continued)

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
Weeroona	AGD66, AGD84	-30.9187	115.4813	11
Weeroona West	AGD66, AGD84, GDA94	-30.9190	115.4789	11
Winooka	AGD66, AGD84, GDA94	-30.7937	115.4894	7

Table 14 Dwellings with increased potential to experience EMI to DTV from television broadcast transmitters

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone		
			Moora	Lancelin	Perth
1	*372941*	*6587196*	*X*	*X*	
2	*375235*	*6594717*			*X*
3	*381763*	*6588980*		*X*	
7	*375432*	*6594610*	*X*		*X*
8	*375112*	*6595186*			*X*
9	*368350*	*6586805*	*X*		*X*
11	*375102*	*6595251*			*X*
13	*376418*	*6586164*	*X*		*X*
17	*381769*	*6588946*		*X*	
41	*375211*	*6594801*			*X*
81	*372505*	*6585617*	*X*	*X*	
150	*382485*	*6588827*		*X*	
155	*383134*	*6589269*		*X*	
156	*382738*	*6590081*		*X*	
214	383597	6588157		X	
240	382288	6584481		X	
250	381331	6581815		X	
268	382484	6596508		X	
277	382461	6594955		X	
331	366787	6583923	X		
342	373993	6588254	X	X	
356	373767	6589266	X	X	
367	374922	6597855			X
369	382462	6586883		X	
400	384386	6594495		X	
418	367353	6581207	X		
426	382804	6596788		X	
440	375038	6583549	X	X	X
455	373928	6588049	X	X	
463	374934	6597959			X
504	373570	6585092	X	X	

1. Stakeholder dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.

Table 15 Summary of service operators contacted by DNV and responses received to date

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
1	Fixed point-to-point: 2 links crossing the Project site Point-to-point #1 and #2: no turbines in diffraction exclusion zone or potential near-field interference zone established by DNV, 2 turbines (63, 64) in potential reflection/scattering interference zone established by DNV	DBNGP (WA) Nominees Pty Ltd (DBNGP) 10524539-AUMEL-L-01-A	Response received by email on 5 May 2025, based on the preliminary turbine layout: *"In regard to the potential impact on our radiocommunication assets (based on the current wind turbine locations) our Senior Communications Engineer has advised there will be no issues."* Current turbine layout provided on 30 June 2025 No response received to date
2	Fixed point-to-point: 2 links crossing the Project site Point-to-point #3 and #4: no turbines in diffraction exclusion zone or potential near-field interference zone established by DNV, 2 turbines (63, 64) in potential reflection/scattering interference zone established by DNV Fixed point-to-multipoint: 21 km from Project boundary	Electricity Networks Corporation (Western Power) 10524539-AUMEL-L-02-A	Response received by email on 20 May 2025, based on the preliminary turbine layout: *"The proposed Yathroo Wind Farm turbines should not cause any EMI impact on any Western power's existing and currently proposed point to point radio links. One of the point to multipoint DA remote radio service[s] will have EMI impact on the link. Advisable that Western Power… cut over the mentioned remote DA unit to [another] nearby DA base [to avoid impacts on this remote unit and relevant services].* *Conclusion assumes (based on current data and analysis) that the proposed wind turbine locations for Yathroo Wind Farm could be constructed as proposed."* Current turbine layout provided on 30 June 2025 No response received to date
3	Fixed point-to-point: 1 link crossing the Project site Point-to-point #8: no turbines in interference zones established by DNV Emergency services point-to-area: 7 km from Project boundary	St John Ambulance Western Australia Pty Ltd (St John Ambulance) 10524539-AUMEL-L-03-A	No response received to date

Table 15 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
4	Fixed point-to-point: 1 link crossing the Project site Point-to-point #9: no turbines in interference zones established by DNV PMTS/spectrum (mobile phone): 1125 m from nearest turbine	Telstra Limited (Telstra) 10524539-AUMEL-L-04-A	No response received to date
5	Fixed point-to-point: 3 links crossing the Project site Point-to-point #10 and #12: no turbines interference zones established by DNV Point-to-point #11: no turbines in diffraction exclusion zone or potential near-field interference zone established by DNV, 5 turbines (42, 43, 44, 55, 56) in potential reflection/scattering interference zone established by DNV Emergency services point-to-area: 1125 m from nearest turbine	Western Australia Police (WA Police) 10524539-AUMEL-L-05-A	Response received by email on 17 April 2025, based on the preliminary turbine layout: *"The change board has provided feedback on the proposal as* *'approved, based on information submitted'* *If details change, please contact us for the opportunity to assist in assessing WA Police radio requirements."* Current turbine layout provided on 30 June 2025 No response received to date

Table 15 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
6	Fixed point-to-point: 2 links crossing the Project site Point-to-point #6 and #7: no turbines in diffraction exclusion zone or potential near-field interference zone established by DNV, 4 turbines (22, 25, 29, 34) in potential reflection/scattering interference zone established by DNV PMTS/spectrum (mobile phone): 712 m from nearest turbine	Optus Mobile Pty Limited (Optus) 10524539-AUMEL-L-06-A	Response received by email on 14 April 2025, based on the preliminary turbine layout: *"Our technical team has reviewed this proposal and advised no interference issues with Optus equipment."* Response received by email on 2 July 2025 after contact with CPS Technology & Infrastructure, based on the preliminary turbine layout: *"Following assessment of the wind turbine locations in relation to planned [point-to-point link], I can confirm all reviewed turbine positions are at a safe distance from the… link path.* *Specifically, turbines 22/25/29/34 along the proposed link route maintain a horizontal separation of over 200m from the centreline. Vertical clearance between turbine blade tip and… beam [is] 21 to 24 metres based on the beam heights of… 280m (proposed) and 290m (proposed)."* Response received by email on 2 July 2025, based on the current turbine layout: *"Our technical team has reviewed this updated proposal and advised no interference issues with Optus equipment."*
7	Fixed point-to-multipoint: 35 km from Project boundary Meteorological radar: 68 km from Project boundary	Bureau of Meteorology 10524539-AUMEL-L-07-A	Response received by email on 1 May 2025, based on the preliminary turbine layout: *"Our assessment of the current Yathroo wind farm proposal has determined it poses a significant risk to the Watheroo radar.* *The Bureau cannot support the development without a detailed assessment of potential impacts and possible mitigation measures for your development.* *This service… would include the following:* *Comprehensive EMI modelling of the proposed development* *Detailed service impact assessments* *Mitigation options to restore services and maintain quality, proposed as development requirements rather than detailed designs* *Summary of Bureau's findings."* Current turbine layout provided on 30 June 2025 No response received to date

Table 15 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
8	Fixed point-to-multipoint: 11 km from Project boundary	Karakin Wind Pty Ltd and North East Equity Pty Ltd 10524539-AUMEL-L-08-A	Response received by email on 14 April 2025, based on the preliminary turbine layout: *"We are using the PtMP licence for telemetry between Regans Ford substation and the Karakin Wind Farm which is to the west of Brand Highway.* *I don't see any issues with this."* **Further consultation is not considered necessary**
9	Fixed point-to-multipoint: 11 km from Project boundary	Water Corporation 10524539-AUMEL-L-09-A	Response received by email on 11 April 2025, based on the preliminary turbine layout: *"We have thoroughly reviewed the list of Water Corporation sites mentioned in your email, and we can confirm that none of our sites are located in close proximity to the wind farm. Furthermore, based on their geographic locations and operating parameters, we can also confirm that there is no likelihood of interference with the wind farm's operations."* **Further consultation is not considered necessary**
10	Trigonometrical station: 1.1 km from nearest turbine GNSS station: 29 km from Project boundary	Geoscience Australia 10524539-AUMEL-L-11-A	Response received by email on 2 April 2025, based on the preliminary turbine layout: *"Geoscience Australia do not foresee any interference to our GNSS infrastructure as a result of the proposed Yathroo Wind Farm."* **Further consultation is not considered necessary**

Table 15 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
11	Spectrum (wireless internet): 19 km from Project boundary	NBN Co 10524539-AUMEL-L-12-A	<u>Response received by email on 9 April 2025, based on the preliminary turbine layout:</u> *"I have reviewed the data provided based on the proposed wind farm location; there are areas in the north east of the wind farm boundary overlapping with existing nbn wireless coverage boundaries but there are no existing nbn customers inside the wind farm boundary. The proposed wind tower locations pose no risk of introducing a physical obstruction along any customer RF profiles.* *It is also noted that none of the wind tower locations are in, or near, any boresight paths of existing nbn microwave links.* *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 frequency and transmit power, channel bandwidths, antenna types and radiation patterns as well as the exact location with antenna height, boresight azimuth and tilt (mechanical and electrical tilt).* *A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows…* *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 75 km of the proposed Yathroo Wind Farm.* *nbn have strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place.* *nbn will be forced to consider its position as part of the planning should there an interference issue.* *If the Application is amended before it is lodged we request that we are sent any amended Application so we can determine whether we have any objections to the amended Application.* *We note that, as you would be aware, under section 197 of the Radiocommunications Act 1992 (Cth) it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications."* <u>Response received by email on 2 July 2025, based on the current turbine layout:</u> *"The new turbine location plan makes no material change to the response provided 2nd April 2025."*

Table 15 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
12	Spectrum (wireless internet): 1906 m from nearest turbine	Starlink Australia Pty Ltd (Starlink) 10524539-AUMEL-L-13-A	No response received to date
13	CBRS repeater: 512 m from nearest turbine	The Trustee for John Brown Family Trust	Advice received from The Trustee for John Brown Family Trust via the Customer on 4 April 2025: The registered licence is a GPS reference point for farming operations used by the landowner and the owners of neighbouring properties. Interference to this service is not expected. There is no required clearance distance or need for mitigation. **Further consultation is not considered necessary**

LIST OF FIGURES

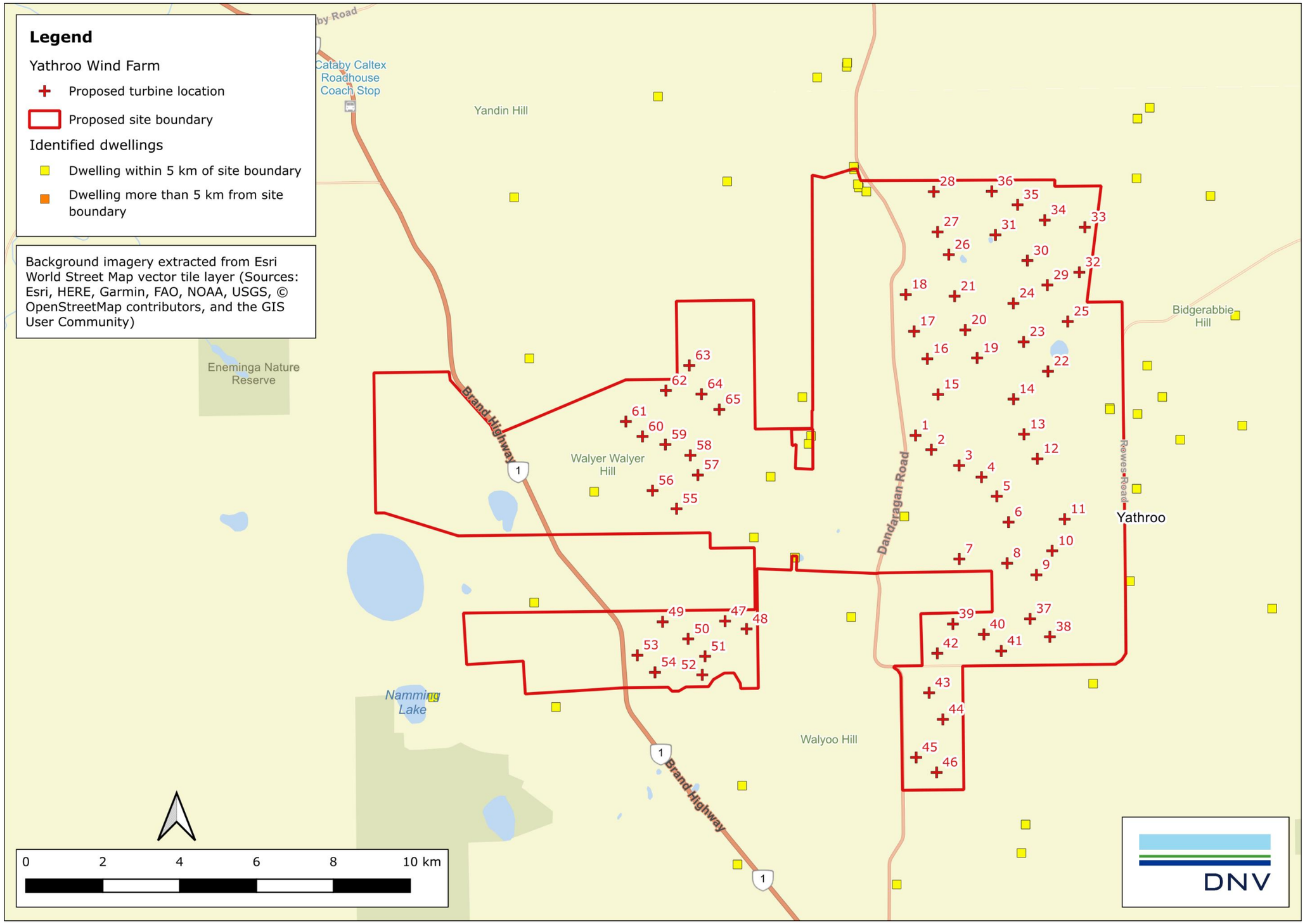

Figure 1 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby dwellings

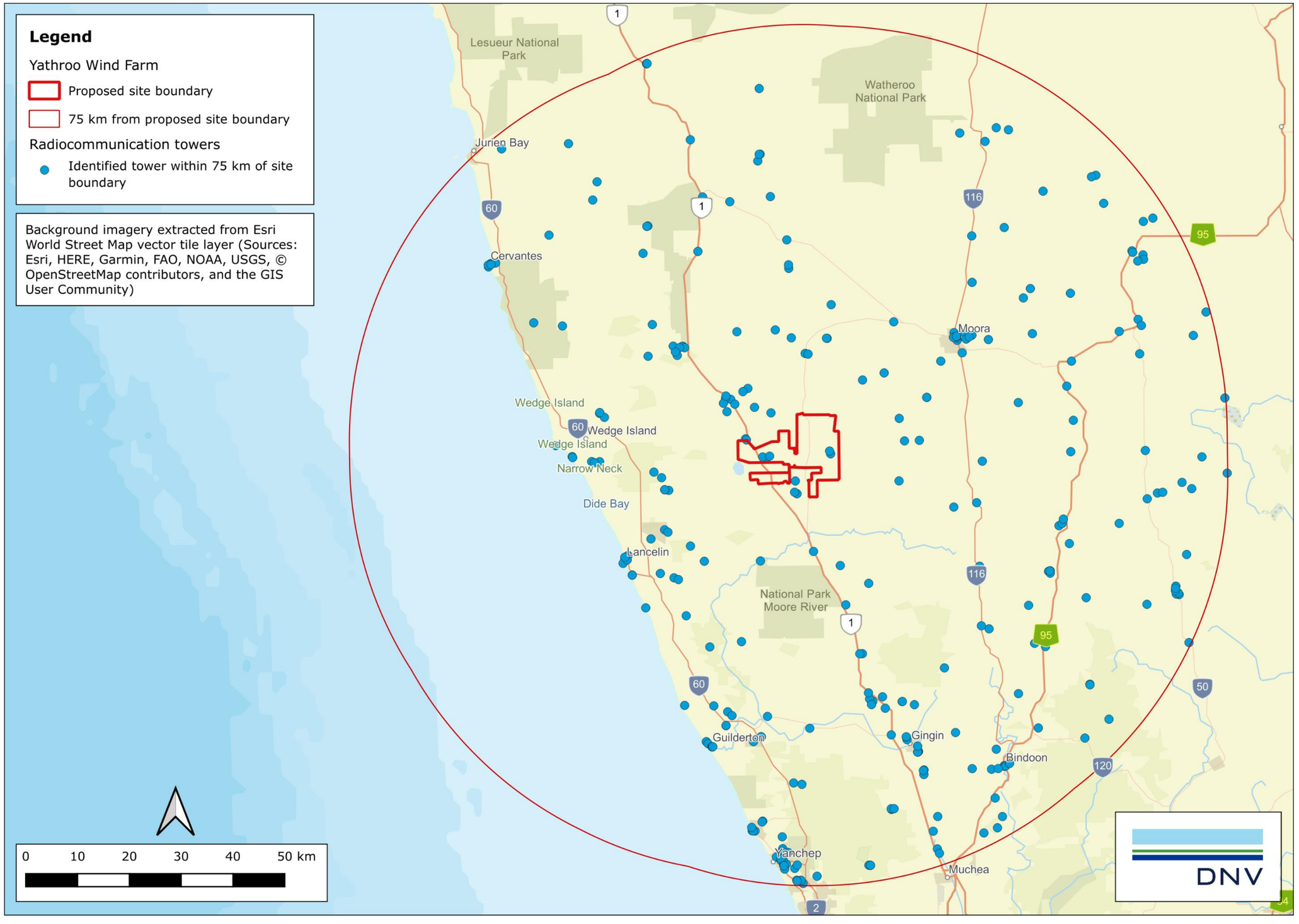

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

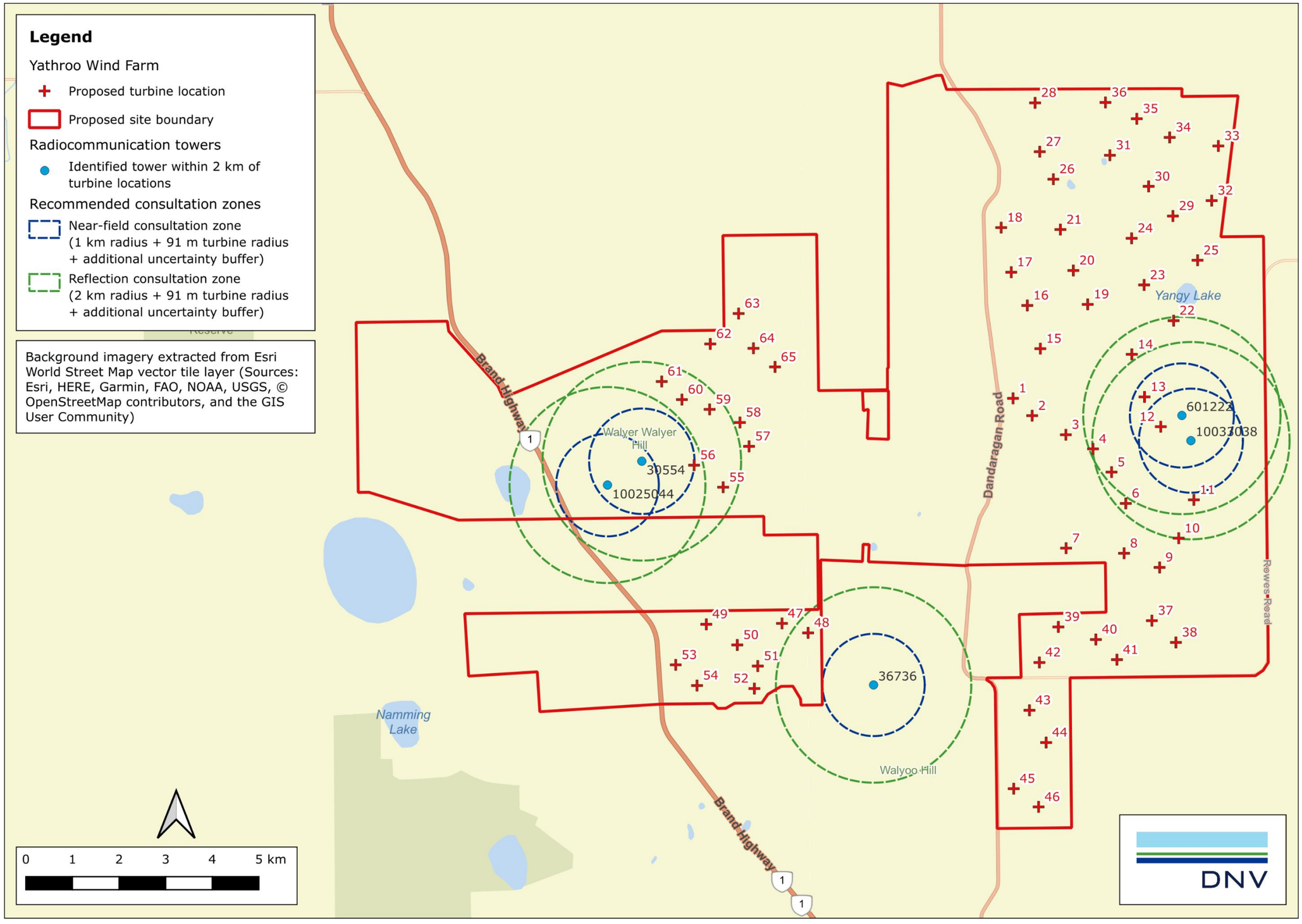

Figure 3 Identified radiocommunication sites within 2 km of the proposed turbine locations

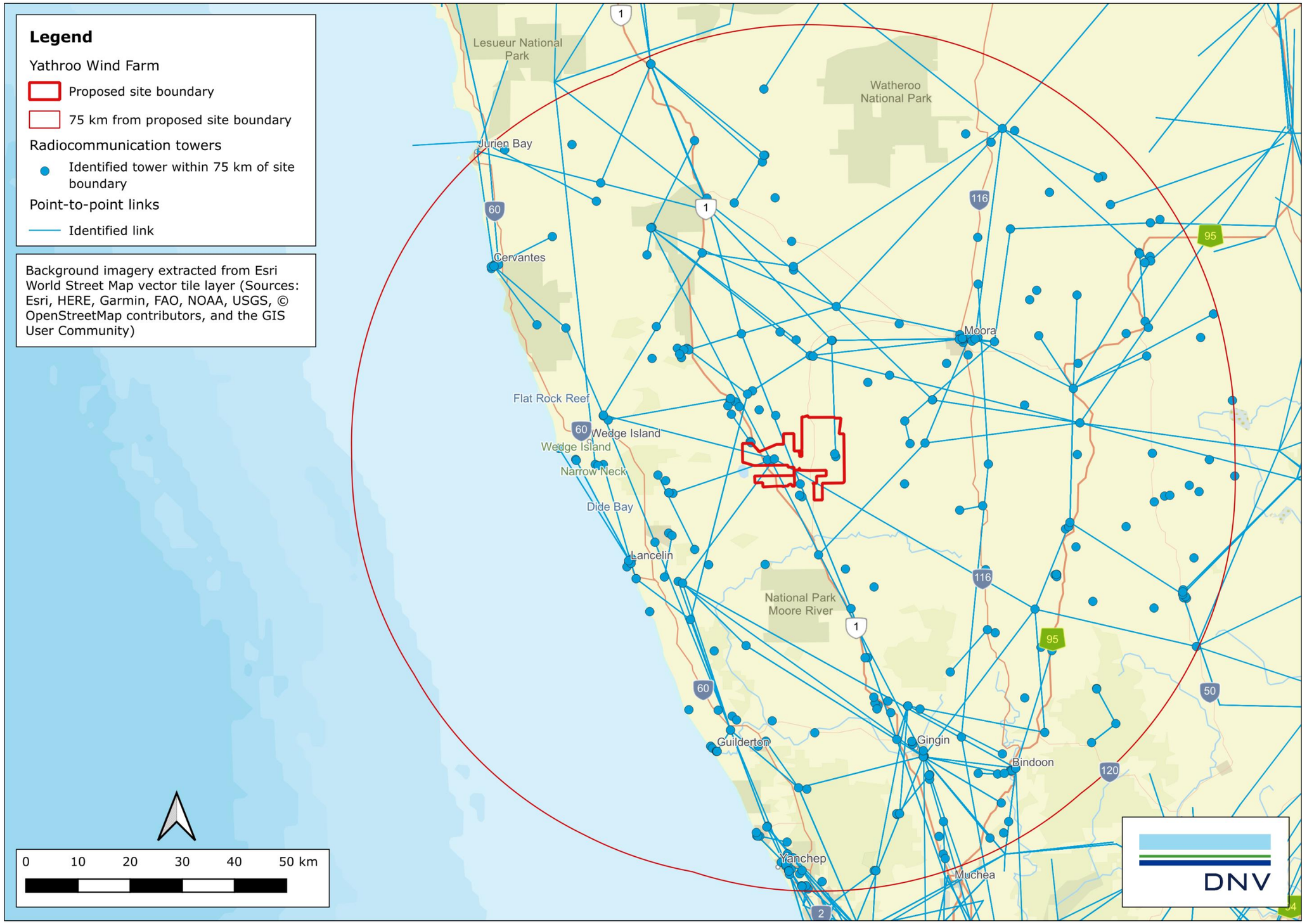

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

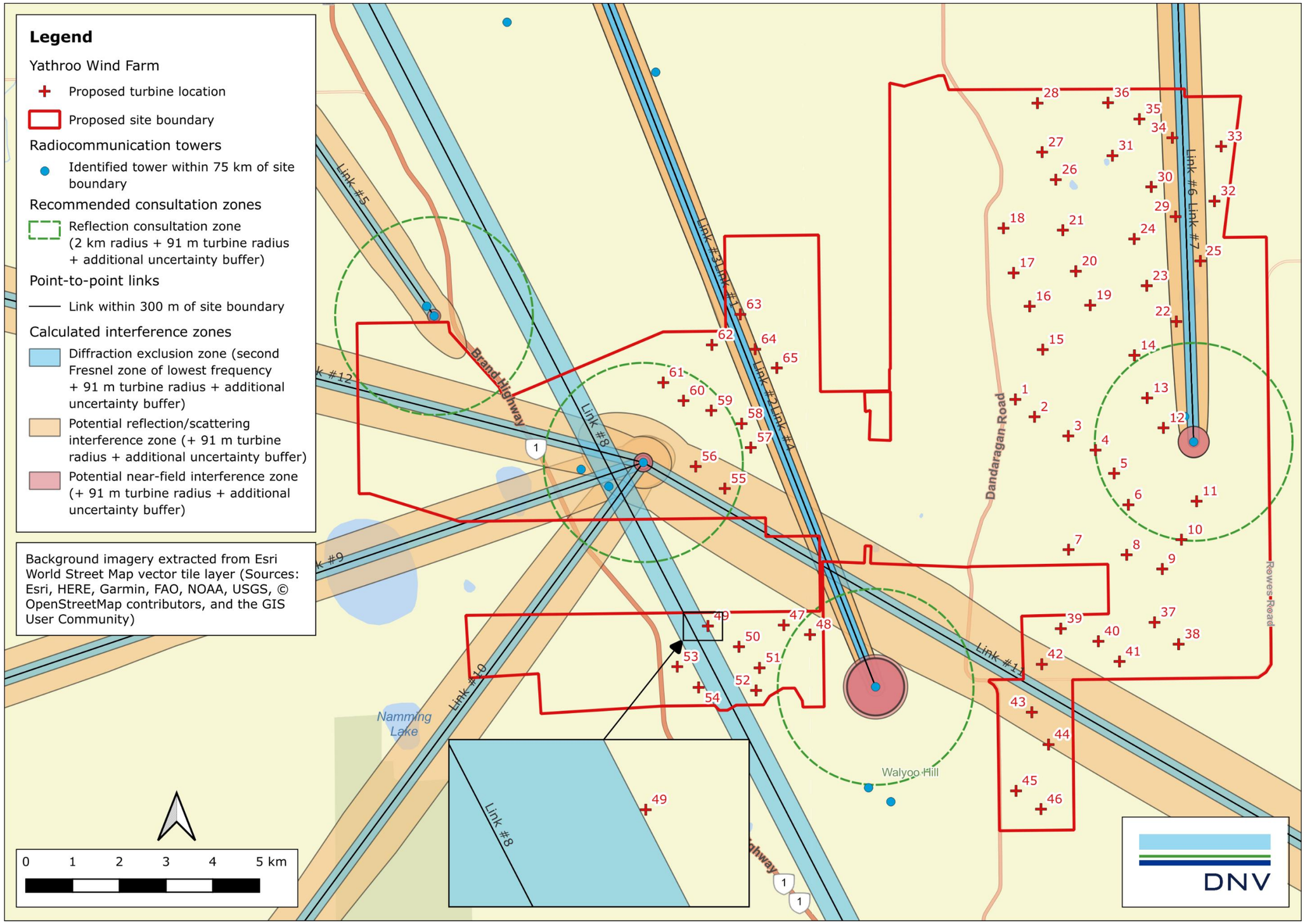

Figure 5 Identified point-to-point radiocommunication vectors crossing or within 300 m of the proposed Project and calculated interference zones

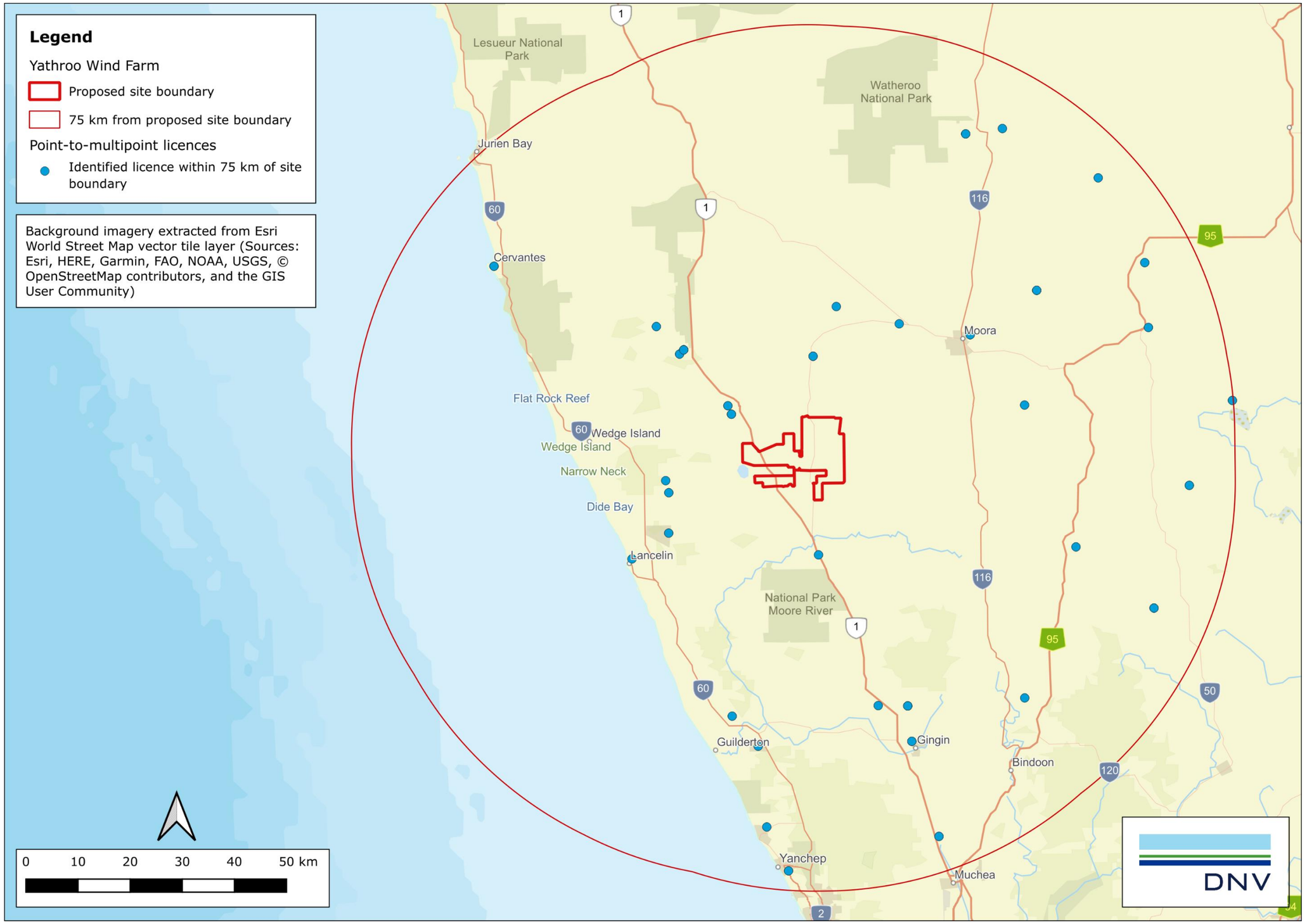

Figure 6 Location of point-to-multipoint licences in the vicinity of the proposed Project

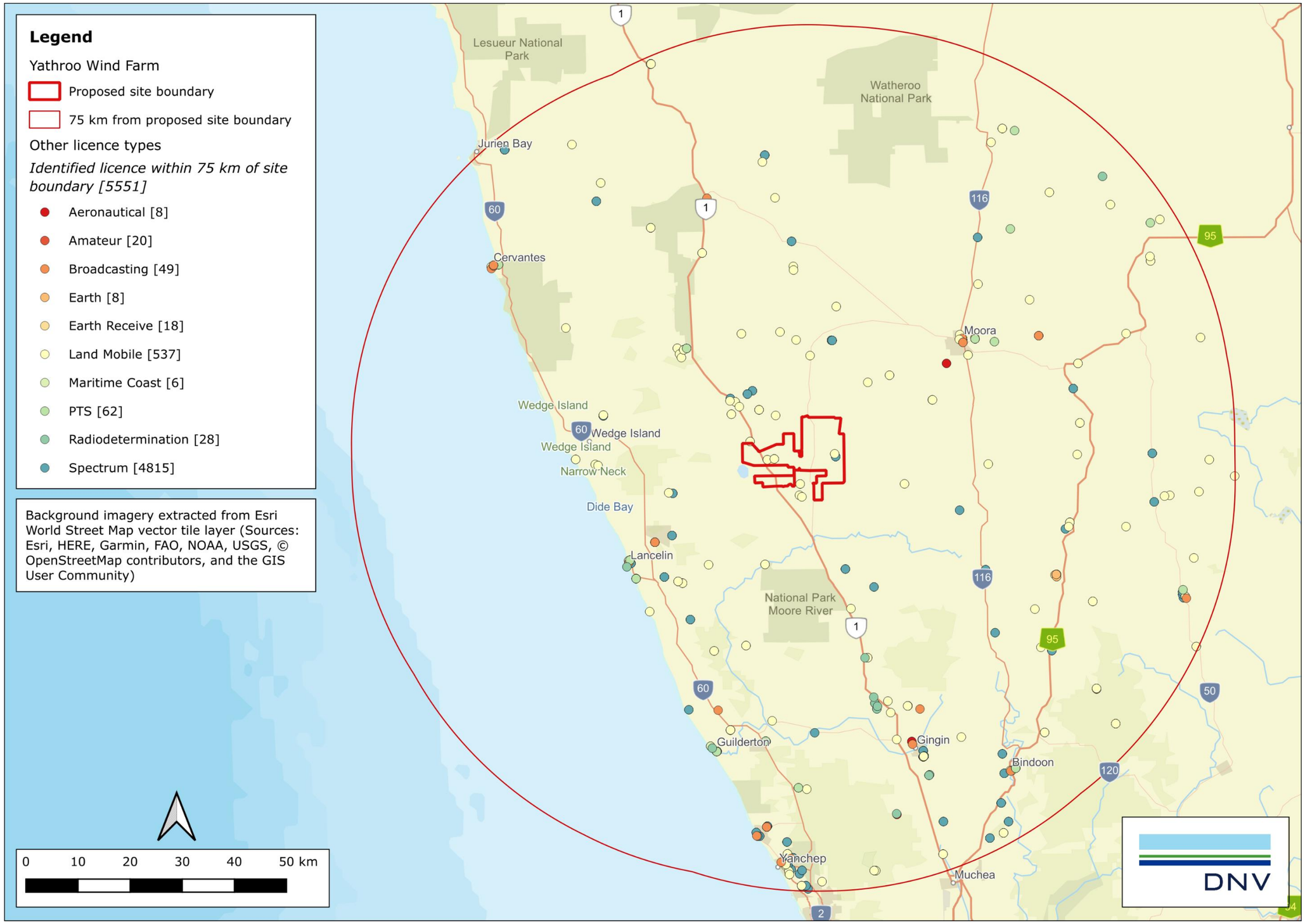

Figure 7 Location of other licence types within 75km of the proposed Project

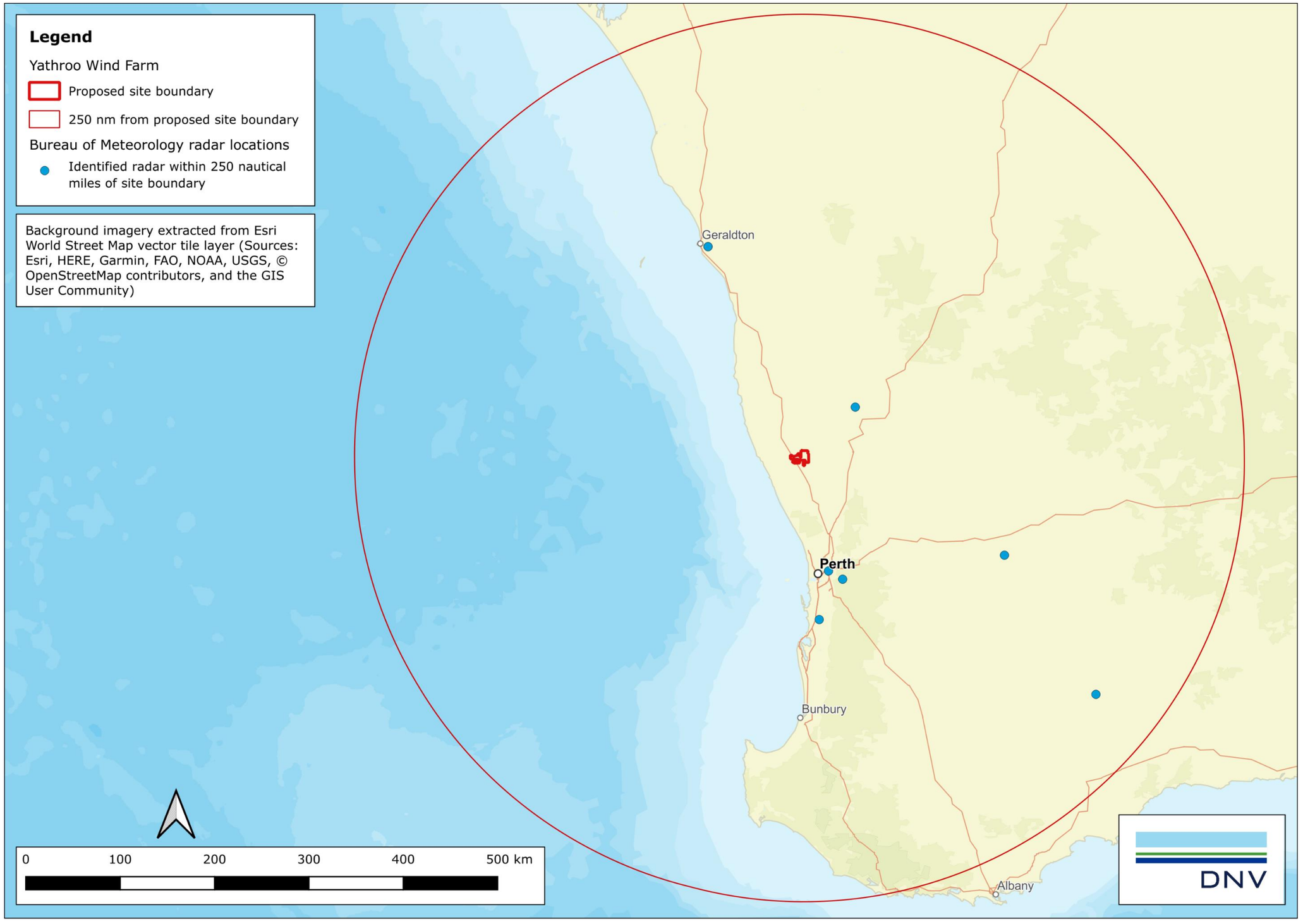

Figure 8 Location of meteorological radar sites within 250 nautical miles of the proposed Project

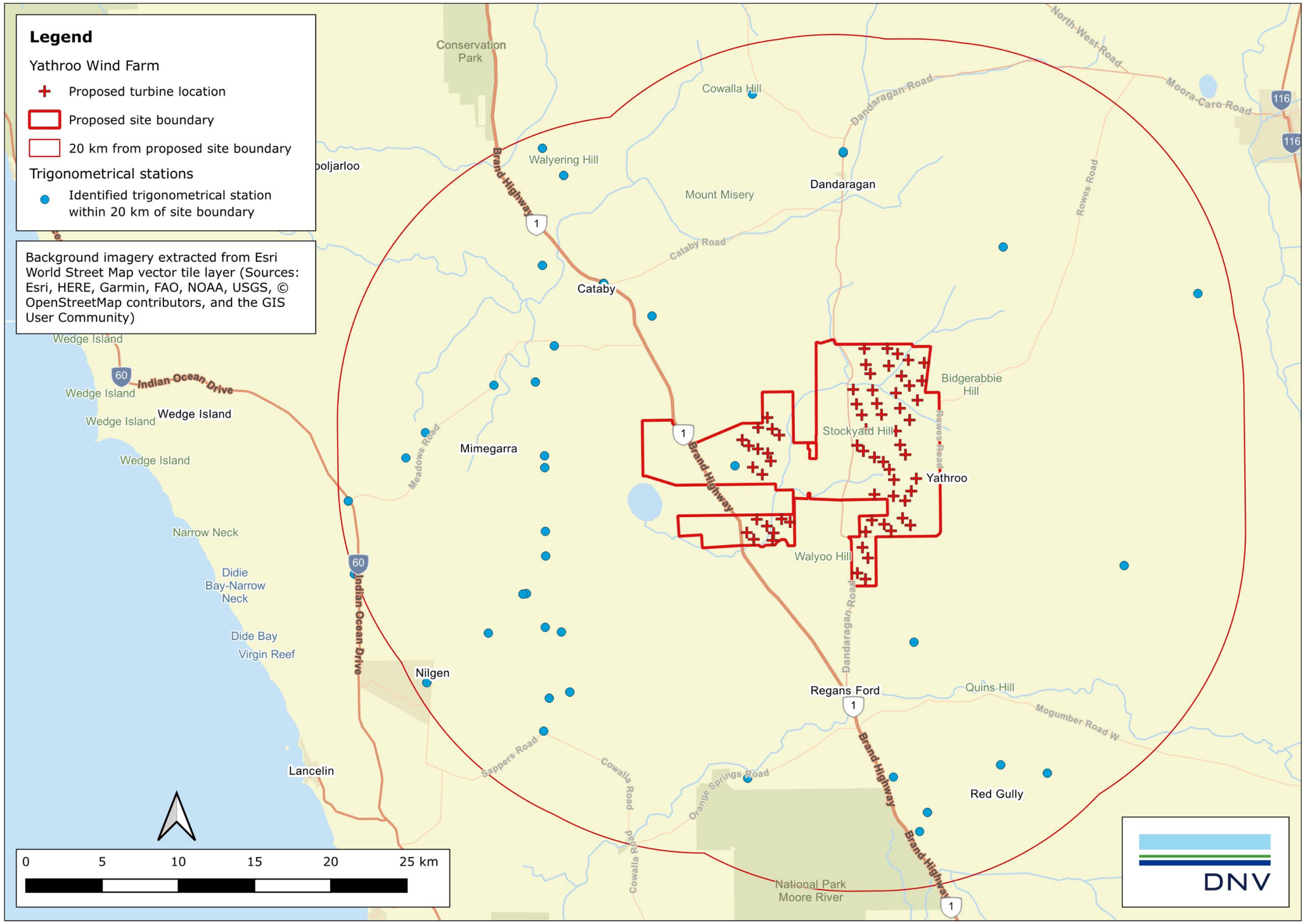

Figure 9 Location of trigonometrical stations within 20 km of the proposed Project

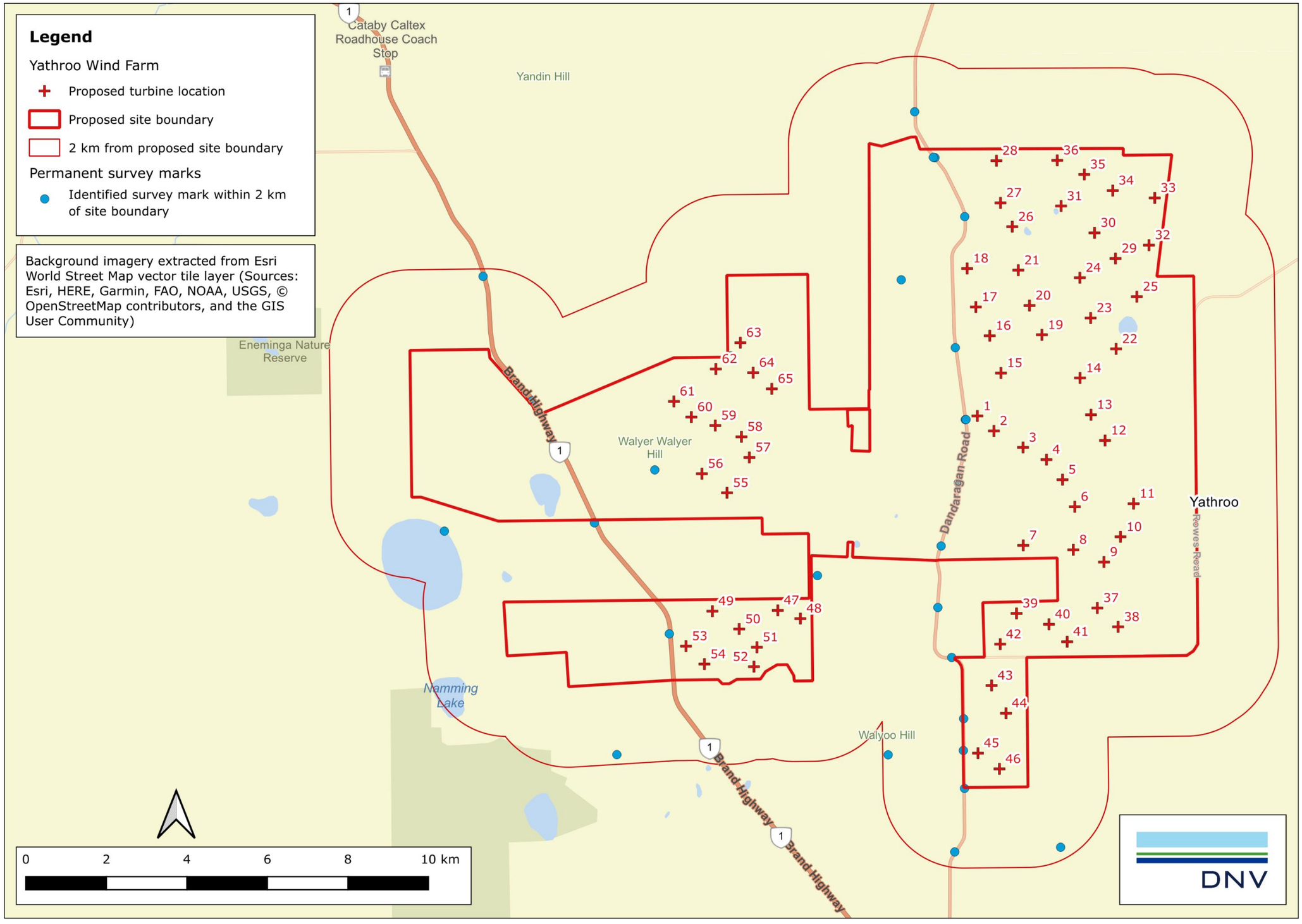

Figure 10 Location of permanent survey marks within 2 km of the proposed Project boundary

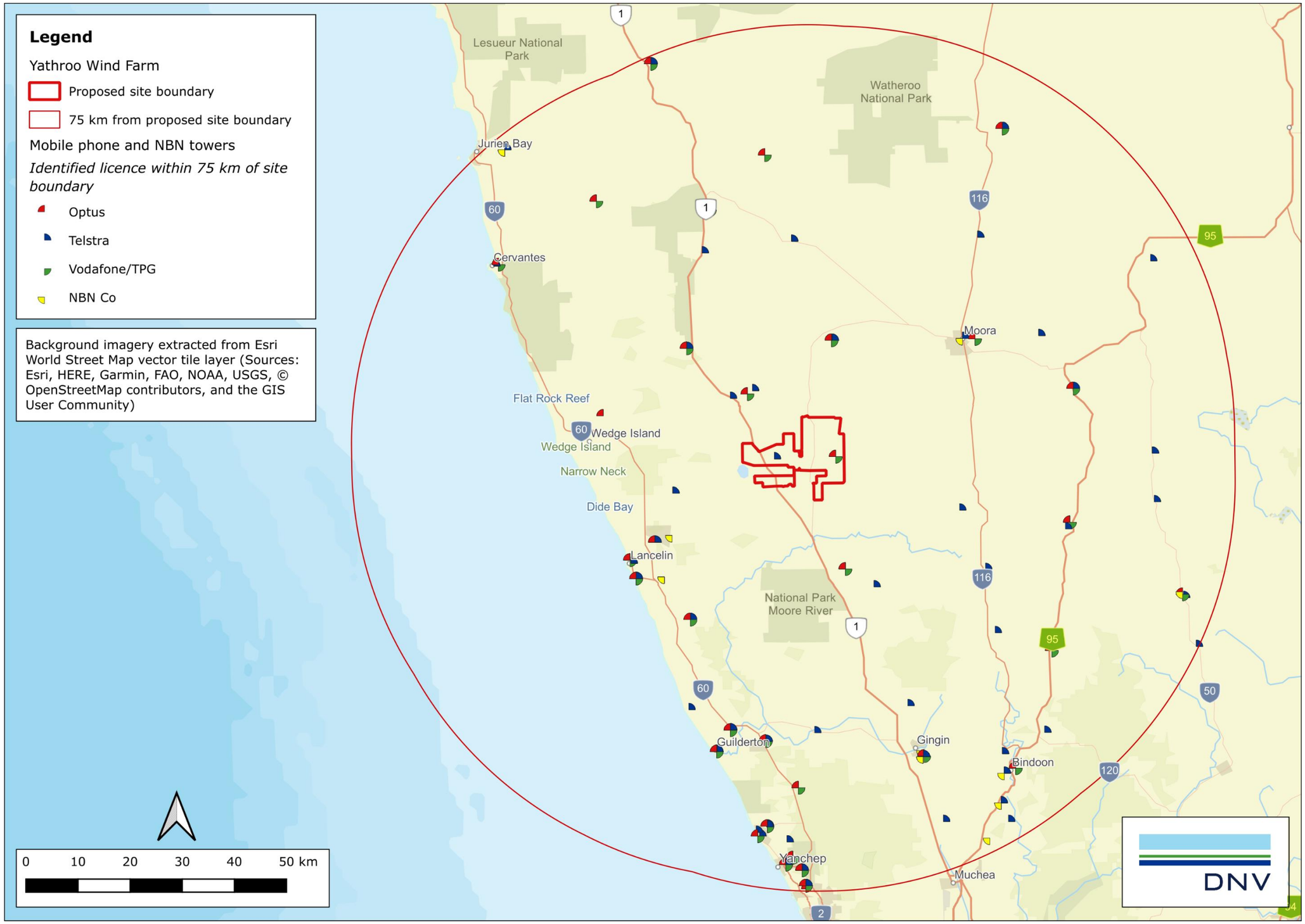

Figure 11 Location of mobile phone and NBN towers within 75 km of the proposed Project

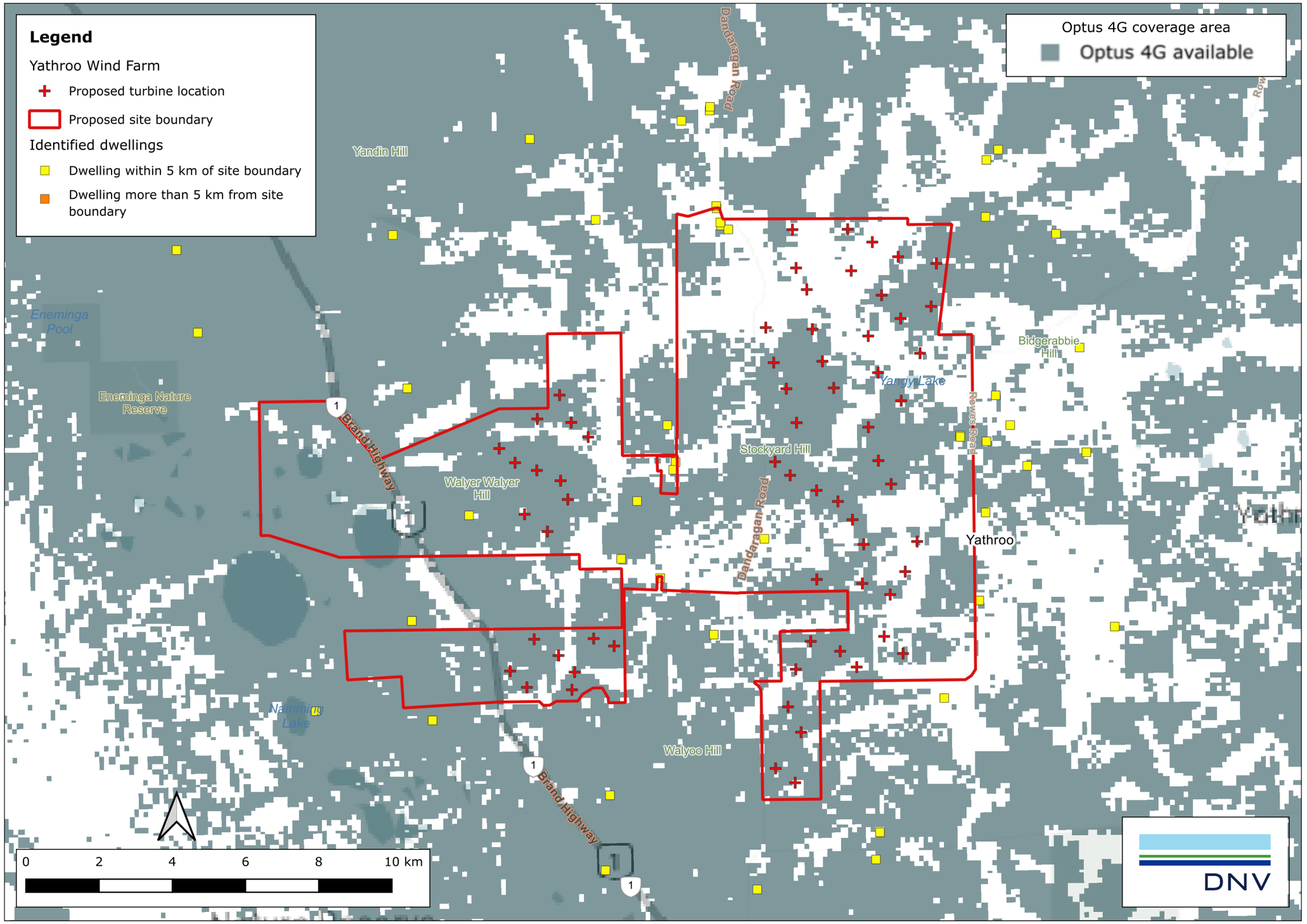

Figure 12 Optus Mobile 4G network coverage for the proposed Project

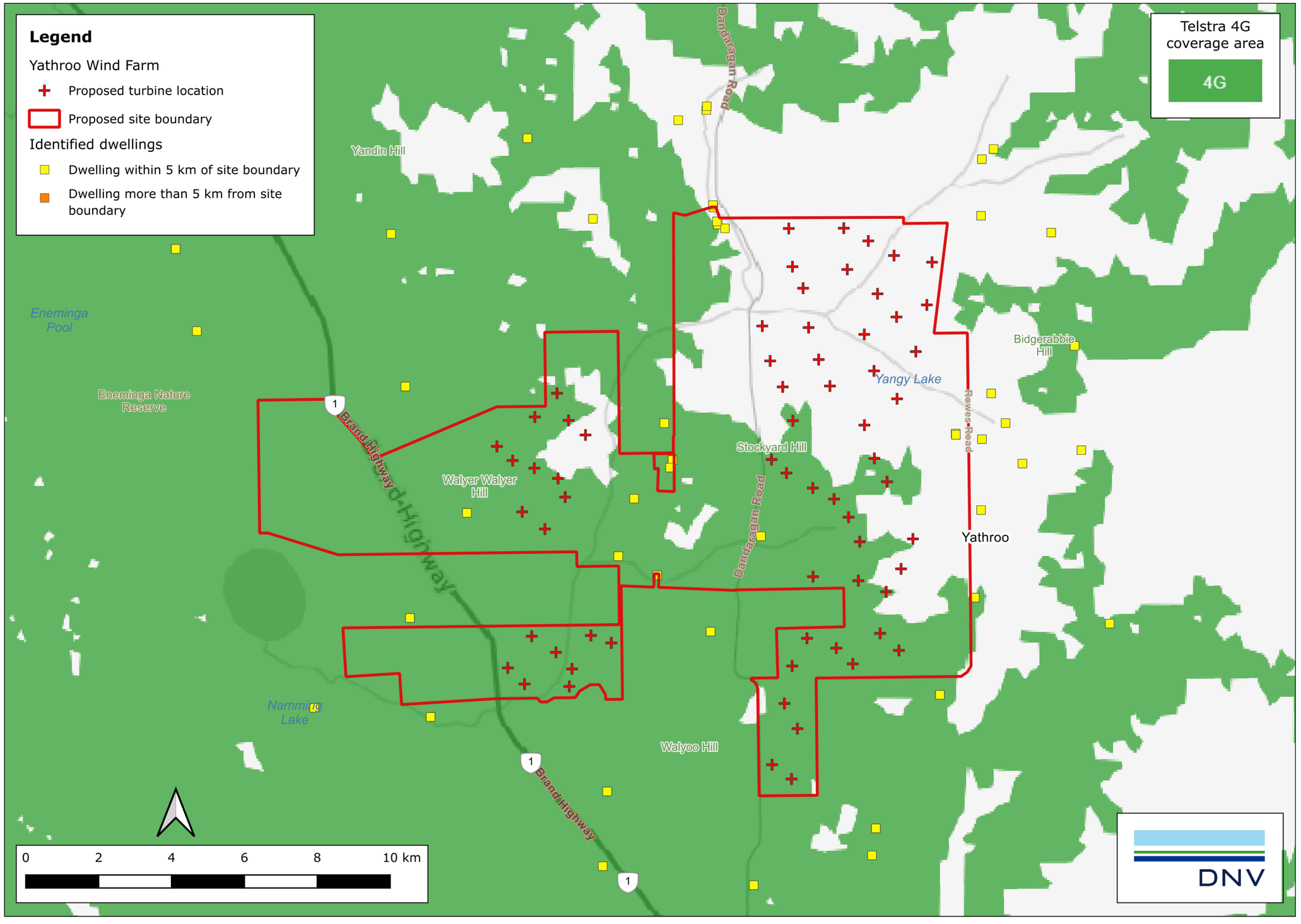

Figure 13 Telstra 4G network coverage for the proposed Project

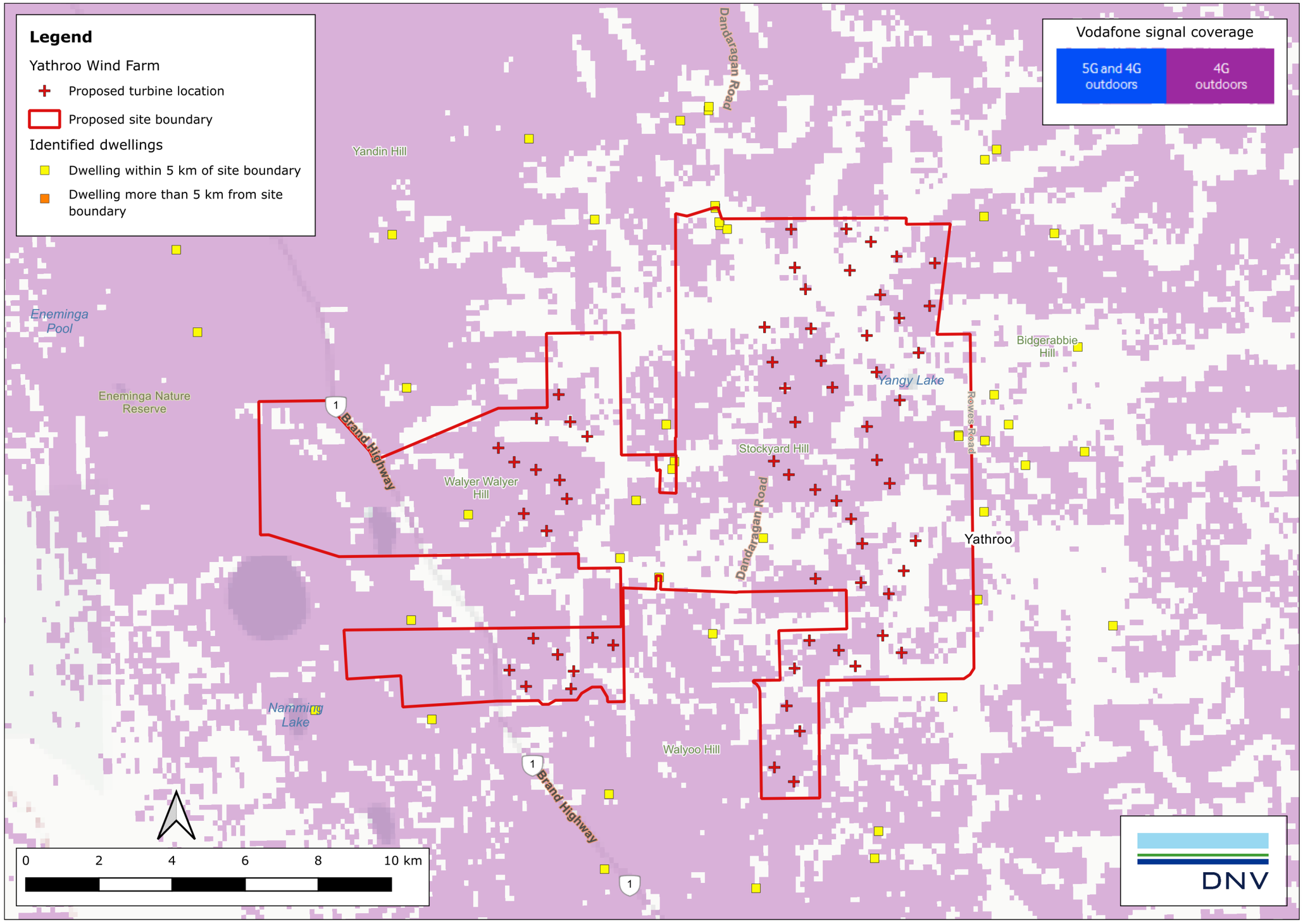

Figure 14 Vodafone network coverage (Apple iPhone 13 handset) for the proposed Project

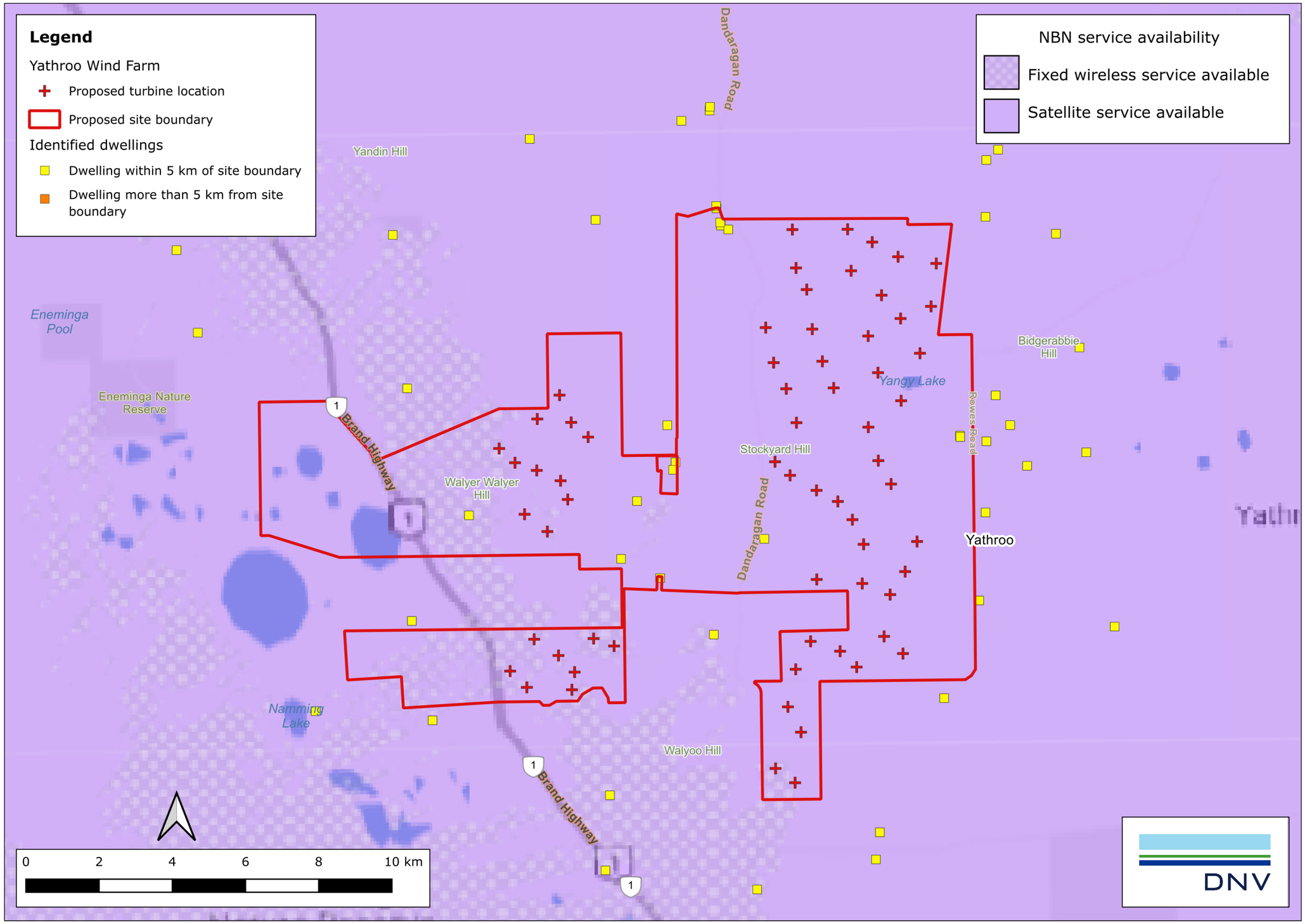

Figure 15 NBN internet coverage in the vicinity of the proposed Project

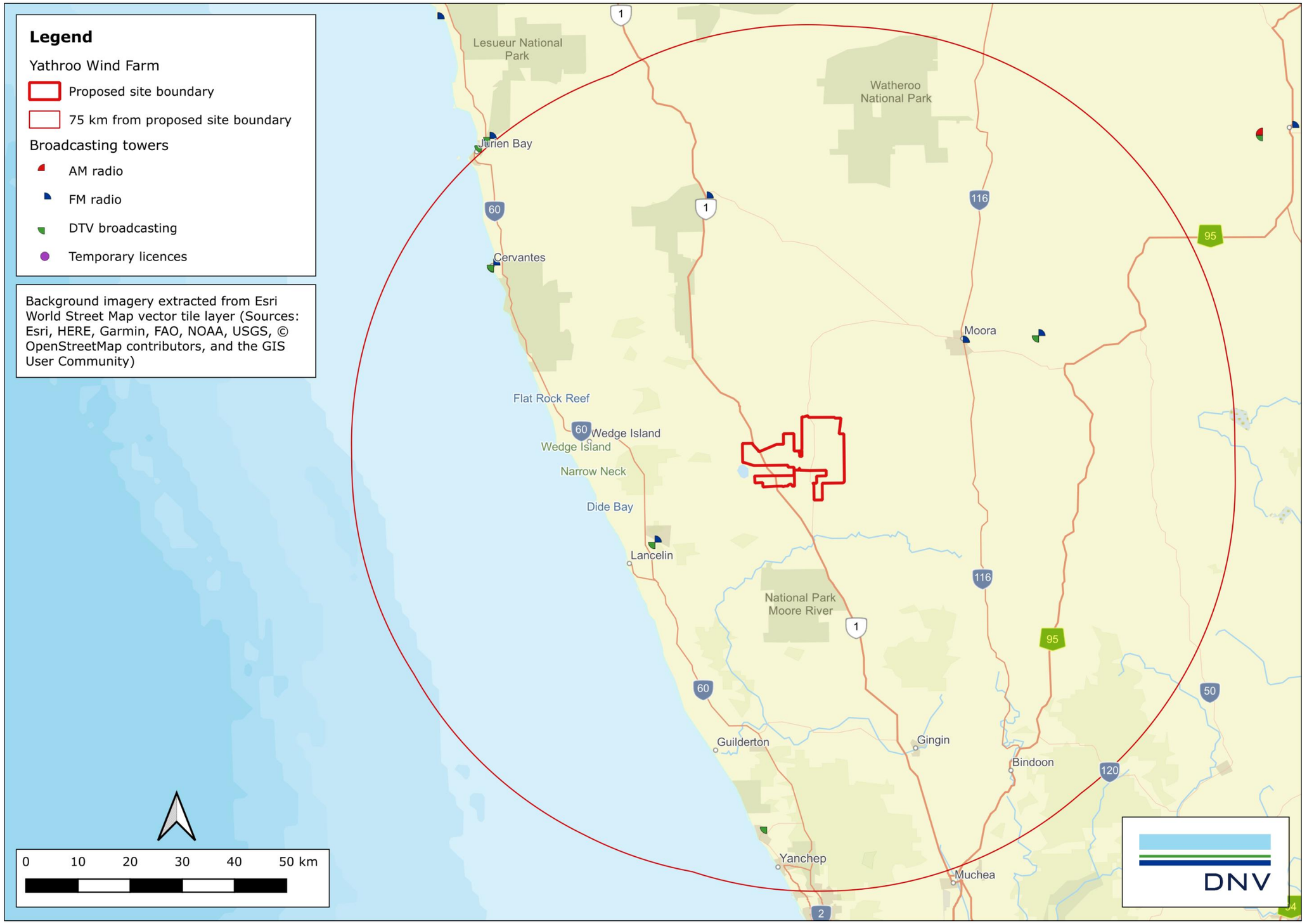

Figure 16 Location of broadcast transmitters in the vicinity of the proposed Project

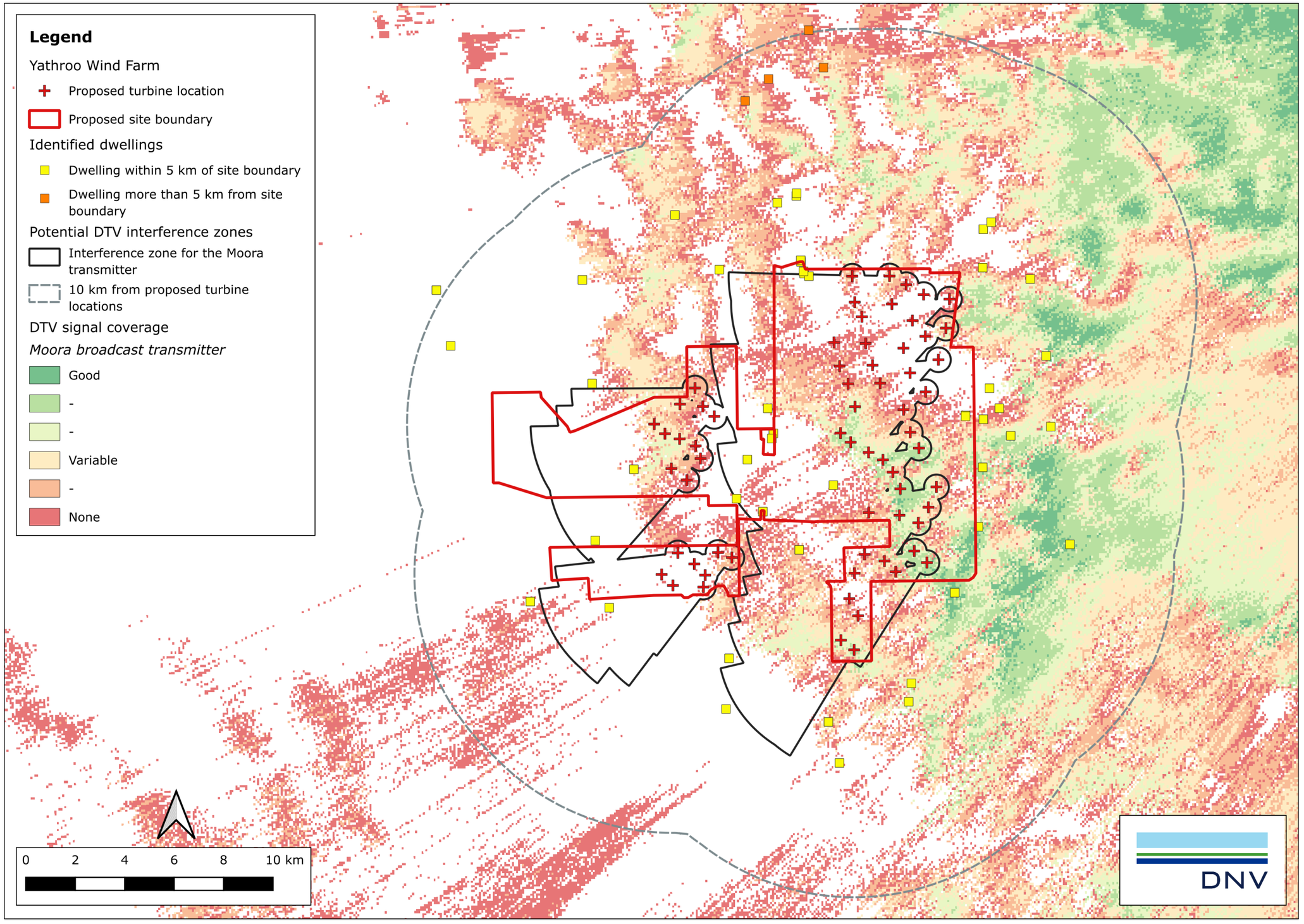

Figure 17 Potential television EMI zones for the Moora broadcast transmitter from the proposed Project

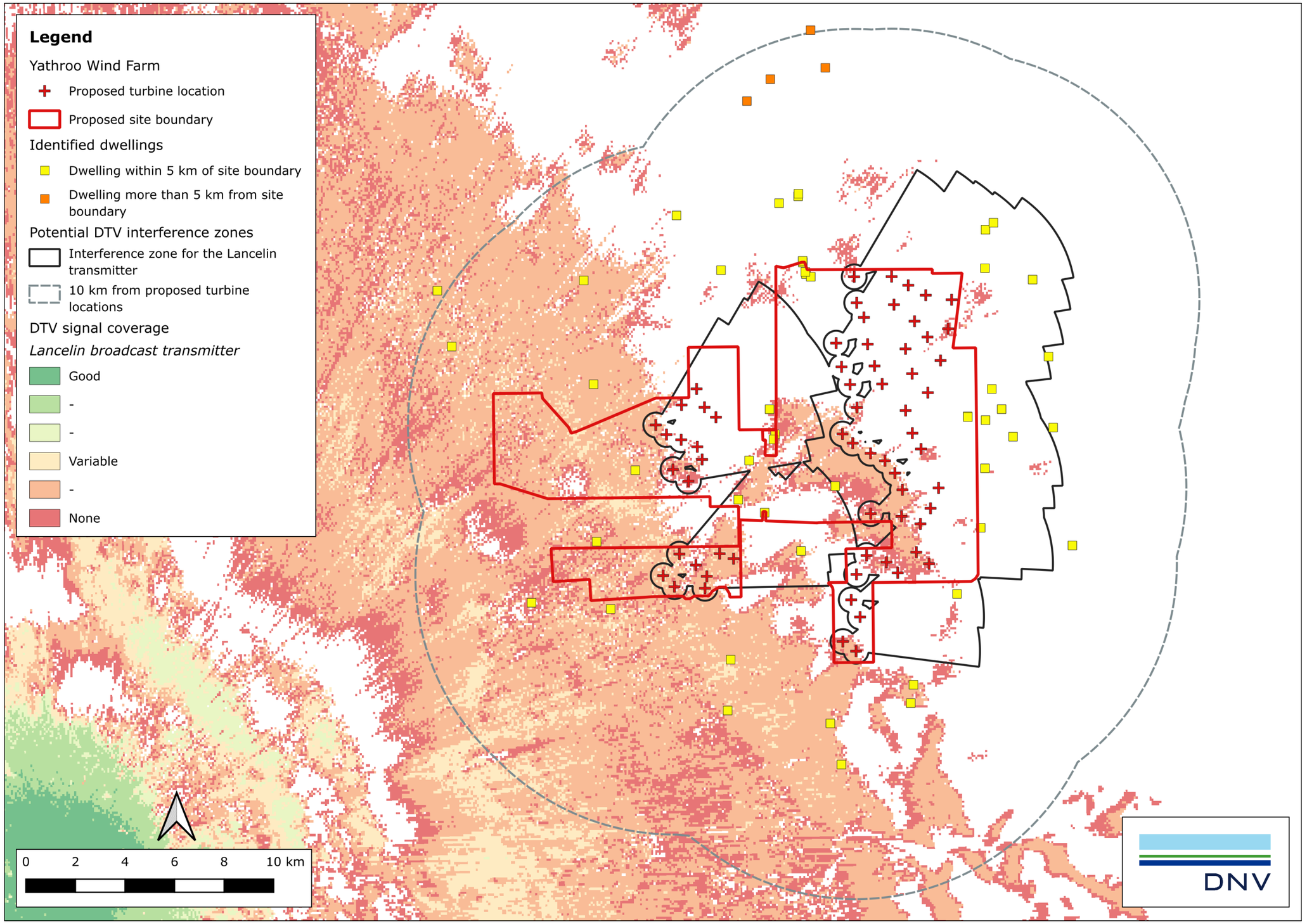

Figure 18 Potential television EMI zones for the Lancelin broadcast transmitter from the proposed Project

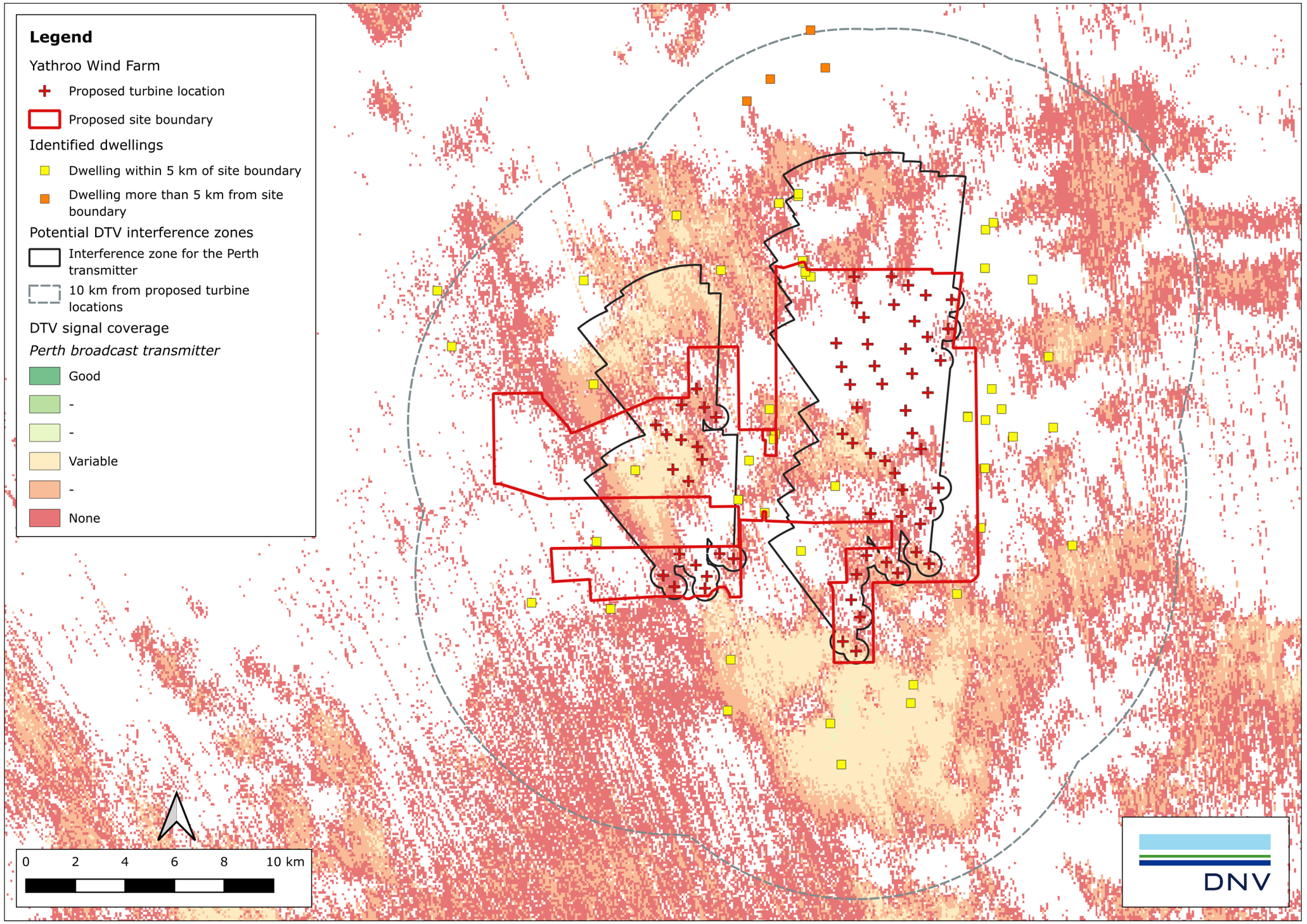

Figure 19 Potential television EMI zones for the Perth broadcast transmitter from the proposed Project

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimising the performance of a wind farm, analysing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.