WINTERBOURNE WIND FARM

EMI Assessment

Environmental Resources Management Australia Pty Ltd

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EXECUTIVE SUMMARY

DNV has been commissioned by Environmental Resources Management Australia Pty Ltd ("ERM" or "the Customer") on behalf of WinterbourneWind Pty Ltd ("WinterbourneWind" or "the Proponent") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Winterbourne Wind Farm ("the Project") in northeastern New South Wales (NSW). 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 Planning Secretary's Environmental Assessment Requirements for the Winterbourne Wind Farm [1], NSW Wind Energy Guideline [2], and Draft National Wind Farm Development Guidelines [3]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

A Project layout consisting of 119 wind turbine generators (WTG) with a rotor diameter of 162 m and tip height of 230 m has been considered. These dimensions represent the maximum overall tip height within the maximum rotor and tower hub height dimensions.

Outcomes of the assessment

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

In its current configuration, there is a potential for the Project to interfere with several point-to-point links crossing the proposed Project Area, and point-to-area style communications hosted by radiocommunication towers located within 2 km of the proposed WTG locations.

In the case of links operated by the New South Wales Government Telecommunications Authority (NSW Telco Authority), DNV recommends relocating WTGs during the detailed design phase of the Project as proposed by the NSW Telco Authority. DNV understands that the Proponent intends to relocate WTGs as requested by the NSW Telco Authority as part of future detailed design work for the Project, if the concerns raised by the NSW Telco Authority cannot be resolved through further consultation or alternative mitigation measures.

Advice received by DNV from the NSW National Parks and Wildlife Service and Walcha Council, and previous advice received by the Proponent from the NSW Rural Fire Service, suggests that they do not expect the Project to cause material interference to their links. Consultation with Telstra is ongoing to confirm their required clearances and potential for impact to their point-to-point link crossing the Project Area.

The potential for interference with point-to-area style communications such as mobile radio systems and amateur and CB radio systems may also be minimised by moving WTGs further from the towers, if required. Alternative mitigation options would need to be identified in discussion with the relevant operators, and consultation with the operators of these services is ongoing to confirm the required clearances and potential for impact.

WTGs at the Project may also interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. However, all feedback received from the operators of these services

has indicated that impacts are not expected. If interference to these services is experienced, a range of options are available to rectify difficulties.

Impacts to satellite television and internet signals that may be received at dwellings in the vicinity of the Project Area are considered unlikely. The proposed WTGs are not expected to interfere with any satellite television or internet services intended for Australian audiences. Interference is possible for signals from satellites that do not provide services designed for Australian audiences, however these are unlikely to be used by nearby residents.

While the Project may cause interference to other radiocommunication services in the surrounding area, such as point-to-multipoint links and meteorological radar, further information from the operators of those services is required to determine the likely impacts. DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact, and no concerns have been raised to date.

Summary of EMI assessment results for the Project

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Radiocommunication towers	4 towers within 2 km of proposed WTG locations, hosting point-to-point links and point-to-area style communications operated by: Brian Smith Timber Transport Pty Ltd Edwin Scott Dening (Coffs Harbour and District Amateur Radio Club) Goodcom Communications Pty Ltd New South Wales Government Telecommunications Authority (NSW Telco Authority) NSW Rural Fire Service Telstra Corporation Limited (Telstra) Walcha Council Walcha Radio Group	**Point-to-point links:** see impact for point-to-point links **Point-to-area style communications:** high likelihood of interference through reflection or scattering of signals	Potential for interference to point-to-point links raised by NSW Telco Authority (see feedback for point-to-point links) No concerns raised by Walcha Council Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely No response received from other operators	**Point-to-point links:** see recommendations for point-to-point links below **Point-to-area style communications:** Continue to engage with remaining operators to confirm potential for impact and mitigation options (if needed) If potential for interference exists and cannot be resolved through other means, relocate WTGs to be further from tower If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators

Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Fixed point-to-point links	11 links crossing Project Area, operated by: Bureau of Meteorology (BoM) New South Wales Government Telecommunications Authority (NSW Telco Authority) NSW Rural Fire Service Office of Environment and Heritage (NSW National Parks and Wildlife Service) Telstra Corporation Limited (Telstra) Walcha Council **Diffraction effects:** 14 WTGs in exclusion zones established by DNV for links operated by NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, Walcha Council **Reflection/scattering effects:** 8 WTGs in interference zones established by DNV for links operated by NSW Telco Authority, NSW Rural Fire Service, Walcha Council **Near-field effects:** no WTGs in interference zones established by DNV	**Diffraction effects:** high likelihood of interference to links operated by NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, Walcha Council **Reflection/scattering effects:** low likelihood of interference to links operated by NSW Telco Authority, NSW Rural Fire Service, Walcha Council	Potential for interference raised by NSW Telco Authority – relocation of 3 WTGs proposed No concerns raised by BoM, NSW National Parks and Wildlife Service, Walcha Council Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely No response received from Telstra	Continue to engage with NSW Telco Authority and Telstra to confirm potential for impact and mitigation options (if needed) **NSW Telco Authority links:** if concerns cannot be resolved through other means, relocate WTGs B154, B138, B139 as proposed **All links:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators
Fixed point-to-multipoint links	64 assignments within 75 km of Project Area 3 base stations within 20 km of Project Area, operated by Walcha Council	Potential for interference if link paths cross the Project near WTGs	No concerns raised by BoM, Walcha Council No response received from other operators	Continue to engage with remaining operators to confirm link paths and mitigation options (if needed) If link paths pass near WTGs and potential for interference cannot be resolved through other means, relocate WTGs to be outside interference zones If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators

Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
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:** NSW Telco Authority, NSW Rural Fire Service, and NSW National Parks and Wildlife Service links crossing Project Area (see findings for point-to-point links) **Mobile telephony systems:** NSW Telco Authority towers within 2 km of WTGs	**Point-to-point links:** see impact for point-to-point links **Mobile telephony systems within 2 km of WTGs:** high likelihood of interference **Other services:** unlikely to cause interference	Potential for interference to point-to-point links raised by NSW Telco Authority (see feedback for point-to-point links) No concerns raised by NSW Ambulance, NSW National Parks and Wildlife Service, NSW Police Force, St John Ambulance Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely Need for internal impact assessment raised by NSW SES	**Point-to-point links:** see mitigation for point-to-point links above **Mobile telephony systems:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators **NSW SES:** engage with NSW SES to facilitate internal assessment of potential impacts
Meteorological radar	Nearest radar: "Namoi", 135 km from Project	Potential for interference if WTGs at the Project are visible to radars	Impacts are expected to be manageable	Notify the BoM prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the BoM in the event of severe weather conditions

Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Trigonometrical stations	Trigonometrical stations: unlikely to be affected	Unlikely to cause interference	No concerns raised by Geoscience Australia No concerns raised by NSW Spatial Services, provided survey marks are protected from physical disturbance during construction	None
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	No concerns raised by Optus, Vodafone, Field Solutions Group No response received from other operators	**All services:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators **Telstra:** engage with Telstra to facilitate assessment of electrical impacts on their fixed network infrastructure
Wireless internet	**Mobile broadband service providers:** mobile phone networks (Optus, Telstra, Vodafone), Field Solutions Group, Pivotel Mobile **NBN:** available as a satellite service only	**Mobile broadband services:** low likelihood of interference **NBN:** none	No concerns raised by Optus, Vodafone, Field Solutions Group, NBN Co No response received from other operators	**Mobile broadband services:** as for mobile phones **NBN:** engage further with NBN Co prior to construction of the Project, to identify any changes to the NBN fixed wireless internet coverage areas
Satellite television and internet	**Services intended for Australian audiences:** unlikely to be affected **Services intended for international audiences:** signals from 15 satellites intercepted at 23 dwellings	Low likelihood of interference	Consultation with operators not considered necessary	If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents

Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to WTGs **FM signals from nearby transmitter:** may experience interference in areas to northwest of Project with marginal reception **Digital radio signals:** Project is outside the intended coverage area	**AM and FM signals:** low likelihood of interference **Digital radio signals:** none	No concerns raised	**AM signals:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents **FM signals:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents or relevant operators **Digital radio signals:** none
Television broadcasting	May experience interference in areas with poor or marginal reception **Armidale (Dumaresq) transmitter:** good to variable coverage within Project Area and to north and northwest, limited coverage to south and east 55 dwellings in potential interference zone, but some dwellings may be able to receive a stronger alternative signal from Walcha transmitter	High likelihood of interference	No concerns raised	If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents or relevant operators
	Upper Namoi (Mount Dowe) transmitter: variable coverage to north and northwest of Project Area, poor or no coverage elsewhere 34 dwellings in potential interference zone, but signal coverage is limited in that area	Low likelihood of interference – identified dwellings are unlikely to be receiving signals from this transmitter	No concerns raised	
	Walcha transmitter: good coverage around Walcha and across south and southwest of Project Area, poor or no coverage elsewhere 34 dwellings in potential interference zone, but signal coverage is limited in that area	Low likelihood of interference – most identified dwellings are unlikely to be receiving signals from this transmitter	No concerns raised	

1 INTRODUCTION

Environmental Resources Management Australia Pty Ltd ("ERM" or "the Customer") on behalf of WinterbourneWind Pty Ltd ("WinterbourneWind" or "the Proponent") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Winterbourne Wind Farm ("the Project") in northeastern New South Wales (NSW). The results of this work are reported here. This document has been prepared in accordance with the subcontract between ERM and DNV dated 3 May 2022, and is subject to the terms and conditions in that agreement.

In accordance with the Planning Secretary's Environmental Assessment Requirements (SEARs) for the Winterbourne Wind Farm [1], the NSW Wind Energy Guideline for State significant wind energy development (NSW Wind Energy Guideline) prepared by the NSW Department of Planning and Infrastructure in December 2016 [2], and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [3], this assessment investigates the potential EMI impact of the Project on:

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

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

2 PROJECT DESCRIPTION

2.1 Overview

The following information has been provided by the Customer [4].

The Winterbourne Wind Farm Project involves the construction and operation of a wind farm with up to 119 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project design has been revised and refined in response to the identification and assessment of environmental constraints, constructability requirements, and considerations of the outcomes of agency, landowner, and community consultations.

The Project consists of the following key components:

- *up to 119 WTGs, each with:*
  - *a generating capacity of approximately 6.2 MW*
  - *three blades mounted to a rotor hub (hub height of 149 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 230 m above ground level (AGL)*
  - *a gearbox and generator assembly housed in the nacelle*
  - *adjacent hardstands for use as crane pads, assembly, and laydown areas*
- *two 33/330 kV electrical substations, including control room, transformers, circuit breakers, switches and other ancillary equipment*
- *an operations and maintenance facility*
- *a battery energy storage system (BESS) of up to 100 MW/200 MWh capacity (two hours of storage)*
- *aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substations (generally following site access tracks)*
- *a 330 kV single or double circuit twin conductor overhead transmission line (transmission line) route of approximately 50 km connecting the two substations to a new electrical switchyard (including circuit breakers, switches and other ancillary equipment), located approximately 7 km south of Uralla and adjacent to TransGrid's 330 kV Tamworth to Armidale transmission line (Line 85)*
- *internal access tracks (combined total length of approximately 113 km) connecting the WTGs and associated Project infrastructure with the public road network*
- *upgrades to roads and intersections required for the delivery of oversize and overmass WTG components, transformers and associated construction-phase materials and vehicular movements*
- *decommissioning of four temporary meteorological monitoring masts and installation of up to two permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL, equivalent to the hub height of the installed WTGs.*

The following temporary elements will be required during the construction phase of the Project:

- *site buildings and facilities for construction contractors/equipment, including site offices, car parking and amenities for the construction workforce*
- *mobile concrete batching plant/s to supply concrete for WTG footings and substation construction works*

- *earthworks for access tracks, WTG platforms and foundations, potentially including controlled blasting in certain areas*
- *potential rock crushing facilities for the generation of suitable aggregates for concrete batching and/or for access track and hardstand construction*
- *hardstand laydown areas for the storage of construction materials, plant, and equipment*
- *up to four temporary meteorological monitoring masts. The temporary monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL*
- *external water supply and storage for concrete batching and construction activities*
- *the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure*
- *beneficial reuse of materials won from within the development footprint during cut and fill and WTG foundation excavation works for use in access track, hardstands and foundation material.*

The Project may also require the subdivision of land for the substations and switchyard.

Ultimately, the Project will be decommissioned and the Project Area will be rehabilitated.

Table 1 provides an overview of the approximate dimensions of the Project components.

Table 1 Indicative Project components utilised for this assessment [4]

Project components and infrastructure	Approximate dimensions	Quantity
WTGs		
Rotor diameter	162 m	119 WTGs
Blade length	Blade length of 79.3 m. Distance from the centrepoint of the hub to the tip of the blade equals 81 m	
Uppermost blade tip	230 m	
Tower (hub) height	149 m	

2.2 Project details used in this assessment

2.2.1 Proposed wind farm layout

A Project layout consisting of 119 WTGs was provided by the Customer [5]. A map of the Project Area with the proposed WTG layout is shown in Figure 1, and the coordinates of the proposed WTG locations are presented in Table 7.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project Area have been provided by the Customer [6]. For the purposes of this assessment, DNV has considered all identified dwellings within 5 km of the Project Area. The coordinates of these dwellings are presented in Table 8, and the dwellings and Project Area considered in this assessment are shown in Figure 1.

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 listed dwellings are inhabited.

3 REGULATORY REQUIREMENTS

The SEARs for the Winterbourne Wind Farm [1] outline the following requirements for the assessment of interference to telecommunication services:

> *"Telecommunications – identify possible effects on telecommunication systems, assess impacts and mitigation measures including undertaking a detailed assessment to examine the potential impacts as well as analysis and agreement on the implementation of suitable options to avoid potential disruptions to radio communication services, which may include the installation and maintenance of alternative sites."*

In addition, the NSW Wind Energy Guideline [2] currently states:

> *"…the consent authority will give consideration to the risk of electromagnetic interference with telecommunication services in the area, and the adequacy of the measures proposed to ensure the level of service is maintained."*

Although both the SEARs and the NSW Wind Energy Guideline describe the requirements for assessing EMI related impacts, they do not provide detailed methodologies for these assessments.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [3]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development.

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

DNV considers that the recommendations of the Draft National Guidelines meet, if not exceed, the requirements of the SEARs and the NSW Wind Energy Guideline, and therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 METHODOLOGY AND RESULTS

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

The Customer has asked DNV to complete this assessment based upon a layout provided for the Project consisting of 119 WTGs, as outlined in Table 7.

For the purpose of the EMI assessment, a hypothetical WTG with a rotor diameter of 162 m and a tip height of 230 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 WTG configuration will be conservative for all configurations with dimensions that remain inside the WTG envelope by satisfying all of the following criteria:

- a rotor diameter of 162 m or less
- an upper tip height of 230 m or less.

The Draft National Guidelines recommend that a radial distance of 50 km to 60 km from the centre of a wind farm would normally capture all of the potentially affected services in the area. However, the methodology for assessing the potential radiocommunications interference used in this assessment is to locate all of the radiocommunication towers within approximately 75 km of the Project, and then assess the radiocommunication licences attached to these towers. This reduces the likelihood that radiocommunication links crossing the Project Area 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 27 April 2022 [7].

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

The radiocommunication licences and services with potential to experience EMI-related impacts from the 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.

4.1 Radiocommunication towers

WTGs located close to radiocommunication sites have the potential to cause interference through near-field effects or reflection or scattering of the signals. According to the Draft National Guidelines [3], 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 WTG location be considered as a having the potential to be impacted by near-field effects. The potential for a WTG to cause reflection or scattering of signals also depends on a number of factors, including the service type, the required signal-to-noise ratio for the service, and the distances between the user, transmission tower, and WTG. Since there is no single criterion for potential impact on radiocommunication services due to near-field effects and reflection or scattering, the Draft National Guidelines recommend consulting with the service operator if any WTG is to be located within 2 km of a radiocommunication site.

4.1.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 423 radiocommunication towers within a nominal 75 km of the Project Area. The locations of these radiocommunication towers relative to the Project are shown in Figure 2.

There are four radiocommunication towers located within 2 km of the proposed WTG locations. These towers and the consultation zones recommended by the Draft National Guidelines [3] are shown in Figure 3 and Figure 4 based on information obtained from the ACMA RRL database, provided by the link operators, and extracted from aerial or satellite imagery. Each consultation zone includes the rotor radius for WTGs with a 162 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer for each link is based on the deviations between the tower locations given in the ACM RRL database or provided by the link operators and the apparent locations determined from aerial or satellite imagery.

Details of the licences associated with these radiocommunication towers are given in Table 2**.** These licences and services include point-to-point links and point-to-area style communications, comprising land mobile licences used for private mobile telephony (mobile radio and paging systems) and amateur and CB radio repeater licences.

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

Site ID	Operator	Licence/service types	Distance to nearest WTG [m]
6726	Edwin Scott Dening (Coffs Harbour and District Amateur Radio Club)	Point-to-area (amateur repeater)	325
	Goodcom Communications Pty Ltd	Point-to-area (CB radio repeater)	
	New South Wales Government Telecommunications Authority (NSW Telco Authority)	Point-to-point links Point-to-area (land mobile)	
	NSW Rural Fire Service	Point-to-point links	
	Walcha Council	Point-to-point links Point-to-area (land mobile)	
	Walcha Radio Group	Point-to-area (amateur repeater)	
6748	Telstra Corporation Limited (Telstra)	Point-to-point links	1485
280079	Brian Smith Timber Transport Pty Ltd	Point-to-area (land mobile)	356
10022185	New South Wales Government Telecommunications Authority (NSW Telco Authority)	Point-to-point links Point-to-area (land mobile)	366

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 4.2. For the point-to-point links associated with the radiocommunication towers shown in Table 2, DNV has established potential reflection/scattering and near-field interference zones as described in Sections 4.2.1.2 and 4.2.1.3. 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 through reflection or scattering of the signals.

Point-to-area style radiocommunications such as mobile radio, paging, and CB and amateur radio systems are typically designed to operate in a range of environments and are generally not affected by the presence of WTGs 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 WTGs are located close to the transmission tower. Reference [8] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts due to reflection or scattering of signals. Other references recommend that WTGs be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for these types of services [9].

Given the proximity of the proposed WTG locations to the towers shown in Table 2, there is a potential for the Project to interfere with the associated point-to-area style communications 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.

4.1.2 Stakeholder consultation and responses

DNV has contacted the operators of the services associated with the towers shown in Table 2 to determine the likelihood that the Project will cause interference to their services through near-field effects or reflection or scattering of signals.

The responses received from the NSW Telco Authority, NSW Rural Fire Service, and Walcha Council in relation to their point-to-point links are summarised in Section 4.2.2. No concerns have been raised by the NSW Telco Authority and Walcha Council in relation to their mobile radio or paging services. Telstra have confirmed the location of their tower shown in Table 2, but have not yet provided any feedback on the potential for interference to the licences and services operated from that tower. No other responses have been received to date.

4.1.3 Mitigation options

Potential mitigation options for impacts to point-to-point links associated with the towers shown in Table 2 are discussed in Section 4.2.3.

If consultation with the operators suggests that there is a potential for interference to the point-to-area style communications associated with the towers shown in Table 2, mitigation options may include relocating WTGs during the detailed design phase of the Project to be further from the affected tower, 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 Area.

4.2 Fixed licences of point-to-point type

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

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

4.2.1 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 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 5 based on information obtained from the ACMA RRL database, provided by the link operators, and extracted from aerial or satellite imagery. 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 11 point-to-point links that pass over the Project Area, operated by the Bureau of Meteorology (BoM), New South Wales Government Telecommunications Authority (NSW Telco Authority), NSW Rural Fire Service, Office of Environment and Heritage (NSW National Parks and Wildlife Service), Telstra Corporation Limited (Telstra), and Walcha Council. The details of the links are provided in Table 9, and the link paths are shown in greater detail in Figure 6 and Figure 7 based on information obtained from the ACMA RRL database, provided by the link operators, and extracted from aerial or satellite imagery.

DNV notes that there are two additional NSW Rural Fire Service links passing over the Project Area recorded in the ACMA RRL database, but the NSW Rural Fire Service has advised that one of these links has been removed and the other does not exist and is no longer planned to be installed. The assessment presented here is based on the actual links crossing the Project Area, as confirmed by the relevant operators.

The potential interference mechanisms and interference zones established by DNV for these links are described in Sections 4.2.1.1, 4.2.1.2, and 4.2.1.3, and summarised in Section 4.2.1.4. Feedback obtained from the operators of the links, including their recommended clearance zones to reduce the potential for interference, is summarised in Section 4.2.2.

4.2.1.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [3, 10, 11], typically defined in terms of the Fresnel zones for the link. The *n*th Fresnel zone is comprised of all points for which, if the signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n-\lambda}{2}$, where λ = wavelength.

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

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

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

To avoid interference to point-to-point links caused by signal diffraction, WTGs, including the blades, should be kept outside of an exclusion zone based on either the second Fresnel zone as recommended in [10], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [8] (although DNV understands that this zone is under review by the authors of that document). For each of the links crossing the Project Area, 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 6 and Figure 7. Each exclusion zone includes the rotor radius for WTGs with a 162 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer for each link is based on the deviations between the tower locations given in the ACM RRL database or provided by the link operators and the apparent locations determined from aerial or satellite imagery.

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

The results of this analysis are summarised in Table 3. Considering the diffraction exclusion zones in both the horizontal and vertical planes, there are 14 WTGs located within the exclusion zones established by DNV for point-to-point links passing over the Project Area operated by NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, and Walcha Council. Therefore, there is potential for the Project to cause interference to these links through diffraction of the signals.

4.2.1.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a WTG will reflect, or scatter. electromagnetic waves is characterised by its radar cross section (RCS) [10].

Reference [10] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a WTG at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and WTG, and comparing this to the required C/I ratio, a potential interference zone can be defined.

For each of the identified links with a transmission tower near the proposed WTG locations, DNV has established a reflection/scattering interference zone based on the antenna gains and length of the link, the worst-case RCS for the WTG calculated according to the equation proposed in [12], and an assumed minimum C/I ratio of 20 dB [12]. The radiation patterns for the antennas were approximated using the reference radiation patterns given in the International Telecommunication Union (ITU) Recommendation F.699-8 [13].

The potential reflection/scattering interference zones are shown in Figure 6 and Figure 7. Each interference zone includes the rotor radius for WTG with a 162 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer for each link is based on the deviations between the tower locations given in the ACM RRL database or provided by the link operators and the apparent locations determined from aerial or satellite imagery. For comparison, Figure 7 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 Area.

The results of this analysis are summarised in Table 3. There are eight WTGs located within the potential reflection/scattering interference zones established by DNV for point-to-point links passing over the Project Area operated by NSW Telco Authority, NSW Rural Fire Service, and Walcha Council.

The method used to establish the reflection/scattering interference zones shown in Figure 6 and Figure 7 assumes that the direct path for the point-to-point link has a clear line-of-sight with respect to the first Fresnel zone, and that the paths for the reflected or scattered signal from the transmitter to the WTG and from the WTG to the receiver are also line-of-sight [10]. For low frequency links, the direct path between the transmitter and the receiver is often obstructed by terrain. In this situation, a signal that has been reflected or scattered from a WTG with a clear line of sight to the transmitter or receiver may be considerably stronger than the direct signal and therefore have greater potential to cause interference [8]. As indicated in Table 3, point-to-point links 4, 5, and 10 crossing the Project Area, operated by NSW Telco Authority, NSW Rural Fire Service, and Telstra, do not have a clear line of sight between the transmitter and receiver. For these links, the necessary clearance zones to minimise the potential for interference caused by reflection or scattering may be larger than those shown in Figure 6 and Figure 7.

Nevertheless, DNV notes that the reflection/scattering interference zones shown in Figure 6 and Figure 7 are approximations only and may be overly conservative [3]. 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 [8]. The WTG RCS and C/I ratios used to establish the interference zones were based on recommendations developed on behalf of the United Kingdom telecommunications regulator Ofcom [12], and may not be appropriate for point-to-point links operating in Australia. Uncertainties are also associated with the assumptions used to derive the Ofcom recommendations, and the use of ITU reference radiation patterns rather than the actual radiation patterns for the transmitting and receiving antennas. To account for these uncertainties, the potential for the Project to cause interference to fixed point-to-point links passing over the Project Area through reflection or scattering has been further assessed through consultation with the operators of those links, as described in Section 4.2.2.

4.2.1.3 Interference caused by near-field effects

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

Reference [10] presents an equation for estimating the radius of the near-field zone for a point-to-point link from the properties of the transmitting or receiving antenna. For each of the identified links with a transmission tower located near the proposed WTG locations, DNV has established a near-field interference zone based on the operating frequency and antenna gain for that link.

The potential near-field interference zones are shown in Figure 7. Each interference zone includes the rotor radius for WTGs with a 162 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer for each link is

based on the deviations between the tower locations given in the ACM RRL database or provided by the link operators and the apparent locations determined from aerial or satellite imagery.

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

4.2.1.4 Summary of point-to-point interference effects

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

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

Link no.	Operator	WTGs within potential interference zone			
		Diffraction		Reflection/ scattering	Near-field
		Horizontal plane	Vertical plane		
1	Bureau of Meteorology (BoM)	None	Not assessed[1]	Not assessed[2]	Not assessed[2]
2	New South Wales Government Telecommunications Authority (NSW Telco Authority)	2 turbines (B138, B139)	2 turbines (B138, B139)	4 turbines (B151, B152, B153, B154)	None
3	New South Wales Government Telecommunications Authority (NSW Telco Authority)	1 turbine (B154)	1 turbine (B154)	3 turbines (B152, B153, B154)	None
4	New South Wales Government Telecommunications Authority (NSW Telco Authority)	None	Not assessed[1]	3 turbines[3] (B152, B153, B154)	None
5	NSW Rural Fire Service	5 turbines (B013, B014, B038, B167, B172)	4 turbines[4] (B013, B014, B167, B172)	None[3]	None
6	NSW Rural Fire Service	2 turbines (B160, B161)	2 turbines (B160, B161)	Not assessed[2]	Not assessed[2]
7	NSW Rural Fire Service	None	Not assessed[1]	4 turbines (B030, B032, B033, B034)	None
8	NSW Rural Fire Service	None	Not assessed[1]	3 turbines (B152, B153, B154)	None
9	Office of Environment and Heritage (NSW National Parks and Wildlife Service)	2 turbines (B071, B073)	2 turbines (B071, B073)	Not assessed[2]	Not assessed[2]
10	Telstra Corporation Limited (Telstra)	1 turbine (B149)	None[4]	None[3]	None
11	Walcha Council	3 turbines (B141, B144, B146)	3 turbines (B141, B144, B146)	4 turbines (B151, B152, B153, B154)	None

1. WTGs are sufficiently clear of the diffraction zone in the horizontal plane.
2. Transmission towers are located more than 5 km from the proposed WTG locations. Interference caused by reflection or scattering of signals or near-field effects is not expected for this link.
3. Direct link path does not have a clear line-of-sight with respect to the first Fresnel zone. The necessary clearance zone to minimise potential for interference caused by reflection or scattering may be larger than shown in Figure 6 or Figure 7 for this link.
4. Second Fresnel zone is expected to pass under the WTG rotor for at least one WTG in the vertical plane.

4.2.2 Stakeholder consultation and responses

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

Responses have been received from the BoM, NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, and Walcha Council, as summarised in Table 16.

The response received from Walcha Council indicates that they do not expect the Project to cause material interference to their point-to-point link crossing the Project Area (link 11 in Table 9 and Figure 7), based on advice received from their radiocommunication provider. However, DNV notes that this advice is inconsistent with the findings of the assessment presented here, which indicate that there may be potential for interference to the point-to-point link operated by Walcha Council.

The response received the BoM indicates that they do not expect the Project to cause interference to their point-to-point link crossing the Project Area (link 1 in Table 9 and Figure 7), and that they have no objections to the Project provided that the Proponent agrees in writing to ensure that no WTGs are located within 600 m of the link path. The 600 m clearance zone requested by the BoM is shown in Figure 8, and there are no WTGs currently located within this clearance zone.

The response received from the NSW National Parks and Wildlife Service also indicates that they do not expect the Project to cause interference to their point-to-point link crossing the Project Area (link 9 in Table 9 and Figure 7). According to the NSW National Parks and Wildlife Service, modelling undertaken by the NSW Rural Fire Service on their behalf has shown that the link is expected to be sufficiently clear of WTGs in the vertical plane to avoid any material interference. However, DNV notes that this advice is inconsistent with the findings of the assessment presented here. This suggests that the clearance applied by the NSW Rural Fire Service to the point-to-point link operated by NSW National Parks and Wildlife Service may be different to the diffraction exclusion zone considered by DNV. The NSW National Parks and Wildlife Service has also noted that the developers of other wind farms have committed to working with them to resolve any issues in the event that interference is experienced after the wind farms are operational, and that they have been comfortable to proceed on that basis. DNV recommends that the Proponent considers making a similar commitment, to provide assurance to the NSW National Parks and Wildlife Service that any interference caused by the Project following construction will be rectified.

Concerns have been raised by the NSW Telco Authority regarding the potential for WTGs at the Project to cause interference to two of their point-to-point links crossing the Project Area (links 2 and 3 in Table 9 and Figure 7). To mitigate the potential for interference to their links, the NSW Telco Authority have proposed the following changes to the WTG layout:

- licence number 10330342/1 (link 2 in Table 9 and Figure 7)
  - WTG B138 – move 50 m northeast from proposed location
  - WTG B139 – move 140 m southwest from proposed location
- licence number 10956325/2 (link 3 in Table 9 and Figure 7)
  - WTG B154 – move 30 m east from proposed location.

The NSW Telco Authority has advised that these changes to the WTG layout have been determined from diffraction exclusion zones based on the first Fresnel zone for link 2 and the third Fresnel zone for link 3. Figure 9 shows diffraction exclusion zones in the horizontal plane for links 2 and 3 based on the first and third Fresnel zones respectively, as proposed by the NSW Telco Authority. Each exclusion zone includes the rotor radius for WTGs with a 162 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations as discussed in Section 4.2.1.1. The WTG movements proposed by the NSW Telco Authority are broadly consistent with the movements suggested by the diffraction zones shown in Figure 9.

A partial response has been received from the NSW Rural Fire Service, indicating that they expect the required clearance zone for at least one of their point-to-point links to pass under the WTG rotors. The Customer has also provided DNV with previous advice received by the Proponent from

the NSW Rural Fire Service [14], which indicates that impacts to their point-to-point links are considered unlikely. The correspondence provided suggests that the NSW Rural Fire Service does not expect the Project to cause material interference to their UHF point-to-point links (believed to be links 5 and 6 in Table 9 and Figure 6), and that they intend to test the operation of those links to confirm that there are no impacts following construction of the Project. However, DNV notes that this is advice is inconsistent with the findings of the assessment presented here. This suggests that the clearance applied by the NSW Rural Fire Service to their UHF point-to-point links may be different to the diffraction exclusion zone considered by DNV. DNV is not aware of any specific advice provided by the NSW Fire Service regarding the potential for interference to their higher frequency links (links 7 and 8 in Table 9, Figure 6, and Figure 7). However, the assessment presented here suggests that WTGs at the Project are unlikely to cause interference to links 7 and 8 through diffraction of the signals and there is only a low likelihood of interference through reflection or scattering of the links.

Telstra has confirmed the path for their point-to-point link crossing the Project Area (link 10 in Table 9 and Figure 7), but have not yet provided feedback on the potential for impact to that link.

4.2.3 Mitigation options

If the concerns raised by the NSW Telco Authority regarding their point-to-point links crossing the Project Area cannot be resolved through other means, DNV recommends that WTGs B154, B138, B139, and B152 be relocated during the detailed design phase of the Project as proposed by the NSW Telco Authority and outlined in Section 4.2.2.

The advice received from the NSW National Parks and Wildlife Service and Walcha Council indicates that changes to the WTG layout will not be required to avoid interference to their point-to-point links crossing the Project Area. Similarly, previous advice received by the Proponent from the NSW Rural Fire Service suggests that changes to the WTG layout will not be required to avoid interference to NSW Rural Fire Service point-to-point links, and that any interference can be rectified after construction of the Project.

Alternative mitigation options would need to be identified in consultation with the relevant operators, but may include upgrading the equipment for the affected link, re-routing the link via an existing or new tower, or replacing the link with an alternative communication technology.

DNV understands that the design of the Project is still progressing, and that the Proponent intends to relocate WTGs B138, B139, B152, and B154 as requested by the NSW Telco Authority as part of future detailed design work before the Project is constructed, if the concerns raised by the NSW Telco Authority cannot be resolved through further consultation or alternative mitigation measures [15]. DNV also understands that the Proponent intends to agree to the condition specified by the BoM to ensure that no WTGs are located within 600 m of their point-to-point link crossing the Project Area [16].

4.3 Fixed licences of point-to-multipoint type

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

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

From the ACMA RRL database, DNV has identified 64 point-to-multipoint Assignment IDs within approximately 75 km of the Project Area. These licences are shown in Figure 10. The details of the licence holders as given in the ACMA RRL database are provided in Table 10.

There are three point-to-multipoint base stations within 20 km of the Project Area, operated by Walcha Council (Site ID 41044, 402425, 9013090). There are also several point-to-multipoint base stations located more than 20 km from the Project.

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

4.3.2 Stakeholder consultation and responses

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

Responses have been received from the Bureau of Meteorology and Walcha Council, and no concerns have been raised. No other responses have been received to date.

4.3.3 Mitigation options

If interference to point-to-multipoint links is experienced, mitigation options may include re-routing the links, installing additional towers, or replacing the affected links with alternative communications infrastructure.

4.4 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.

4.4.1 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 Project Area. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 11 and Table 11.

Most of the licences identified can be broadly described as base to mobile station or point-to-area style communications, including commercial and private mobile telephony and radio and television broadcasting. These licence types are generally not affected by the presence of WTGs 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 4.5 and 4.10 respectively, while the potential for interference to radio and television broadcasting services is considered in Sections 4.13 and 4.14.

A number of aeronautical licences, and radiodetermination licences which may be used for aircraft navigation, have been identified. DNV understands that potential impacts to these services have been considered as part of an aviation impact assessment [17].

4.5 Emergency services

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

4.5.1 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 12 along with their contact details. The nearest licence is associated with a tower located within the Project Area, 325 m from the nearest turbine, as discussed in Section 4.1.1.

The potential for the WTGs at the Project to interfere with emergency services mobile telephony licences within 2 km of the proposed WTG locations and point-to-point links crossing the Project Area is discussed in Sections 4.1 and 4.2 respectively.

Given the distance of other emergency services licences from the Project, DNV considers it unlikely that the Project will cause interference to the radiocommunications operated by those services.

4.5.2 Stakeholder consultation and responses

DNV has contacted the operators of all potentially affected stations within approximately 60 km of the Project to seek feedback regarding any potential impact that the Project could have on their operations and services.

The response received from NSW Telco Authority in relation to their mobile telephony services and point-to-point links are summarised in Sections 4.1.2 and 4.2.2. The responses received from the NSW Rural Fire Service and NSW National Parks and Wildlife Service in relation to their point-to-point links are also discussed in Section 4.2.2.

No concerns have been raised by NSW Ambulance, NSW Police Force, and St John Ambulance.

The NSW SES has advised that a detailed assessment impact will need to be conducted by their radio networks vendor in order to evaluate the potential for impacts to their operations and services, and has asked that the cost of this assessment be borne by the Proponent. DNV recommends that the Proponent engages with the NSW SES to facilitate their internal assessment.

4.5.3 Mitigation options

Potential mitigation options for impacts to emergency services mobile telephony services associated with towers located within 2 km of the proposed WTG locations and point-to-point links crossing the Project Area are discussed in Sections 4.1.3 and 4.2.3.

As noted above, interference with mobile telephony services associated with towers located more than 2 km from the proposed WTG locations 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.

4.6 Aircraft navigation systems and radar

DNV understands that a separate aviation impact assessment has been undertaken to assess the impact of the Project on nearby aviation navigation systems and radar [17].

4.7 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather radars across Australia consisting of high-resolution Doppler radars and standard weather watch or weather surveillance radars. Operation of the BoM's part-time wind finding radar installations ceased in August 2019 [18].

Standard weather watch radars emit pulsed microwave radiation and use reflections or "echoes" of that radiation from water particles in the atmosphere to detect rain and storm activity. Doppler radar installations operate in the same way but are also able to measure the speed of the moving water particles, and therefore can provide information about wind speed and direction [19, 20].

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

The optimal coverage area for a weather radar generally extends approximately 200 km from the radar installation at a height of around 3000 m [21, 22], and approximately 100 km at a height of 1000 m [22]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

The World Meteorological Organisation (WMO) currently states that WTGs should not be located within 5 km of a meteorological radar site, due to the high potential for complete or partial blockage of the radar signal and subsequent loss of weather data [23, 24]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of WTGs causing reflection or scattering of the radar signals or interfering with Doppler velocity measurements. At distances of between 20 km and 45 km, the presence of a wind farm may produce radar echoes or signal clutter that can cause loss of data or be mistaken for rain. Significant impacts are generally not expected for wind farms located more than 45 km from a meteorological radar, since in most cases the WTGs 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 BoM 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 Project should be consulted [3].

4.7.1 Locations of meteorological radars and potential for interference

DNV has identified that the BoM operates nine weather radars within 250 nautical miles of the Project, with the closest radar, "Namoi", located approximately 134 km west of the Project Area. The locations of these radars are shown in Figure 12 and the details of each radar are given in Table 13.

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

4.7.2 Stakeholder consultation and responses

DNV has contacted the BoM regarding the Project, as recommended by the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely. The response received from the BoM indicates that the potential impact of the Project on their meteorological radars will be manageable, and that they have no objections to the Project provided that the Proponent agrees to the following conditions in writing:

- the BoM is informed of any changes to the Project design, including changes to the turbine locations or height
- the owner or operator of the Project gives the BoM at least two weeks' notice of any planned shutdown of the Project, to allow the BoM to calibrate their systems while the turbines are not operating and hence account for the presence of the Project in their signal processing and interpretation
- the owner or operator of the Project collaborates with the BoM in the event of severe weather conditions in the interests of community safety.

4.7.3 Mitigation options

According to the WMO, there are currently no automated signal processing techniques available that can be used to effectively filter radar data to remove interference caused by wind farms [24], However, if analysis indicates there is a potential for the wind farm to cause reflection or scattering of radar signals, the WMO suggests it may be possible to reduce the potential impact through the relocation of individual WTGs prior to construction. In situations where the expected interference is limited to signal clutter, the radar operator may also be able to mask these effects in the data or train the users to take the locations of the wind farms into account.

Compliance with the conditions specified by the BoM and outlined in Section 4.7.2 may also help to mitigate any potential impacts to meteorological radar operations. DNV understands that the Proponent intends to agree to these conditions [16].

4.8 Trigonometrical stations

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

Some trig points may host surveying equipment such as Global Positioning System (GPS) antennas and electronic distance measuring (EDM) devices. EDM devices measure the distance from the trig point to the target object by means of a beam of known velocity which is reflected back to the unit

from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed.

The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 km to 5 km, and could be intercepted or obstructed by the presence of WTGs. However, the 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 [25].

Global navigation satellite system (GNSS) technology is also commonly used for surveying and distance measurements, as it enables users to accurately determine their geographic location using positioning and timing information received from satellite signals. Geoscience Australia currently operates several GNSS networks across Australia, including the Australian Regional GNSS Network (ARGN) and the AuScope GNSS network [26]. The ARGN is comprised of 20 permanent GNSS Continuously Operating Reference Stations (CORS) which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Eight stations from the ARGN form the Australian Fiducial Network (AFN) [27], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country, and several private and state-based GNSS CORS networks. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, or satellite communications.

4.8.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [28], there are 25 trig points within 20 km of the Project Area. Two trig points, Bald Knob and Moona, are located inside the Project Area approximately 211 m south and 432 m north of the nearest proposed WTG locations respectively. The details of these trig points are provided in Table 14 and their locations are illustrated in Figure 13.

DNV has reviewed the primary geodetic network of Australia [29] 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 21 km south of the Project, at Yarrowitch [30]. 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.

4.8.2 Stakeholder consultation and responses

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV has contacted Geoscience Australia and NSW Spatial Services to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

The responses received from Geoscience Australia and NSW Spatial Services indicate that they do not expect the Project to interfere with their systems. However, NSW Spatial Services has noted the proximity of the proposed WTG locations to four survey marks and associated witness marks,

including the trig points at Bald Knob (identified as TS6296 by NSW Spatial Services), Moona (identified as TS5650), and Blue Mountain (identified as TS6296). Therefore, NSW Spatial Services has advised that they have no objection to the Project provided that the following conditions are met:

- NSW Spatial Services is advised of any distance-related restrictions for working in proximity to a WTG that would prevent surveyors from accessing and using nearby survey marks and associated witness marks
- survey marks and associated witness marks are located and physically protected from disturbance during construction of the Project
- photographs of survey marks and associated witness marks are taken before and after construction of the Project and submitted to NSW Spatial Services
- the construction foreman is advised of the importance of protecting the survey marks and associated witness marks
- a new submission is lodged for assessment by NSW Spatial Services if there are any major variations to the Project proposal.

4.9 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.

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

4.9.2 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.

4.10 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 WTGs. However, mobile phone networks are designed to operate in such conditions and in most cases, if there is sufficient mobile network coverage and signal strength, the presence of WTGs is unlikely to cause any interference.

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is theoretically possible that WTGs could cause some interference to the signal. However, there is little evidence in the literature of WTGs 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.

4.10.1 Availability of mobile phone services and potential for interference

DNV has reviewed the locations of mobile phone towers in the vicinity of the Project. The locations of these towers are shown in Figure 14. The nearest mobile phone tower is located approximately 5 km south of the Project Area.

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

Figure 15 and Figure 16 show the Optus network coverage for the Project Area [31]. Outdoor 3G and 4G coverage is available to the south and southwest of the Project Area, around Walcha, and to the west and northwest around Woolbrook and Kentucky, although the coverage area for the 3G network is generally larger than for the 4G network. Some areas in the southern and western parts of the Project Area are able to receive Optus 3G signals, although an external antenna is required in most of these locations. 4G coverage within the Project Area is limited to the far southwest. There are also areas to the north of the Project Area around Enmore where 3G and 4G signals can be received with the use of an external antenna, but there is limited or no coverage available to the immediate north of the Project Area and in areas to the east and southeast.

Figure 17 and Figure 18 show the Telstra network coverage for the Project Area [32]. Telstra 3G and 4G coverage is available to the south and southwest of the Project Area, around Walcha, and to the north and northwest around Woolbrook and Kentucky, with isolated areas of coverage to the north, east, and southeast. Coverage within the Project Area is concentrated in the west, east, and southeast, with limited coverage through the centre of the Project Area, although the 3G network is available over a larger area than the 4G network.

Figure 19 shows the Vodafone network coverage for the Project Area [33]. Indoor and outdoor 4G coverage is available to the south and southwest of the Project Area, around Walcha, to the west and northwest around Woolbrook and Kentucky, and to the north around Enmore. Outdoor 3G coverage extends over a larger area to the south, west, and northwest. Vodafone coverage within the Project Area consists of outdoor 3G coverage in the west, east, and southeast, with smaller areas of outdoor 4G coverage within these regions. There is no coverage available through the centre of the Project Area and to the immediate north and east.

Field Solutions Group and Pivotel Mobile also hold public mobile telecommunications service licences in the vicinity of the Project, with the nearest licences located 35 km south of the Project and 57 km northwest of the Project respectively. As the areas currently serviced by Field Solutions Group and Pivotel Mobile are not known, it is not possible to determine whether there is any potential for interference to these services. However, it is considered unlikely that towers at these distances will be servicing customers in the vicinity of the Project Area.

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

4.10.2 Stakeholder consultation and responses

DNV has contacted Optus, Telstra, Vodafone, Field Solutions Group, and Pivotel Mobile to inform them of the Project and to seek feedback on any potential impact that the Project could have on their services.

Responses have been received from Optus, Vodafone, Field Solutions Group, and no concerns have been raised. No response has been received from Pivotel Mobile to date.

No response has been received from Telstra to date in relation to their mobile phone services. However, Telstra have advised that they currently operate underground telecommunications infrastructure within the Project Area that may be vulnerable during construction or operation of the Project, and have asked that the Proponent seek further information about the locations of this infrastructure and advise Telstra if any physical impacts are expected. Telstra have also advised that, in addition to and assessment of potential EMI impacts on their wireless radiocommunications, they also need to consider potential electrical impacts on their network infrastructure. DNV recommends that the Proponent engages with Telstra to facilitate an assessment of potential electrical impacts on their fixed network infrastructure.

4.10.3 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.

4.11 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).

4.11.1 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.

4.11.1.1 Availability of wireless broadband services and potential for interference

Residents in the vicinity of the Project may use wireless broadband services provided by Optus, Telstra, Vodafone, Field Solutions Group, and Pivotel Mobile. These wireless broadband services use the same networks as mobile phone services, and therefore the comments made in Section 4.10.1 are applicable here. Specifically, there is a low theoretical potential for interference in areas with marginal reception if a WTG intercepts the signal between a receiver and the tower.

4.11.1.2 Stakeholder consultation and responses

DNV has contacted Optus, Telstra, Vodafone, Field Solutions Group, and Pivotel Mobile as discussed in Section 4.10.2, to seek feedback on the potential for the Project to interfere with their services, and no concerns have been raised to date.

4.11.1.3 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 4.10.3 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.

4.11.2 National Broadband Network

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

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

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a maximum range of 14 km [34]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and WTGs [35].

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.

4.11.2.1 Availability of NBN services and potential for interference

The NBN website [36] indicates that the network is currently available as a satellite internet service using the NBN SkyMuster I and II satellites in the areas surrounding the Project, Fixed wireless internet services are available in areas around Armidale and Uralla to the north and northwest, although the coverage areas for this service do not cross the Project Area.

Figure 20 shows the NBN coverage for the Project Area. Given that the network is currently only available as a satellite internet service in the areas immediately surrounding the Project, it is unlikely that the Project will impact on residents who are currently using the NBN.

DNV understands that NBN Co is planning to extend the fixed wireless coverage range for some towers from 14 km to 29 km [37]. The nearest NBN fixed wireless internet tower is located approximately 25 km from the Project Area, at Uralla. If the coverage from this tower is extended and residents in the vicinity of the Project begin receiving fixed wireless internet signals prior to the construction of the Project, there may be potential for interference to the NBN fixed wireless service in the future. However, the assessment presented here is based on the current network availability, as shown in Figure 20, which suggests that interference to NBN fixed wireless internet services is unlikely.

The potential for interference to satellite internet signals from the NBN Sky Muster I and II satellites is considered in Section 4.12.

4.11.2.2 Stakeholder consultation and responses

DNV has contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps. The response received from NBN Co indicates that they do not expect the Project to interfere with their existing services.

DNV recommends that the Proponent engages further with NBN Co prior to the construction of the Project, to identify any changes to the NBN fixed wireless internet coverage areas in the vicinity of the Project and to confirm the potential for impacts to this service.

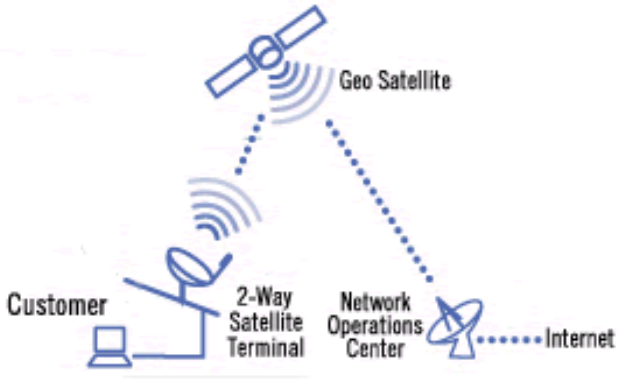
4.12 Satellite television and internet

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

Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. Satellite television signals are typically transmitted to the user's antenna in one of two frequency bands: the C-band between 4 GHz and 8 GHz, or the Ku-band between 12 GHz and 18 GHz. Signals in the C-band are susceptible to interference due to radio relay links, radar systems, and other devices operating at a similar frequency. Signals in the Ku-band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. The main satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [38, 39].

In the case of satellite internet, the user's computer is connected to a satellite modem which is in turn linked to a satellite dish or antenna mounted on the building roof. When the user accesses the internet, a request is sent to the operation centre of the satellite internet provider via the satellite

antenna. Data is then sent back to the user's computer via the same path as shown in the figure below. Satellite internet signals are typically transmitted in the Ku-band, as for satellite television, or the Ka-band, with frequencies ranging from 26.5 GHz to 40 GHz. Like signals in the Ku-band, signals in the Ka-band are susceptible to deterioration caused by moisture in the air, but newer satellites contain technologies that help to minimise the loss of signal quality associated with rain and other weather conditions. The main satellites for providing satellite internet in Australia are the IPSTAR (THAICOM-4) and Optus D2 satellites, and the NBN SkyMuster I and II satellites.



Two-way connection to the internet via satellite [40]

4.12.1 Locations of satellite vectors and potential for interference

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

A number of satellites transmit television and internet signals that can be received in Australia. Although only a small number of satellites are likely to be providing services specifically intended for Australian audiences, DNV has considered the line of sight to dwellings in the vicinity of the Project from all theoretically viewable satellites.

The results of the analysis are shown in Table 4. Based on these results, WTGs at the Project may intercept signals from 15 satellites at 23 nearby dwellings, 18 of which are stakeholder dwellings.

DNV understands that all the potentially affected satellites shown in Table 4 provide television signals intended for international audiences, and considers it unlikely that residents in the vicinity of the Project will currently be receiving signals from these satellites. Many of the satellites have a low angle of elevation above the horizon at the wind farm site location, and so degradation caused by atmospheric effects or interference from terrain or other obstacles may already prevent the signals from being received at the affected dwellings. For some of these satellites, the programs transmitted on the beam footprints that cover Australia may also be available through other satellite services which have a higher angle of elevation above the horizon and are not expected to be intercepted by WTGs at the Project. If residents are not currently receiving signals from the satellites identified in Table 4, either by choice or because those signals are not available due to existing degradation or interference, there will be no potential for the Project to impact on those services.

Table 4 Satellite vectors with potential to be intercepted by the Project

Intercepted satellite	Services provided [41]	Affected dwellings[1]
Intelsat 22 (IS-22)	Programs intended for international audiences	*SR086*, *SR120*, *SR259*
G-Sat 7 (Insat 4F, Rukmini), G-Sat 11, G-Sat 14, G-Sat18	Programs intended for international audiences	*SR002*, *SR061*, SR068, SR087, SR088, SR117, *SR119*, *SR160*, SR216, *SR259*
ABS 2 (ST 3, Koreasat 8, Condosat 2), ABS 2A (Mongolosat-1)	Programs intended for international audiences	*SR002*, SR087, *SR119*, *SR121*, *SR152*, *SR160*, *SR200*, *SR286*, *SR288*
Apstar 7	Programs intended for international audiences	SR006, SR087, *SR121*, *SR151*, *SR160*, *SR200*, *SR286*, *SR288*
Thaicom 6 (Africom 1), Thaicom 8	Programs intended for international audiences	*SR120*, *SR121*, *SR125*, *SR160*, *SR212*
Express 80	Programs intended for international audiences	*SR005*, *SR009*, *SR120*, *SR121*, *SR125*
G-Sat 10, G-Sat 5 (Insat 4E), G-Sat 12, G-Sat 30	Programs intended for international audiences	*SR009*

1. Involved dwellings are indicated by *underlined italic text*.

4.12.2 Stakeholder consultation

As discussed in Section 4.12.1, it is unlikely that nearby residents are currently receiving signals from satellites that may be affected by interference from WTGs at the Project. If desired by the Proponent, the potential for impact could be confirmed by engaging with the residents of the dwellings identified in Table 4 prior to construction of the Project to determine if any are currently receiving signals from the potentially affected satellites and to establish an understanding of how any impact to these services may be mitigated.

4.12.3 Mitigation options

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

4.13 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.

4.13.1 AM radio

AM radio signals are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also reflected or refracted by the ionosphere at night. This means that AM radio waves are able to travel significant distances under the right conditions. Due to their long wavelength, they can readily propagate around physical obstructions on the surface of the

earth (such as WTGs), however they do not propagate easily through some dense building materials such as brick, concrete, and aluminium.

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

However, as noted above, the presence of physical obstructions such as WTGs 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 WTG [42].

4.13.1.1 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 [43], and are shown in Figure 21.

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 WTGs.

4.13.1.2 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.

4.13.2 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 WTGs can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [44]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a WTG, where the signal-to-noise ratio is low [42, 45].

WTGs 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 WTG, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [44]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing WTG. However, this type of interference is

generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the WTGs are located within approximately 4 km of the transmitter [46].

4.13.2.1 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 [43], and are shown in Figure 21.

The closest FM broadcast transmitter is located approximately 3 km from the Project Area or 3.4 km from the nearest WTG (B039). Given the relatively small distance between the transmitter and the Project, it is possible that the FM radio signals from this tower could be impacted by the WTGs. The location of the transmitter in relation to the Project and the sector in which physical obstruction of the signal may occur is shown in Figure 22. Since the transmitter is located to the southeast of the proposed WTG locations, the potential interference sector extends to the northwest of the Project. However, DNV notes that previous advice received from the operator of this tower, BAI Communications, in relation to FM radio broadcasting has indicated that they do not expect wind farm developments to interfere with FM radio signals.

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 WTGs.

4.13.2.2 Stakeholder consultation and responses

DNV has contacted the operator of the nearby FM broadcast transmitter, BAI Communications, to inform them of the Project and to seek feedback on any potential impact that the Project could have on their services. The response received from BAI Communications indicates that they do not expect the Project to cause interference to FM radio signals from this transmitter.

4.13.2.3 Mitigation options

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

4.13.3 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 [47]. 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 [44] 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 WTG.

4.13.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [48], 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.

4.14 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 [49]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from WTGs. DNV has experience in situations where dwellings were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

The susceptibility of DTV signals to interference from WTGs is discussed further in Section A.1 of Appendix A.

4.14.1 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 [50], and are shown in Figure 21. The main DTV transmitter used by residents in the vicinity of the Project is the Armidale transmitter at Dumaresq. However, according to the Australian Government mySwitch website [51], it is also possible that residents in the vicinity of the Project are able to receive DTV signals from the Upper Namoi transmitter at Mount Dowe and the Walcha transmitter. Coverage maps for these broadcast transmitters are reproduced in Figure 23 to Figure 25.

DTV signal coverage form the Armidale transmitter is generally good to variable within the Project Area, and in areas to the north and northwest, with isolated areas of coverage available to the south and east of the Project Area. Coverage from the Upper Namoi transmitter is marginal in most areas around the Project, with only variable coverage available to the west and northwest and very limited coverage within the Project Area. Coverage from the Walcha transmitter is concentrated in the area around Walcha to the southwest of the Project, with good to variable coverage extending across the south and southwest of the Project Area.

4.14.1.1 Interference caused by large scale effects

For broadcast signals, large scale interference can generally be avoided by placing the WTGs 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 [11].

The closest DTV transmitter to the Project is the Walcha relay transmitter, which is approximately 6 km from the Project Area. Therefore, it is considered unlikely that the Project will cause large scale interference to signals from this transmitter.

4.14.1.2 Interference caused by reflection or scattering

Although DTV signals are generally unlikely to be susceptible to interference from WTGs in areas of adequate coverage, interference could be encountered in areas where coverage is marginal and

antennas at dwellings may receive a reflected signal from a WTG that is of sufficient power to interfere with the signal received directly from the transmitter. Based on the coverage maps for the area around the Project, it is possible that some areas could be deemed to have marginal reception and interference could be encountered.

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 WTG 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 15 and Figure 23 to Figure 25. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 5.

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 WTG locations, previous advice received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, has indicated that interference to DTV broadcasting may be experienced at distances of up to 10 km from WTGs. For comparison, Figure 23, Figure 24, and Figure 25 also show the area within 10 km of the proposed WTG locations, although a more detailed assessment would be required to determine whether there is any potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

Table 5 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
Armidale (Dumaresq)	55 (25 involved dwellings)	Good to variable within the Project Area, limited in areas to the south and east
Upper Namoi (Mount Dowe)	34 (25 involved dwellings)	Poor – dwellings in potential interference zone are unlikely to be receiving signals from this transmitter
Walcha	34 (25 involved dwellings)	Variable to poor – most dwellings in potential interference zone are unlikely to be receiving signals from this transmitter

Dwellings within the Project Area and to the south and east of the Project have increased potential to experience interference to DTV signals from the Armidale transmitter. Based on the coverage map and the local terrain, it is possible that some dwellings within the potential interference zones may not have a direct line of sight to the Armidale transmitter. These dwellings could potentially receive a forward-scattered signal from the WTGs at the Project that is stronger than the direct signal from the transmitter and therefore may be more likely to experience interference. Dwellings

within the Project Area and to the immediate north and to the east and southeast may also have increased potential to experience interference to DTV signals from the Upper Namoi transmitter, while the potential interference zone for the Walcha transmitter includes dwellings within the Project Area and to the north and east of the Project.

However, this assessment does not consider whether the dwellings in the potentially-affected areas are currently receiving signals from the corresponding transmitter. The coverage map reproduced in Figure 23 suggests that, due to terrain effects, some of the dwellings in the potential interference zone for the Armidale transmitter may not be able to receive signals from that transmitter. In addition, the coverage map reproduced in Figure 25 suggests that dwellings within the potential interference zone for the Armidale transmitter to the south of the Project may be able to receive a stronger alternative signal from the Walcha transmitter. Similarly, most of the dwellings within the potential interference zones for the Upper Namoi and Walcha transmitters are outside of the expected signal coverage areas shown in Figure 24 and Figure 25 and therefore are unlikely to be receiving signals from those transmitters. If desired by the Proponent, the availability of DTV signals in these areas could be confirmed by undertaking a pre-construction survey of the reception strength in the vicinity of the Project, to determine the average signal strength for each transmitter and whether the dwellings in the identified interference zones are likely to be receiving DTV signals from the corresponding transmitter.

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 4.14.3.

4.14.2 Stakeholder consultation and responses

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

BAI Communications has conducted an assessment of the potential for turbines at the Project to interfere with DTV signals from the Armidale (Little Duval Lower, Dumaresq), Walcha, Upper Namoi (Mt Dowe), and Uralla transmitters [52]. The method used by BAI Communications involved modelling the reflection or scattering of DTV signals from the wind turbines, and identifying locations within 10 km of the Project where the resulting C/I ratio for a directional antenna oriented towards the transmitter of interest would be less than required for adequate signal reception.

From the results of their modelling, BAI Communications have advised that they do not expect the Project to cause interference to DTV signals from any of the transmitters that provide coverage in the surrounding area.

4.14.3 Mitigation options

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

1. Realigning the user's television antenna more directly towards their existing transmitter.
2. Tuning the user's antenna into alternative sources of the same television signal or a substitute signal.
3. Installing a more directional or higher gain antenna at the affected dwelling.

4. Relocating the antenna to a less affected position.
5. Installing cable or satellite television at the affected dwelling.
6. Installing a television relay transmitter.

In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. However, the effectiveness of this mitigation may be reduced if there is no clear line of sight from the antenna to the transmitter. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue, however, as noted in [53], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [54] 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 [55].

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 119 WTG. DNV has considered a WTG geometry that will be conservative for WTG configurations with dimensions satisfying all of the following criteria: a rotor diameter of 162 m or less and an upper tip height of 230 m or less.

The results of this assessment, including feedback obtained from relevant stakeholders, are summarised in Table 6.

In its current configuration, there is a potential for the Project to interfere with several point-to-point links crossing the Project Area, and point-to-area style communications hosted by radiocommunication towers located within 2 km of the proposed WTG locations.

In the case of links operated by the NSW Telco Authority, DNV recommends relocating WTGs during the detailed design phase of the Project as proposed by the NSW Telco Authority. DNV understands that the Proponent intends to relocate WTGs as requested by the NSW Telco Authority as part of future detailed design work for the Project, if the concerns raised by the NSW Telco Authority cannot be resolved through further consultation or alternative mitigation measures.

Advice received by DNV from the NSW National Parks and Wildlife Service and Walcha Council, and previous advice received by the Proponent from the NSW Rural Fire Service, suggests that they do not expect the Project to cause material interference to their links. Consultation with Telstra is ongoing to confirm their required clearances and potential for impact to their point-to-point link crossing the Project Area.

The potential for interference with point-to-area style communications such as mobile radio systems and amateur and CB radio systems may also be minimised by moving WTGs further from the towers, if required. Alternative mitigation options would need to be identified in consultation with the relevant operators.

WTGs at the Project may also interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial DTV broadcasting, particularly in areas with poor or marginal signal coverage. However, all feedback received from the operators of these services has indicated that impacts are not expected. If interference to these services is experienced, a range of options are available to rectify difficulties.

Impacts to satellite television and internet signals that may be received at dwellings in the vicinity of the Project Area are considered unlikely. The proposed WTGs are not expected to interfere with any satellite television or internet services intended for Australian audiences. Interference is possible for signals from satellites that do not provide services designed for Australian audiences, however these are unlikely to be used by nearby residents.

Since it is not possible to determine the potential EMI impacts on point-to-multipoint links, emergency services, and meteorological radars without obtaining further information from the service operators, consultation with the operators has helped to determine the potential for the Project to cause interference to these services. All responses received to date indicate that the Project is unlikely to have any impact on these services.

Potential EMI impacts on other services considered in this assessment, including trigonometrical stations, are either considered to be minor or have been assessed through consultation with the service operators.

Table 6 Summary of EMI assessment results for the Project

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Radiocommunication towers	4 towers within 2 km of proposed WTG locations, hosting point-to-point links and point-to-area style communications operated by: Brian Smith Timber Transport Coffs Harbour and District Amateur Radio Club Goodcom Communications NSW Telco Authority NSW Rural Fire Service Telstra Walcha Council Walcha Radio Group Nearest tower: 325 m from WTGs	**Point-to-point links:** see impact for point-to-point links **Point-to-area style communications:** high likelihood of interference through reflection or scattering of signals	Potential for interference to point-to-point links raised by NSW Telco Authority (see feedback for point-to-point links) No concerns raised by Walcha Council Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely No response received from other operators	**Point-to-point links:** see recommendations for point-to-point links below **Point-to-area style communications:** Continue to engage with remaining operators to confirm potential for impact and mitigation options (if needed) If potential for interference exists and cannot be resolved through other means, relocate WTGs to be further from tower If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators
Fixed point-to-point links	11 links crossing Project Area, operated by: Bureau of Meteorology NSW Telco Authority NSW Rural Fire Service NSW National Parks and Wildlife Service Telstra Walcha Council **Diffraction effects:** 14 WTGs in exclusion zones established by DNV for links operated by NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, Walcha Council **Reflection/scattering effects:** 8 WTGs in interference zones established by DNV for links operated by NSW Telco Authority, NSW Rural Fire Service, Walcha Council **Near-field effects:** no WTGs in interference zones established by DNV	**Diffraction effects:** high likelihood of interference to links operated by NSW Telco Authority, NSW Rural Fire Service, NSW National Parks and Wildlife Service, Walcha Council **Reflection/scattering effects:** low likelihood of interference to links operated by NSW Telco Authority, NSW Rural Fire Service, Walcha Council	Potential for interference raised by NSW Telco Authority – relocation of 4 WTGs proposed No concerns raised by BoM, NSW National Parks and Wildlife Service, Walcha Council Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely No response received from Telstra	Continue to engage with NSW Telco Authority and Telstra to confirm potential for impact and mitigation options (if needed) **NSW Telco Authority links:** if concerns cannot be resolved through other means, relocate WTGs B154, B138, B139 as proposed **All links:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators

Table 6 Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Fixed point-to-multipoint links	64 assignments within 75 km of Project Area 3 base stations within 20 km of Project Area, operated by Walcha Council	Potential for interference if link paths cross the Project near WTGs	No concerns raised by BoM, Walcha Council No response received from other operators	Continue to engage with operators to confirm link paths and mitigation options (if needed) If link paths pass near WTGs and potential for interference cannot be resolved through other means, relocate WTGs to be outside interference zones If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators
Other licence types	**Point-to-area style communications:** see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting **Aeronautical and radiodetermination:** considered as part of a separate aviation impact assessment	-	-	-

Table 6 Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Emergency services	**Point-to-point links:** NSW Telco Authority, NSW Rural Fire Service, and NSW National Parks and Wildlife Service links crossing Project Area (see findings for point-to-point links) **Mobile telephony systems:** NSW Telco Authority towers within 2 km of WTGs	**Point-to-point links:** see impact for point-to-point links **Mobile telephony systems within 2 km of WTGs:** high likelihood of interference **Other services:** unlikely to cause interference	Potential for interference to point-to-point links raised by NSW Telco Authority (see feedback for point-to-point links) No concerns raised by NSW Ambulance, NSW National Parks and Wildlife Service, NSW Police Force, St John Ambulance Previous advice received by the Proponent from NSW Rural Fire Service suggests material interference is unlikely Need for internal impact assessment raised by NSW SES	**Point-to-point links:** see recommendations for point-to-point links above **Mobile telephony systems:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators **NSW SES:** engage with NSW SES to facilitate internal assessment of potential impacts
Meteorological radar	Nearest radar: "Namoi", 135 km from Project	Potential for interference if WTGs at the Project are visible to radars	Impacts are expected to be manageable	Notify the BoM prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the BoM in the event of severe weather conditions
Trigonometrical stations	25 stations within 20 km of Project Area Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by WTGs	Unlikely to cause interference	No concerns raised by Geoscience Australia No concerns raised by NSW Spatial Services, provided survey marks are protected from physical disturbance during construction	None
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None

Table 6 Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Mobile phones	Variable coverage across areas surrounding the Project Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	No concerns raised by Optus, Vodafone, Field Solutions Group No response received from other operators	**All services:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the relevant operators **Telstra:** engage with Telstra to facilitate assessment of potential impacts on fixed network infrastructure
Wireless internet	**Mobile broadband service providers:** mobile phone networks (Optus, Telstra, Vodafone), Field Solutions Group, Pivotel Mobile **NBN:** available as a satellite service only in areas surrounding the Project	**Mobile broadband services:** low likelihood of interference **NBN:** none	No concerns raised by Optus, Vodafone, Field Solutions Group, NBN Co No response received from other operators	**Mobile broadband services:** as for mobile phones **NBN:** engage further with NBN Co prior to construction of the Project, to identify any changes to the NBN fixed wireless internet coverage areas
Satellite television and internet	**Services intended for Australian audiences:** unlikely to be affected **Services intended for international audiences:** signals from 15 satellites intercepted at 23 dwellings	Low likelihood of interference	Consultation with operators not considered necessary	If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to WTGs **FM signals from nearby transmitter:** may experience interference in areas to northwest of Project with marginal reception **Digital radio signals:** Project is outside the intended coverage area	**AM and FM signals:** low likelihood of interference **Digital radio signals:** none	No concerns raised	**AM signals:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents **FM signals:** if interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents or relevant operators **Digital radio signals:** none

Table 6 Summary of EMI assessment results for the Project (continued)

Licence or service type	Assessment findings	Expected impact based on assessment findings	Stakeholder feedback (to date)	Recommendations
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception **Armidale (Dumaresq) transmitter:** good to variable coverage within Project Area and to north and northwest, limited coverage to south and east 55 dwellings (25 involved dwellings) in potential interference zone, but some dwellings may be able to receive a stronger alternative signal from Walcha transmitter	High likelihood of interference	No concerns raised	If interference is experienced after the Project is operational, apply appropriate mitigation in consultation with the affected residents or relevant operators
	Upper Namoi (Mount Dowe) transmitter: variable coverage to north and northwest of Project 34 dwellings (25 involved dwellings) in potential interference zone, but signal coverage is limited in that area	Low likelihood of interference – identified dwellings are unlikely to be receiving signals from this transmitter	No concerns raised	
	Walcha transmitter: good coverage around Walcha and across south and southwest of Project Area, poor or no coverage elsewhere 34 dwellings (25 involved dwellings) in potential interference zone, but signal coverage is limited in that area	Low likelihood of interference – most identified dwellings are unlikely to be receiving signals from this transmitter	No concerns raised	

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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 [44] 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 WTGs.

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

- the proximity of WTGs to the television broadcast transmitter
- the proximity of WTGs to receivers (dwellings)
- the location of WTGs 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

WTGs 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 WTG has the potential to scatter electromagnetic waves carrying DTV signals both forward and back.

Forward scatter can occur when the transmitter, one or more WTGs, 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 WTG, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [53]. Both of these effects can potentially degrade the DTV signal quality.

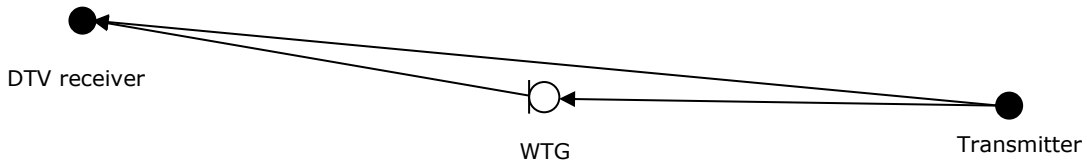

Figure A.1 Forward scatter signal path for DTV signals

Back scatter from WTGs occurs when DTV signals are reflected from WTG 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-WTG-receiver).

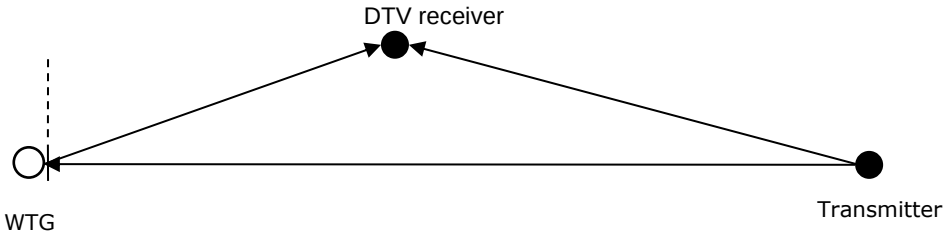

Figure A.2 Back scatter signal path for DTV signals

Interference to DTV signals from WTGs can potentially occur in both the forward and backward scatter region. The effect of a WTG on a DTV signal can be different depending on the scattering region where the receiver is located [53].

According to Ofcom [44], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [11, 56]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the WTGs [44]. 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 [11, 44], 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.

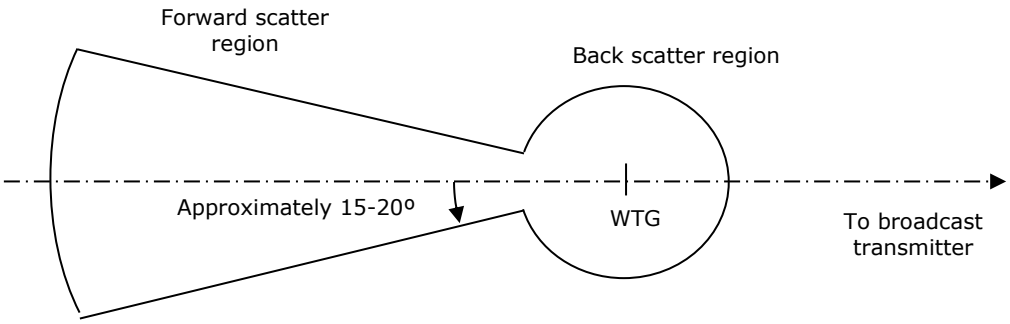

Figure A.3 Potential television interference zones around a WTG

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

In Australia, DTV signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [57] states the following in regards to the forward scatter region for DVB-T signals:

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

In other words, WTGs are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [54] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more WTGs, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [54].

With regards to back scattering, the ITU states:

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

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

A.3 Theoretical models for WTG scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [58]. 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 [57], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally, DNV notes that it only applies to a single WTG rather than a wind farm as a whole.

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 WTG location [44]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

Table 7 Proposed WTG layout for the Project [5]

WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
B001	375827	6590868	1084	B064	387659	6582641	1190
B002	375651	6590370	1128	B065	388014	6582185	1221
B003	375617	6589833	1162	B066	388231	6581632	1229
B004	375274	6589422	1176	B068	388995	6581503	1235
B005	374738	6589302	1184	B069	388828	6580913	1249
B006	374431	6588437	1290	B070	389164	6580512	1249
B007	374099	6588075	1304	B071	380088	6580146	1217
B011	368111	6585524	1251	B072	380923	6580570	1219
B012	368646	6585230	1244	B073	380193	6581345	1189
B013	369136	6584945	1241	B074	380607	6581056	1209
B014	369258	6584380	1221	B076	380783	6582283	1166
B015	369652	6583822	1214	B078	381487	6581777	1213
B016	369731	6583320	1260	B079	381813	6581380	1252
B018	370122	6582739	1205	B081	382629	6580414	1203
B019	370091	6582072	1168	B082	382730	6579837	1211
B020	369780	6581507	1173	B083	381990	6582600	1123
B021	369711	6580983	1186	B086	384506	6582081	1192
B023	365589	6583240	1138	B087	384242	6581491	1221
B024	365940	6582728	1165	B088	383961	6581029	1228
B025	366254	6582232	1178	B092	384963	6580577	1282
B026	366404	6581689	1192	B093	385211	6579851	1282
B027	366642	6580824	1217	B100	384127	6578294	1243
B028	367017	6580393	1208	B101	383820	6577801	1227
B029	367163	6579705	1220	B102	383688	6577340	1212
B030	367362	6579161	1211	B105	386071	6579830	1255
B032	367272	6578379	1176	B107	386684	6579593	1246
B033	367522	6577619	1170	B108	386692	6578780	1235
B034	367600	6577110	1183	B109	386401	6578339	1243
B036	368798	6578039	1235	B110	387581	6577820	1244
B037	368676	6577560	1245	B111	386331	6577758	1254
B038	369072	6577272	1240	B112	386376	6577010	1261
B039	369052	6576780	1240	B113	386307	6576513	1249
B044	369591	6578928	1171	B115	386940	6575796	1232
B045	369427	6579886	1190	B116	387271	6574896	1241
B046	378439	6584090	1169	B118	386619	6573826	1251
B047	378879	6583792	1159	B119	386565	6573251	1264
B048	378893	6583004	1136	B120	386874	6572841	1255
B051	380340	6585757	1139	B121	386482	6572439	1245
B052	380239	6585139	1126	B122	388916	6572120	1288
B053	380323	6584603	1156	B123	389233	6571682	1290
B054	379854	6584418	1155	B124	387721	6571855	1266
B056	387034	6586729	1139	B127	391239	6570524	1302
B057	386532	6586240	1188	B128	390759	6570150	1308
B060	386060	6586006	1149	B129	390555	6569656	1295
B061	385967	6585506	1115	B130	391119	6569365	1330
B062	385648	6584920	1090	B131	391131	6568969	1313
B063	387182	6583062	1156	B132	391058	6568460	1265

Table 7 Proposed WTG layout for the Project [5] (continued)

WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
B138	386215	6568122	1275	B160	370523	6584163	1162
B139	386652	6567835	1252	B161	370453	6583407	1211
B140	386441	6567134	1229	B168	381631	6579450	1184
B141	386425	6566676	1207	B167	369124	6581616	1175
B142	386478	6566207	1191	B169	381630	6578922	1181
B144	387967	6566690	1228	B170	381577	6578012	1151
B145	388260	6565946	1205	B171	381841	6577594	1184
B146	389117	6566221	1217	B172	369146	6580329	1200
B149	391316	6567313	1261	B173	379244	6588701	1145
B151	393062	6566093	1311	B174	379265	6588196	1135
B152	393593	6565826	1320	B175	379313	6587678	1135
B153	393479	6565305	1301	B176	375066	6588638	1222
B154	394105	6565125	1314				

1. Coordinate system: MGA zone 56, 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 Dwellings in the vicinity of the Project [6]

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest WTG [km]
SR002	*375959*	*6579209*	*Involved*	*4.2*
SR003	*371504*	*6574602*	*Involved*	*3.3*
SR004	385929	6588126	Non-involved	1.8
SR005	*391269*	*6565826*	*Involved*	*1.5*
SR006	394987	6571349	Non-involved	3.8
SR007	385382	6587897	Non-involved	2.0
SR009	*380923*	*6588366*	*Involved*	*1.7*
SR010	*371916*	*6574209*	*Involved*	*3.8*
SR011	367342	6571758	Non-involved	5.3
SR012	*388366*	*6568246*	*Involved*	*1.6*
SR017	372277	6572542	Non-involved	5.3
SR031	*375398*	*6585552*	*Involved*	*2.8*
SR034	362460	6576713	Non-involved	5.1
SR037	368103	6573364	Non-involved	3.5
SR038	*396327*	*6563009*	*Involved*	*3.1*
SR043	*378160*	*6580858*	*Involved*	*2.1*
SR044	*371875*	*6573511*	*Involved*	*4.3*
SR050	364294	6574551	Non-involved	4.2
SR051	*381359*	*6570806*	*Involved*	*5.4*
SR055	364584	6573394	Non-involved	4.8
SR057	364336	6573063	Non-involved	5.2
SR058	*377527*	*6579893*	*Involved*	*2.6*
SR060	387285	6588997	Non-involved	2.3
SR061	*387048*	*6584466*	*Involved*	*1.4*
SR062	*369733*	*6590030*	*Involved*	*4.8*
SR063	391784	6562332	Non-involved	3.4
SR065	*386835*	*6577879*	*Involved*	*0.5*
SR068	376546	6576208	Non-involved	5.3
SR075	384236	6563459	Non-involved	3.5
SR078	*387492*	*6569749*	*Involved*	*2.1*
SR083	382159	6562801	Non-involved	5.5
SR084	382329	6565743	Non-involved	4.2
SR086	*385205*	*6575756*	*Involved*	*1.3*
SR087	374027	6579791	Non-involved	4.5
SR088	373385	6579947	Non-involved	3.8
SR092	365669	6574165	Non-involved	3.5
SR093	365275	6574097	Non-involved	3.8
SR095	362766	6576176	Non-involved	4.9
SR100	*377860*	*6586658*	*Involved*	*1.8*
SR102	372060	6593523	Non-involved	4.6
SR103	*388250*	*6583682*	*Involved*	*1.2*
SR105	386330	6588153	Non-involved	1.6
SR107	386974	6588461	Non-involved	1.7
SR108	379024	6592585	Non-involved	3.6
SR109	387413	6587897	Non-involved	1.2
SR116	*364614*	*6574869*	*Involved*	*3.7*
SR117	395162	6572402	Non-involved	4.3
SR119	*383200*	*6579348*	*Involved*	*0.7*
SR120	*386425*	*6580639*	*Involved*	*0.9*
SR121	*386274*	*6581817*	*Involved*	*1.5*
SR123	395024	6562160	Non-involved	3.1

Table 8 Dwellings in the vicinity of the Project [6] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest WTG [km]
SR125	*390519*	*6582179*	*Involved*	*1.7*
SR129	394221	6568377	Non-involved	2.6
SR131	371571	6594231	Non-involved	5.4
SR136	*377641*	*6587039*	*Involved*	*1.8*
SR138	364202	6573828	Non-involved	4.7
SR141	364389	6585954	Non-involved	3.0
SR142	*363665*	*6585585*	*Involved*	*3.0*
SR143	*363512*	*6585384*	*Involved*	*3.0*
SR144	*363401*	*6585558*	*Involved*	*3.2*
SR145	363939	6585930	Non-involved	3.2
SR151	*384996*	*6583992*	*Involved*	*1.1*
SR152	*385157*	*6583792*	*Involved*	*1.2*
SR159	*364337*	*6585129*	*Involved*	*2.3*
SR160	*388814*	*6567825*	*Involved*	*1.4*
SR167	*386778*	*6570665*	*Involved*	*1.5*
SR168	*374958*	*6586279*	*Involved*	*2.0*
SR170	*389047*	*6583131*	*Involved*	*1.4*
SR171	*383868*	*6570065*	*Involved*	*3.0*
SR174	368473	6571731	Non-involved	5.1
SR175	364842	6572306	Non-involved	5.5
SR176	366063	6572278	Non-involved	5.1
SR179	366158	6572260	Non-involved	5.1
SR180	366220	6572240	Non-involved	5.1
SR181	366292	6572195	Non-involved	5.1
SR182	366343	6572191	Non-involved	5.1
SR183	366341	6572175	Non-involved	5.1
SR184	366337	6572151	Non-involved	5.1
SR185	366718	6572078	Non-involved	5.1
SR186	365400	6572581	Non-involved	5.0
SR187	366834	6572075	Non-involved	5.1
SR188	367074	6572183	Non-involved	5.0
SR189	*367060*	*6572009*	*Involved*	*5.1*
SR190	367218	6572088	Non-involved	5.0
SR191	367522	6572091	Non-involved	4.9
SR192	365425	6572548	Non-involved	5.1
SR193	365440	6572540	Non-involved	5.1
SR194	365517	6572412	Non-involved	5.1
SR195	365804	6572309	Non-involved	5.1
SR196	365885	6572295	Non-involved	5.1
SR197	365832	6572294	Non-involved	5.1
SR198	365882	6572264	Non-involved	5.1
SR200	*383771*	*6584162*	*Involved*	*2.0*
SR201	371307	6573062	Non-involved	4.3
SR202	*387223*	*6568891*	*Involved*	*1.2*
SR204	361839	6577359	Non-involved	5.5
SR206	367628	6573167	Non-involved	3.9
SR207	365941	6575274	Non-involved	2.5
SR208	365154	6573265	Non-involved	4.6
SR212	*377321*	*6587671*	*Involved*	*2.0*
SR216	390137	6583586	Non-involved	2.4
SR219	380893	6568618	Non-involved	5.3
SR224	*384679*	*6569658*	*Involved*	*2.2*

Table 8 Dwellings in the vicinity of the Project [6] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest WTG [km]
SR227	*385460*	*6569552*	*Involved*	*1.6*
SR228	*388270*	*6573420*	*Involved*	*1.5*
SR240	385447	6574786	Non-involved	1.5
SR242	371487	6572902	Non-involved	4.6
SR243	370164	6572155	Non-involved	4.8
SR244	370443	6572247	Non-involved	4.7
SR245	370488	6572232	Non-involved	4.8
SR246	370516	6572261	Non-involved	4.8
SR247	370551	6572317	Non-involved	4.7
SR248	370606	6572304	Non-involved	4.7
SR249	370646	6572346	Non-involved	4.7
SR250	370744	6572509	Non-involved	4.6
SR251	370782	6572519	Non-involved	4.6
SR253	*392084*	*6564851*	*Involved*	*1.5*
SR259	*385251*	*6579064*	*Involved*	*0.8*
SR260	370936	6591535	Non-involved	4.4
SR261	*372931*	*6586956*	*Involved*	*1.6*
SR262	365240	6577539	Non-involved	2.2
SR264	391259	6564166	Non-involved	2.5
SR267	*389226*	*6568250*	*Involved*	*1.8*
SR268	393159	6563576	Non-involved	1.8
SR272	391556	6565190	Non-involved	1.8
SR274	379445	6591286	Non-involved	2.6
SR277	365938	6574439	Non-involved	3.1
SR282	383109	6589801	Non-involved	4.0
SR286	*390138*	*6567387*	*Involved*	*1.2*
SR288	*384455*	*6587591*	*Involved*	*2.3*
SR289	384624	6589109	Non-involved	3.4
SR293	*367331*	*6587711*	*Involved*	*2.3*
SR295	373999	6594493	Non-involved	4.1
SR296	373393	6594860	Non-involved	4.7
SR298	369766	6574701	Non-involved	2.2
SR299	*362913*	*6581916*	*Involved*	*3.0*
SR300	386776	6588517	Non-involved	1.8
SR301	387117	6589217	Non-involved	2.5
SR302	367550	6572384	Non-involved	4.6
SR303	383325	6561989	Non-involved	5.3
SR304	389044	6589217	Non-involved	3.2
SR305	365757	6572149	Non-involved	5.3
SR306	365794	6572193	Non-involved	5.2
SR307	365726	6572183	Non-involved	5.3
SR308	365782	6572207	Non-involved	5.2
SR309	365774	6572227	Non-involved	5.2
SR310	365718	6572201	Non-involved	5.3
SR311	365758	6572244	Non-involved	5.2
SR312	365707	6572215	Non-involved	5.2
SR313	365747	6572259	Non-involved	5.2
SR314	365680	6572253	Non-involved	5.2
SR315	365729	6572290	Non-involved	5.2
SR316	365817	6572177	Non-involved	5.2
SR317	365871	6572171	Non-involved	5.2
SR318	365818	6572218	Non-involved	5.2

Table 8 Dwellings in the vicinity of the Project [6] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest WTG [km]
SR319	365875	6572196	Non-involved	5.2
SR320	365809	6572256	Non-involved	5.2
SR321	365826	6572270	Non-involved	5.2
SR322	365881	6572237	Non-involved	5.2
SR323	365868	6572131	Non-involved	5.3
SR324	365883	6572126	Non-involved	5.3
SR325	365905	6572123	Non-involved	5.3
SR326	365926	6572118	Non-involved	5.3
SR327	366108	6572149	Non-involved	5.2
SR328	366166	6572115	Non-involved	5.2
SR329	366162	6571980	Non-involved	5.3
SR330	366212	6572017	Non-involved	5.3
SR331	366392	6571990	Non-involved	5.3
SR332	366443	6571982	Non-involved	5.3
SR333	366471	6571980	Non-involved	5.3
SR334	366307	6571953	Non-involved	5.3
SR335	366362	6571941	Non-involved	5.3
SR336	366316	6572007	Non-involved	5.3
SR337	366326	6572063	Non-involved	5.2
SR338	366437	6571928	Non-involved	5.3
SR339	366482	6571909	Non-involved	5.3
SR340	366549	6571969	Non-involved	5.2
SR341	366535	6571946	Non-involved	5.3
SR342	366536	6571924	Non-involved	5.3
SR343	366534	6571903	Non-involved	5.3
SR344	366529	6571888	Non-involved	5.3
SR345	366616	6571886	Non-involved	5.3
SR346	366610	6571852	Non-involved	5.4
SR347	366673	6571840	Non-involved	5.4
SR348	366811	6571939	Non-involved	5.2
SR349	364146	6573758	Non-involved	4.8
SR350	390966	6584536	Non-involved	3.6
SR351	370581	6572351	Non-involved	4.7
SR352	370638	6572408	Non-involved	4.7
SR353	*369353*	*6589632*	*Involved*	*4.3*
SR354	370591	6572301	Non-involved	4.7
SR355	370599	6572303	Non-involved	4.7
SR356	370613	6572305	Non-involved	4.7
SR357	370621	6572306	Non-involved	4.7
SR358	370629	6572307	Non-involved	4.7
SR359	363586	6576717	Non-involved	4.0

1. Involved dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 56, 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 9 Details of point-to-point links crossing the Project

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
1	433953/1	1305719	151500000	Bureau of Meteorology GPO Box 1289 MELBOURNE VIC 3001
		1305720	151500000	
2	10330342/1	3076773	413750000	New South Wales Government Telecommunications Authority Telco Authority Level 14, McKell Building 2-24 Rawson Place SYDNEY NSW 2000
		3076774	413750000	
		3076775	404300000	
		3076776	404300000	
3	10956325/2	7380548	6197240000	
		7380549	6197240000	
		7380550	5945200000	
		7380551	5945200000	
4	11185845/1	7537026	6256540000	
		7537027	6256540000	
		7537028	6004500000	
		7537029	6004500000	
5	1230580/1	778325	414225000	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142
		778326	414225000	
		778327	404775000	
		778328	404775000	
6	1924689/1	895824	414225000	
		895825	414225000	
		895826	404775000	
		895827	404775000	
7	1960371/1	949435	7718500000	
		949436	7718500000	
		949437	7557500000	
		949438	7557500000	
8	1960373/1	949443	7676500000	
		949444	7676500000	
		949445	7515500000	
		949446	7515500000	
		949447	7676500000	
		949448	7676500000	
		949449	7515500000	
		949450	7515500000	
9	1922976/1	892637	461000000	Office of Environment and Heritage Asset Management Unit level 3 4 PSQ 12 Darcy Street PARRAMATTA NSW 2150
		892638	461000000	
		892639	451500000	
		892640	451500000	
10	62590/1	686720	155325000	Telstra Corporation Limited Radio Engineering Attn Nik Patel Locked Bag 3501 BRISBANE QLD 4001
		686721	155325000	
		686722	150125000	
		686723	150125000	

Table 9 Details of point-to-point links crossing the Project (continued)

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
11	1941585/1	919335	460550000	Walcha Council (ATTN The General Manager) PO Box 2 WALCHA NSW 2354
		919336	460550000	
		919337	451050000	
		919338	451050000	

Table 10 Details of point-to-multipoint licences within 75 km of the Project

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
4265909	250615	10535071/1	-30.544	151.652	29	Armidale Regional Council PO Box 75a ARMIDALE NSW 2350
4265906	250615	10535071/1	-30.544	151.652	29	
808769	404075	1428027/1	-30.544	151.648	29	
808772	404075	1428027/1	-30.544	151.648	29	
1474429	6681	9968818/1	-30.377	151.601	48	
1474432	6681	9968818/1	-30.377	151.601	48	
808761	6647	1428026/1	-30.290	151.743	57	
808764	6647	1428026/1	-30.290	151.743	57	
4265905	250454	10535070/1	-30.217	151.683	65	
4265902	250454	10535070/1	-30.217	151.683	65	
6580303	6647	10924208/1	-30.290	151.743	57	
6580306	6647	10924208/1	-30.290	151.743	57	
2503564	250454	10099499/2	-30.217	151.683	65	
2503563	250454	10099499/2	-30.217	151.683	65	
1305712	7602	433952/1	-30.819	152.202	35	Bureau of Meteorology GPO Box 1289 MELBOURNE VIC 3001
1305709	7602	433952/1	-30.819	152.202	35	
1306022	405163	1145105/1	-31.147	151.231	43	
1306025	405163	1145105/1	-31.147	151.231	43	
2389885	10003453	10179492/1	-31.595	151.827	61	
2389882	10003453	10179492/1	-31.595	151.827	61	
2389886	10003452	10179493/1	-31.462	152.325	62	
2389889	10003452	10179493/1	-31.462	152.325	62	
1305721	7980	433954/1	-31.042	152.573	65	
1305724	7980	433954/1	-31.042	152.573	65	
1306254	6679	1229579/1	-30.482	152.398	67	
1306257	6679	1229579/1	-30.482	152.398	67	
1305705	6679	433950/1	-30.482	152.398	67	
1305708	6679	433950/1	-30.482	152.398	67	
2389894	10003450	10179495/1	-31.445	152.477	71	
2389897	10003450	10179495/1	-31.445	152.477	71	
836146	6481	1569197/1	-31.076	150.959	63	Essential Energy Attn: Ray Northcott PO Box 5730 PORT MACQUARIE BC NSW 2444
836143	6481	1569197/1	-31.076	150.959	63	
1749115	34767	10067310/1	-31.327	151.656	35	Goodcom Communications Pty Ltd PO Box 190 WALCHA NSW 2354
1749180	34767	10067314/1	-31.327	151.656	35	
1749177	34767	10067314/1	-31.327	151.656	35	
1749114	34767	10067310/1	-31.327	151.656	35	

Table 10 Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
872297	48655	1909717/1	-31.352	151.374	51	Tamworth Regional Council Water & Waste - Attn Tim Hurcum PO Box 555 TAMWORTH NSW 2340
872294	48655	1909717/1	-31.352	151.374	51	
1178730	142447	1990912/1	-31.040	151.059	53	
1178733	142447	1990912/1	-31.040	151.059	53	
746323	6426	1145594/1	-31.126	150.939	67	
746327	6426	1145594/1	-31.126	150.939	67	
9145251	6501	11640565/1	-31.117	150.910	69	
9145248	6501	11640565/1	-31.117	150.910	69	
753393	6501	1182386/1	-31.117	150.910	69	
746307	6501	1145592/1	-31.117	150.910	69	
753408	6501	1182387/1	-31.117	150.910	69	
746310	6501	1145592/1	-31.117	150.910	69	
753409	6501	1182388/1	-31.117	150.910	69	
753414	6501	1182388/1	-31.117	150.910	69	
753405	6501	1182387/1	-31.117	150.910	69	
753396	6501	1182386/1	-31.117	150.910	69	
919286	41044	1941580/1	-30.965	151.631	3	Walcha Council (ATTN The General Manager) PO Box 2 WALCHA NSW 2354
919283	41044	1941580/1	-30.965	151.631	3	
2375095	402425	10174592/1	-30.989	151.588	6	
2375092	402425	10174592/1	-30.989	151.588	6	
919294	9013090	1941581/1	-31.052	151.512	16	
919291	9013090	1941581/1	-31.052	151.512	16	
2807269	35571	1109814/2	-30.946	151.145	43	WATER NSW Attn: P Dudley PO Box 398 Parramatta NSW 2124
2807268	35571	1109814/2	-30.946	151.145	43	
2807260	52910	1109812/2	-31.351	151.153	63	
2807261	52910	1109812/2	-31.351	151.153	63	
2807265	6481	1109813/2	-31.076	150.959	63	
2807264	6481	1109813/2	-31.076	150.959	63	

Table 11 Details of other licences identified within 75 km of the Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	419
2 GHz Band	Spectrum	438
2.3 GHz Band	Spectrum	5711
2.5 GHz Band	Spectrum	181
3.4 GHz Band	Spectrum	1048
700 MHz Band	Spectrum	548
800 MHz Band	Spectrum	465
Aeronautical Assigned System	Aeronautical	42
Amateur Repeater	Amateur	24
Ambulatory System	Land Mobile	52
AWL - FSS Only	Spectrum	83
CBRS Repeater	Land Mobile	22
Commercial Radio	Broadcasting	4
Commercial Television	Broadcasting	6
Community Broadcasting	Broadcasting	3
Earth Receive	Earth Receive	21
Fixed Earth	Earth	18
Fixed Receive	Fixed Receive	2
Land Mobile System - > 30MHz	Land Mobile	749
Land Mobile System 0-30MHz	Land Mobile	24
Narrowband Area Service station(s)	Broadcasting	3
Narrowcasting Service (Fixed Tax)	Broadcasting	4
Narrowcasting Service (LPON)	Broadcasting	13
National Broadcasting	Broadcasting	12
Paging System - Exterior	Land Mobile	27
Paging System - Interior	Land Mobile	3
PMTS Class B	PTS	216
PMTS Class B (935-960 MHz)	PTS 900 MHz	108
Radiodetermination	Radiodetermination	16
Retransmission	Broadcasting	11

Table 12 Emergency services with radiocommunication assets in the vicinity of the Project

Emergency service	Contact details	Distance from closest site to Project Area [km]
Ambulance Service of NSW (NSW Ambulance)	Ambulance Service of NSW Service Manager Telecommunications Matt Wheat Locked Bag 105 ROZELLE NSW 2039	3
Guyra Volunteer Rescue Association	Guyra Volunteer Rescue Association PO Box 146 GUYRA NSW 2365	45
Hunter Region Slsa Helicopter Rescue Service	Hunter Region Slsa Helicopter Rescue Service Attn: Facilities Manager PO Box 230 NEW LAMBTON NSW 2305	74
New South Wales Government Telecommunications Authority	New South Wales Government Telecommunications Authority Telco Authority Level 18, McKell Building 2-24 Rawson Place SYDNEY NSW 2000	Within Project Area
NSW Police Force	NSW Police Force Radio Engineering Services Level 4, 151-241 Goulburn Street Sydney Police Centre SURRY HILLS NSW 2010	3
NSW Rural Fire Service	NSW Rural Fire Service. Locked Mail Bag 17 GRANVILLE NSW 2142	Within Project Area
Office of Environment and Heritage (NSW National Parks and Wildlife Service)	Office of Environment and Heritage Asset Management Unit Level 3 4 PSQ 12 Darcy Street PARRAMATTA NSW 2150	26
St John Ambulance Australia (N.S.W.) (St John Ambulance)	St John Ambulance Australia (N.S.W.) 9 Deane Street BURWOOD NSW 2134	32
State Emergency Service (NSW) (NSW SES)	State Emergency Service (NSW) New South Wales State Emergency Service PO Box 6126 WOLLONGONG NSW 2500	5
VRA Rescue NSW Limited	VRA Rescue NSW Limited VRA ICT Committee PO Box 6151 DURAL DC NSW 2158	29
Willawarrin and Temagog Volunteer Bush Fire Brigade	Willawarrin and Temagog Volunteer Bush Fire Brigade 1493 Armidale Road TEMAGOG NSW 2440	72

Table 13 BoM radar sites in the vicinity of the Project

BoM radar site	Radar type	Latitude[1]	Longitude[1]	Distance to Project [km]
Namoi (Blackjack Mountain)	Doppler	150.192	-31.024	134
Grafton	Standard weather watch	152.951	-29.622	173
Newcastle	Doppler	152.025	-32.730	187
Moree	Standard weather watch	149.850	-29.500	226
Sydney (Terrey Hills)	Doppler	151.209	-33.701	301
Sydney (Kurnell)	Doppler	151.226	-34.015	335
Brisbane (Marburg)	Standard weather watch	152.539	-27.608	364
Wollongong (Appin)	Doppler	150.875	-34.263	369
Brisbane (Mt Stapylton)	Doppler	153.240	-27.718	372

1. Coordinate system: Lat/Lon GDA94 datum.

Table 14 Trigonometrical stations in the vicinity of the Project

Station name	Datum	Latitude[1]	Longitude[1]	Distance to Project [km]
Bald Knob	AGD66, AGD84, GDA94	151.637	-30.873	Within Project Area
Basalt	AGD66, AGD84, GDA94	152.015	-31.169	18
Baynes	AGD66, AGD84, GDA94	151.881	-30.895	4
Big Hill	AGD66, AGD84, GDA94	151.785	-31.014	2
Blue Mtn	AGD66, AGD84, GDA94	151.689	-30.833	0.2
Blue Nobby	AGD66, AGD84, GDA94	151.861	-30.702	16
Boree	AGD66, AGD84, GDA94	151.513	-30.955	9
Brackendale	AGD66, AGD84, GDA94	151.693	-31.170	18
CP 9235-0300	AGD84, GDA94	151.720	-31.168	17
Enmore	AGD66, AGD84, GDA94	151.763	-30.731	10
Europambela	AGD66, AGD84, GDA94	151.690	-30.974	6
Ferndale	AGD66, AGD84, GDA94	151.620	-31.123	20
Front	AGD66, AGD84, GDA94	152.045	-30.952	17
Hannah	AGD66, AGD84, GDA94	151.651	-30.667	16
Harnham	AGD66, AGD84, GDA94	151.485	-30.733	17
Harnham Hill	AGD66, AGD84, GDA94	151.485	-30.733	17
Moona	AGD66, AGD84, GDA94	151.890	-31.039	Within Project Area
Oak Hill	AGD66, AGD84, GDA94	151.550	-31.019	11
Ohio Peak	AGD66, AGD84, GDA94	151.517	-30.887	7
Paradise	AGD66, AGD84, GDA94	152.029	-31.013	13
Stony Creek	AGD66, AGD84, GDA94	151.750	-31.073	7
Trinidad	AGD66, AGD84, GDA94	151.903	-31.161	13
Walcha	AGD66, AGD84, GDA94	151.629	-31.016	9
Walcha Road	AGD66, AGD84, GDA94	151.395	-30.945	19
Winterbourne	AGD66, AGD84, GDA94	151.812	-30.826	2

1. Coordinate system: Lat/Lon GDA94 datum.

Table 15 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		
			Armidale	Upper Namoi	Walcha
SR003	371504	6574602		X	
SR005	391269	6565826	X	X	X
SR006	394987	6571349			X
SR009	380923	6588366		X	X
SR010	371916	6574209		X	
SR012	388366	6568246	X		X
SR031	375398	6585552	X		
SR037	368103	6573364	X		
SR038	396327	6563009		X	
SR043	378160	6580858	X		
SR061	387048	6584466	X	X	X
SR062	369733	6590030			X
SR063	391784	6562332	X		
SR065	386835	6577879	X	X	X
SR078	387492	6569749	X		
SR086	385205	6575756	X	X	
SR087	374027	6579791		X	
SR088	373385	6579947		X	
SR100	377860	6586658	X	X	
SR103	388250	6583682	X	X	X
SR109	387413	6587897			X
SR119	383200	6579348	X	X	X
SR120	386425	6580639	X	X	X
SR121	386274	6581817	X	X	X
SR123	395024	6562160	X		
SR125	390519	6582179		X	X
SR129	394221	6568377		X	X
SR136	377641	6587039	X	X	
SR151	384996	6583992		X	X
SR152	385157	6583792		X	X
SR160	388814	6567825	X	X	X
SR167	386778	6570665	X		
SR168	374958	6586279	X		
SR170	389047	6583131	X	X	X
SR188	367074	6572183	X		
SR200	383771	6584162		X	X
SR202	387223	6568891	X		
SR206	367628	6573167	X		
SR207	365941	6575274	X		
SR212	377321	6587671	X	X	
SR216	390137	6583586		X	X
SR228	388270	6573420	X	X	X
SR240	385447	6574786	X	X	
SR243	370164	6572155	X		
SR244	370443	6572247	X		
SR245	370488	6572232	X		
SR246	370516	6572261	X		
SR247	370551	6572317	X		
SR248	370606	6572304	X		
SR249	370646	6572346	X		

Table 15 Dwellings with increased potential to experience EMI to DTV from television broadcast transmitters (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone		
			Armidale	Upper Namoi	Walcha
SR250	370744	6572509	X		
SR251	370782	6572519	X		
SR253	*392084*	*6564851*	*X*	*X*	*X*
SR259	*385251*	*6579064*	*X*	*X*	*X*
SR261	*372931*	*6586956*			*X*
SR262	365240	6577539	X		
SR264	391259	6564166	X	X	X
SR267	*389226*	*6568250*	*X*		*X*
SR268	393159	6563576	X	X	
SR272	391556	6565190	X	X	X
SR277	365938	6574439	X		
SR282	383109	6589801			X
SR286	*390138*	*6567387*	*X*	*X*	*X*
SR288	*384455*	*6587591*			*X*
SR293	*367331*	*6587711*			*X*
SR298	369766	6574701	X		
SR302	367550	6572384	X		
SR304	389044	6589217			X
SR350	390966	6584536		X	X
SR351	370581	6572351	X		
SR352	370638	6572408	X		
SR353	*369353*	*6589632*			*X*
SR354	370591	6572301	X		
SR355	370599	6572303	X		
SR356	370613	6572305	X		
SR357	370621	6572306	X		
SR358	370629	6572307	X		

1. Involved dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 56, 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 16 Summary of service operators contacted by DNV and responses received to date

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
1	Fixed point-to-point link: zones established by DNV – no WTGs in diffraction exclusion zone, potential reflection/scattering and near-field interference zones not assessed; no WTGs in clearance zone requested by Bureau of Meteorology Fixed point-to-multipoint: 35 km from Project Area Meteorological radar: 134 km from Project Area	Bureau of Meteorology 10361261-AUMEL-L-01	<u>Response received by email on 6 June 2022:</u> *"The analysis shows that the proposed WF should have manageable impact on existing radar network on normal weather condition.* *The Bureau has PMP licence (433953/1) that passes through the proposed WF. Based on the provided layout of the farm, some of the turbines (B048, B056, and B060) are marginally clear to impact the PMP service. However, any possible modification on the final location of turbines might change the condition.* *The clearance from the link pass should be around 600 m. The two points of such link is (-30.978346 & 151.584748, and -30.481873 & 152.397570).* *Therefore, the Bureau is ready to agree with your proposed wind farm should the farm operator/owner agree with the following conditions:* *1- No turbines are to be built closer than 600 m from the pass that connects the points (-30.978346 & 151.584748, and -30.481873 & 152.397570).* *2- To inform the Bureau of any changes in the wind farm including varying the layout of the farm, changing the location of each turbine more than 100 meter or altering the turbine's height.* *3- Notify the Bureau at least two weeks before any planned shut-down of the farm (for maintenance or any other reason) enabling us to calibrate radar system without the effect of rotating turbines.* *4- Collaborates with the Bureau on the event of severe weather conditions to assist in endeavours of community safety.* *If the above-mentioned conditions are acceptable, please kindly send us a letter confirming that you agree with those terms and hence the Bureau will issue its formal agreement letter."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
2	Fixed point-to-point link #1: zones established by DNV – 2 WTGs in diffraction exclusion zone, 4 WTGs in potential reflection/scattering interference zone, no WTGs in potential near-field interference zone Fixed point-to-point link #2: zones established by DNV – 1 WTG in diffraction exclusion zone, 3 WTGs in potential reflection/scattering interference zone, no WTGs in potential near-field interference zone Fixed point-to-point link #3: zones established by DNV – no WTGs in diffraction exclusion zone, 3 WTGs in reflection/scattering interference zone, no WTGs in near-field interference zone Point-to-area (land mobile): 324 m from nearest WTG	New South Wales Government Telecommunications Authority (NSW Telco Authority) 10361261-AUMEL-L-02	<u>Response received by email on 27 May 2022:</u> *"[The tower locations and link paths recorded in the ACMA RRL database] are correct. 10022185 and 10023104 are new tower in construction phase. Frequency, latitude, longitude and gain is correct. Antenna heights may change if issues are experienced during construction/implementation, variance can typically range from +/-15m from licenced heights. Those would be the only p2p links related to NSWTA."* <u>Response received by email on 14 June 2022:</u> *"Our transmission team has reviewed the location of the turbines and has raised some concerns. Please see comments below of turbines that will cause disturbance to our links and a proposed relocation that could mitigate the disturbance…"* *[Initial movements proposed – revised and changed in a later response]* <u>Response received by email on 7 July 2022:</u> *"Changes to our infrastructure will be extremely difficult and unfavourable. However we are looking forward to hearing back from the developer and the proposed turbine locations will have a significant impact to the operations of our Public Safety Network."* <u>Response received by email on 18 July 2022:</u> *"We've revisited our analysis for this particular site and have found an error in our calculation. This analysis has been redone and results are below:* *Clearances have been calculated based on Fresnel 1st zones for links UHF Link Licence 10330342/1 and 3rd zone for MW Link Licence: 10956325/2.* *Licence: 10956325/2 (6755 - 10022185) (link PORC-MNTR)* *B154 - move turbine minimum 30m east from the proposed location* *Licence: 10330342/1 (6726 - 41044) MNTR - Walcha-UHF* *B138 - move turbine minimum 50m northeast from the proposed location* *B139 - move turbine 140m southwest from the proposed location."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
3	Fixed point-to-point link #1: zones established by DNV – 4 WTGs in diffraction exclusion zone, no WTGs in potential reflection/scattering and near-field interference zones Fixed point-to-point link #2: zones established by DNV – 2 WTGs in diffraction exclusion zone, potential reflection/scattering near-field interference zones not assessed Fixed point-to-point link #3: zones established by DNV – no WTGs in diffraction exclusion zone, 3 WTGs in potential reflection/scattering interference zone, no WTGs in potential near-field interference zone Fixed point-to-point link #4: zones established by DNV – no WTGs in diffraction exclusion zone, 4 WTGs in potential reflection/scattering interference zone, no WTGs in potential near-field interference zone Point-to-area (land mobile): 3 km from Project Area	NSW Rural Fire Service 10361261-AUMEL-L-03	Feedback received by Proponent on 29 July 2021 [14]: *"The RFS Engineer has completed extensive modelling on the UHF Paging links, turbine locations etc. Whilst a couple of the tower structures are close to the links we believe the UHF links should still be functional.* *The main link impacted is Blakes -> Duval Paging link. However, this link is marginal at best… As far as I can work out, we skip under the turbines in all cases, however one of the towers is almost on the centre link of our link.* *Following the installation of the windfarm the RFS will test the link to Blakes and confirm fully operational."* Response received by email on 15 June 2022: *"Some notes below.* • *Are the link paths shown in the attached Google Earth file correct?* ***YES – noting below*** • *However, based on our previous correspondence and some subsequent information we've received, I understand that RFS links assigned to site ID 6681 (Vertel Comms Site Little Duval Mtn Exmouth Rd Dumaresq) in the ACMA database now actually use site ID 34574 (Commsite Mt Duval).* ***CORRECT, however there is a datum problem with your coordinates. The measured coordinates (WGS84) are -30.40386, 151.63451*** • *Are the other link details (including the signal frequency, site latitude and longitude, and antenna heights and gains) in the table below correct?* ***YES. In our original assessment we determined two links that came within the clearance zone, however a 3D analysis of the link had it pass under the blades and just far enough from the pylon.*** • *Are all of these links currently installed and operational?* ***Link 1960374 has been removed.*** *We've received information that suggests link #1230575/1 (Mt Duval to Porters Camp Rd) doesn't currently exist and isn't planned to be installed.* ***THIS IS CORRECT. THIS LINK WAS EXCLUDED FROM OUR ORIGINAL ASSESSMENT*** • *Are there any other RFS links crossing the wind farm site that we haven't identified?* ***NO****"*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
4	Fixed point-to-point link: zones established by DNV – 2 WTGs in diffraction exclusion zone, potential reflection/scattering and near-field interference zones not assessed Point-to-area (land mobile): 26 km from Project Area	Office of Environment and Heritage (NSW National Parks and Wildlife Service) 10361261-AUMEL-L-04	<u>Response received by email on 25 August 2022:</u> *"I have had advice from RFS using suitable RF 3d modelling tools, that our RF links are well elevated and according to the detail provided from your proposal that the turbines and blades fall below any RF propagation region to cause any notable interference to NPWS RF links and network.* *I have shared this detail with the NSW TA and there has been no response. I will make a final enquiry this afternoon.* *In the absence of a response from the TA, NPWS is comfortable that the desktop review has shown no noticeable impacts to our network performance.* *[Commitments made to the NPWS in relation to other wind farm proposals have] noted that if RF problems to NPWS radio network arise and the proposed turbines may be the cause that the wind farm team will work with NPWS to resolve.* *…NPWS were comfortable with this statement of support."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
5	Fixed point-to-point link: zones established by DNV – no WTGs in diffraction exclusion zone (expected to pass under rotor), no WTGs in potential reflection/scattering and near-field interference zone PMTS/spectrum (mobile phone): 5 km from Project Area	Telstra Corporation Limited (Telstra) 10361261-AUMEL-L-05	<u>Response received by email on 9 August 2022:</u> *"The radio path you have identified is correct and operational, with details of both sites listed below as required.* *There are no other Telstra radio links, however underground copper and fibre network does exist at several locations within your proposed boundary. May I please implore that you contact Dial Before You Dig for further detail before progressing…* *Site #1 (ACMA Site ID: 6748)* *Site Name: Moona Plains SCAX* *Frequency (MHz): TX: 150.125, RX: 155.325* *Coordinates: -31.0175561 , 151.8357211* *Address ID: 45153* *Antenna Height: 13m* *Site #2 (ACMA Site ID: 6733)* *Site Name: Paradise* *Frequency (MHz): TX: 155.325, RX: 150.125* *Coordinates: -31.0466200 , 151.9972280* *Address ID: 229701* *Antenna Height: 9m"* <u>Response received by email on 6 September 2022:</u> *"As previously discussed, Earth Potential Rise (EPR) and Low Frequency Induction (LFI) analysis is also required for us to assess for potential impact of proposed windfarms on any existing fixed network.* *In addition to the turbine locations you have already supplied, may I please request power transmission details… to allow our teams to conduct their fixed network assessments…"*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
6	Fixed point-to-point link zones established by DNV – 3 WTGs in diffraction exclusion zone, 4 WTGs in potential reflection/scattering interference zone, no WTGs in potential near-field interference zone Fixed point-to-multipoint: 3 km from Project Area Point-to-area (land mobile): 325 m from nearest WTG	Walcha Council 10361261-AUMEL-L-06	Response received by email on 4 October 2022: *"…our radio communication provider for our 2-way system, GoodCom, [has] advised that based on the current proposed installation map for Winterbourne Wind Farm we do not have any line of site issues. He has further advised that there could be minor electromagnetic interference that would be negligible.* *Walcha Council lease two towers owned by GoodCom for which he has already assessed the risks in this space. He has further assessed our other towers to not be at risk with the current proposed installation locations."* Response received by email on 6 October 2022: *"GoodCom… advised me that they have the installation map for Winterbourne's towers and they will not interfere with current radio infrastructure."*
7	Fixed point-to-multipoint: 29 km from Project Area	Armidale Regional Council 10361261-AUMEL-L-07	No response received to date
8	Fixed point-to-multipoint: 35 km from Project Area Point-to-area (CB radio repeater): 325 m from nearest WTG	Goodcom Communications Pty Ltd (Goodcom Communications) 10361261-AUMEL-L-08	No response received to date
9	Point-to-area (land mobile): 26 km from Project Area	Ambulance Service of NSW (NSW Ambulance) 10361261-AUMEL-L-10	Response received by email on 1 August 2022: *"I've had a look at the Winterbourne Wind Farm proposal and don't see any issues with it…* *NSW Ambulance will be decommissioning our radio network in the New England region in approximately three years as we will migrate to the NSW Government Public Safety Network."*
10	Point-to-area (land mobile): 44 km from Project Area	Guyra Volunteer Rescue Association (Guyra VRA) 10361261-AUMEL-L-11	No response received to date

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
11	Point-to-area: 3 km from Project Area	NSW Police Force 10361261-AUMEL-L-12	Response received by email on 23 May 2022: *"Based on the attached kml files, and the pdf document with information in relation to the proposed Winterbourne Wind Farm, an assessment is conducted with reference to those wind turbines location…* *In brief, NSWPF's radio link services are not crossing the proposed wind turbine area and the location of two wind turbines (B001 & B142) in proposed Winterbourne Wind Farm are located at least over 20km whilst the wind turbine (B039) is located over 3km (normally a cull radius of 2km is a pre-requisite) from the direct line of sight of existing radio link services. There should be sufficient clearance based on the boundary and location of the wind turbines as identified in the kml files."* Response received by email on 23 May 2022: *"With reference to the proposed wind farm boundary, there is no NSWPF's land mobile radio site location located either near or within the boundary of the proposed wind farm. The nearest Blakes Hill (SID_41044) has a distance separation of about 2.9km from the boundary of the proposed wind farm.* *This will not be regarded as a high risk to NSWPF's mobile radio assets and services and any observed interference problems in the future will have to be investigated and rectified by the wind farm developer."*
12	Point-to-area: 32 km from Project Area	St John Ambulance Australia (N.S.W.) (St John Ambulance) 10361261-AUMEL-L-13	Response received by email on 6 June 2022: *"I have reviewed the proposed location and can confirm it will have negligible impact to our radio communication in the area.* *As such we have no objection to this proposal."*
13	Point-to-area (land mobile): 5 km from Project Area	State Emergency Service (NSW) (NSW SES) 10361261-AUMEL-L-14	Response received by email on 18 July 2022: *"I have just confirmed with our Technical SME that given the current footprint of the proposed site (Winterbourne) we will also seek a quotation for a detailed assessment from our Radio Networks Vendor."* Response received by email on 26 July 2022: *"We have received a quotation for an impact assessment for Winterbourne…* *Can you please engage with the developer for approval to commence and accept the costs."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
14	Trigonometrical station: 211 m from nearest WTG Global Navigational Satellite System (GNSS) station: 21 km from Project Area	Geoscience Australia 10361261-AUMEL-L-16	Response received by email on 27 June 2022: *"Geoscience Australia do not foresee any impact to Commonwealth owned trigonometrical stations or Global Navigation Satellite Systems (GNSS) reference stations or associated assets from the proposed Winterbourne Wind Farm development.* *The identified GNSS reference station at Yarrowitch (YARO) is owned and operated by the NSW Spatial Services."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
15	Trigonometrical station: 211 m from nearest WTG	NSW Spatial Services 10361261-AUMEL-L-17	<u>Response received by email on 6 June 2022:</u> *"The supplied document and files show various proposed wind turbine constructions to be in the vicinity of TS5650, TS5873, TS6296 & SS40200.* *The Office of the Surveyor-General raises no objection to the proposed development subject to the following conditions:* *The closest proximity of any turbine construction to NSW Spatial Services critical infrastructure is B015 (212m to TS6296). Considering the specified diameter of turbine blades and structure height… it's estimated TS6296 will be, at its closest, over 100m from B015's turbine blade trajectory at any given time.* *1. Therefore, if there are 'restrictions' for working within a proximity (m) of a wind turbine i.e., a surveyor requiring 'occupation' of TS6296, which will affect access and use of TS6296, then the proposed location of B015's will have to be revised, or this approval rescinded. Any 'working' restrictions may also affect other sites noted above (see estimated proximities in attached diagrams.). Please advise if there are any access/working restrictions relating to the above.* *2. SS40200 (noted as NOT FOUND in SCIMS) is approximately 73m from B093. In the context of the proposed project, SS40200 is not deemed critical state survey infrastructure, and the above turbine construction proximity is allowable to SS40200 (if found).* *3. Prior to commencement of construction, TS5650, TS5873 & TS6296 & SS40200 (previously 'Not found") and any associated witness marks must be located by your site surveyor and protected by erection of an appropriate physical barrier… to prevent disturbance by construction crews.…* *4. Photographs of TS5650, TS5873, TS6296, SS40200 (if found) and any associated witness marks must be taken prior to the commencement of construction AND after construction is completed. Submit photographs through the DCS Spatial Services Customer Hub…* *5. The construction site foreman is informed of the importance of protecting TS5650, TS5873, TS6296, SS40200 (if found) and their associated witness marks from disturbance.* *6. If there are any major variations to the subject proposal, this consent is nullified, and a new submission must be lodged for assessment by the Office of the Surveyor-General.* *Please note:* *• TS5650, TS5873 & TS6296 and their associated witness marks are important parts of the State's geodetic infrastructure; they are also protected marks under the Surveying and Spatial Information Act 2002 which has penalties for disturbance of such marks.* *• If any survey mark(s) are proposed to be disturbed or destroyed, formal approval to disturb or destroy the mark(s) must be granted by the Office of the Surveyor-General prior to commencement of any works affecting the mark(s)."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
16	PMTS/spectrum (mobile phone): 5 km from Project Area	Optus Mobile Pty Ltd (Optus) 10361261-AUMEL-L-18	Response received by email on 23 May 2022: *"No concern with the wind farm proposal, from Optus microwave link perspective."* Response received by email on 27 May 2022: *"Based on the details provided, we do not expect any major impact on Optus mobile network coverage due to the proposed wind farm."*
17	PMTS/spectrum (mobile phone): 5 km from Project Area	Vodafone Australia Pty Limited (Vodafone) 10361261-AUMEL-L-19	Response received by email on 4 July 2022: *"Based on the KML's I don't see any interference issues caused by Winterbourne windfarm on VHA infrastructure. Closest VHA infrastructure is about 4km away from nearest turbine as shown in screenshot below." "…closest TPG/VHA site 240329_Walcha is 4km from the boundary. No upcoming sites in the area for TPG." "Yes that's correct [there will be no impacts on mobile coverage]."*

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
18	PMTS/spectrum (wireless internet): 25 km from Project Area	NBN Co 10361261-AUMEL-L-20	<u>Response received by email on 3 June 2022:</u> *"I have reviewed the data provided based on the proposed wind farm location. None of the proposed towers are inside existing nbn wireless coverage boundaries and the proposed wind tower locations do not pose any risk of introducing a physical obstruction to existing wireless customer RF Profiles or any boresight paths of existing nbn microwave links. It is noted that the northern end of the wind farm is inside the proposed nbn extended range radius.* *Images show current operational or planned nbn wireless coverage areas relative to wind farm location and turbines. Northern side of wind farm does not overlap current nbn Wireless Coverage Boundaries but is inside 29 km Extended Range boundary.* *A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows;* *Potential Impacts of the Proposed Winterbourne Wind Farm on NBN Co Spectrum Communication Assets* *Referring to your email dated 19th May 2022 regarding the application for the Winterbourne Wind Farm.* *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 75 km of the proposed Hills of Winterbourne 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."*
19	PMTS/spectrum (mobile phone): 35 km from Project Area	Field Solutions Group 10361261-AUMEL-L-21	<u>Response received by email on 23 May 2022:</u> *"Don't foresee any issues or impacts at this point."*
20	PMTS/spectrum (mobile phone): 57 km from Project Area	Pivotel Mobile 10361261-AUMEL-L-22	No response received to date

Table 16 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator and DNV reference	Response received to date
21	FM radio broadcasting: 3 km from Project Area Television broadcasting: 6 km from Project Area	BAI Communications 10361261-AUMEL-L-23	<u>Response received by email on 4 July 2022:</u> *"BAI Communications has done a study on the proposed wind farm located in Winterbourne, NSW… The impact on four broadcast facilities were studied, all digital television. The results show that none of the broadcast facilities are impacted (Walcha, Uralla, Mt Dowe and Little Duval Lower) by the proposed wind turbines. Any remediation required to rectify DTV degradation to the viewers, is expected to form part of the wind farm project.* *…Radiocommunication assets owned by BAI Communications have been identified in the vicinity of the proposed wind farm… The four broadcast sites that have been identified to provide coverage around the area… are… Armidale [Little Duval Lower], Walcha [Walcha], Upper Namoi [Mt Dowe], Uralla [Uralla]* *BAI has conducted field tests on existing wind farms in the past for the impact on FM services. The field test measurements concluded that FM radio had some minor reflections observed but these would not be expected to cause any noticeable effect on reception. Thus, this report will not consider further impacts on FM broadcast.* ***Conclusion*** *BAI have modelled the proposed Winterbourne wind turbines to assess how they will affect DTV services broadcast from Little Duval Lower, Walcha, Mt Dowe and Uralla sites…* *Interference analysis predicts that Little Duval Lower, Walcha, Mt Dowe and Uralla DTV services are not affected by the proposed wind farm.* *Whilst there are minimal persons predicted to be impacted by the wind farm, any degradation of DTV services caused by the wind farm development would be expected to be rectified as part of the project."*
22	Point-to-area (amateur repeater): 325 m from nearest WTG	Edwin Scott Dening (Coffs Harbour and District Amateur Radio Club) 10361261-AUMEL-L-24	No response received to date
23	Point-to-area (amateur repeater): 325 m from nearest WTG	Walcha Radio Group 10361261-AUMEL-L-25	No response received to date
24	Point-to-area (mobile radio): 356 m from nearest WTG	Brian Smith Timber Transport Pty Ltd 10361261-AUMEL-L-26	No response received to date

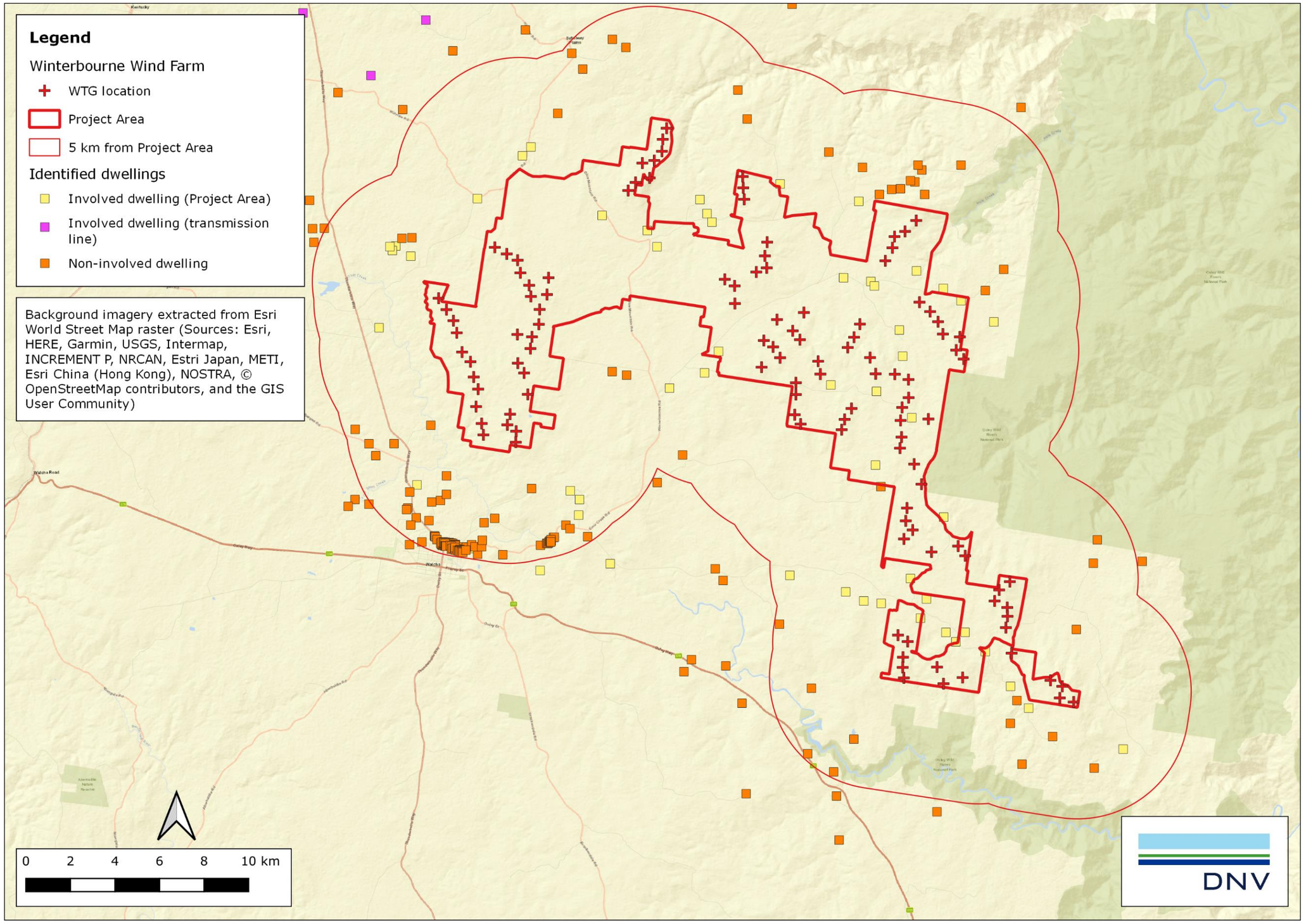

Figure 1 Map of the Project, showing Project Area, WTG locations, and locations of nearby dwellings

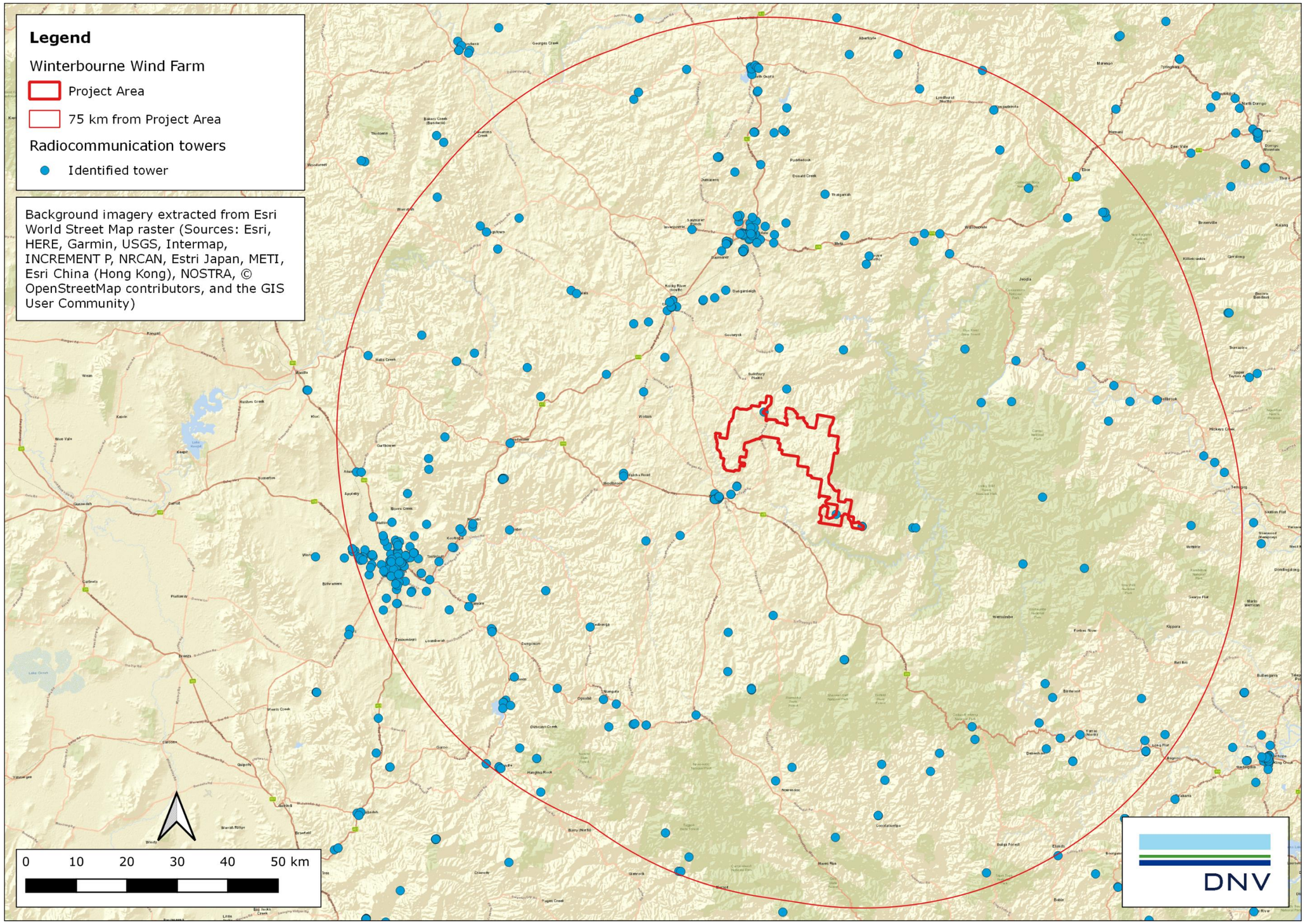

Figure 2 Location of the Project and identified nearby radiocommunication sites

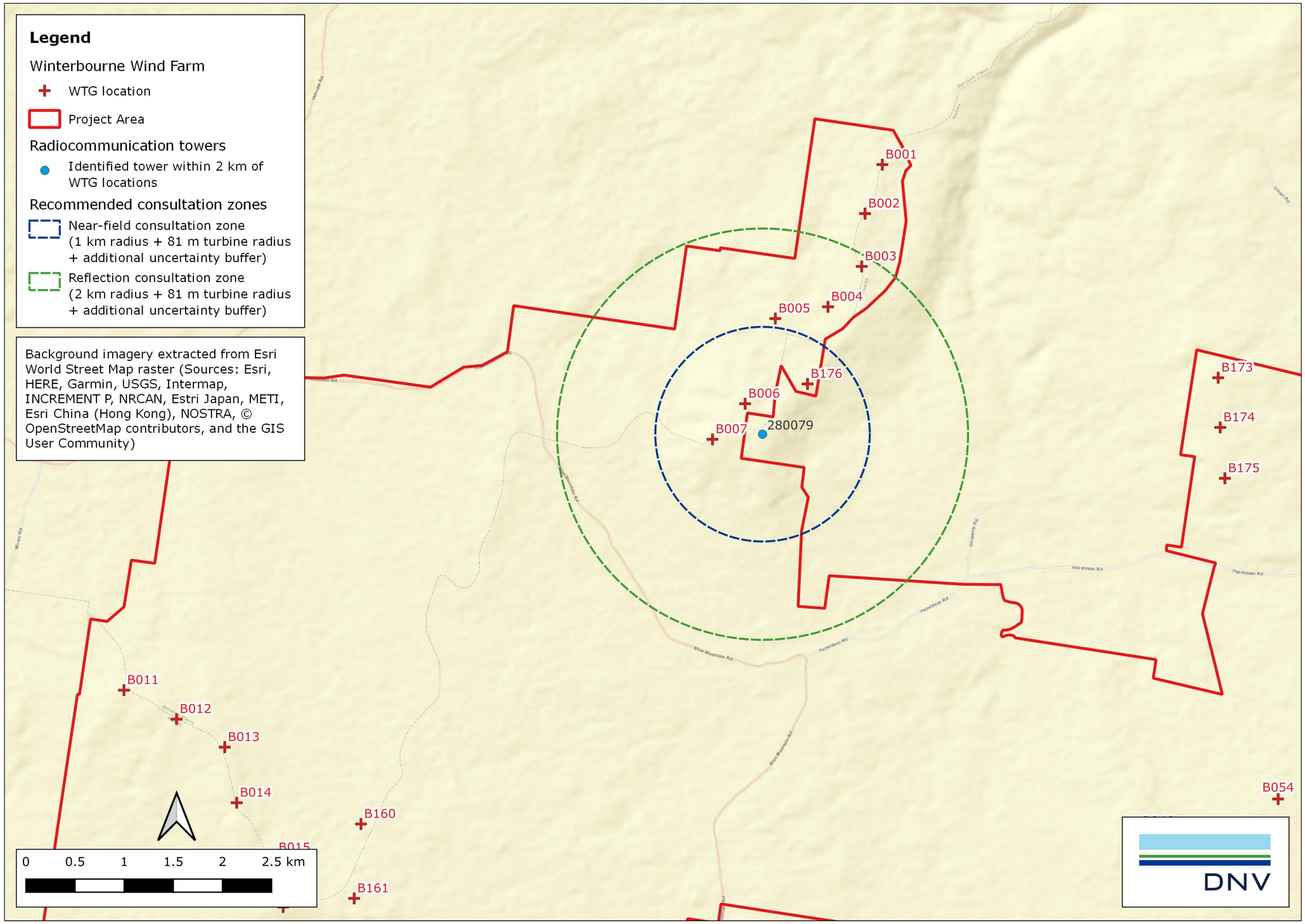

Figure 3 Identified radiocommunication sites within 2 km of the WTG locations for the Project (site ID 280079)

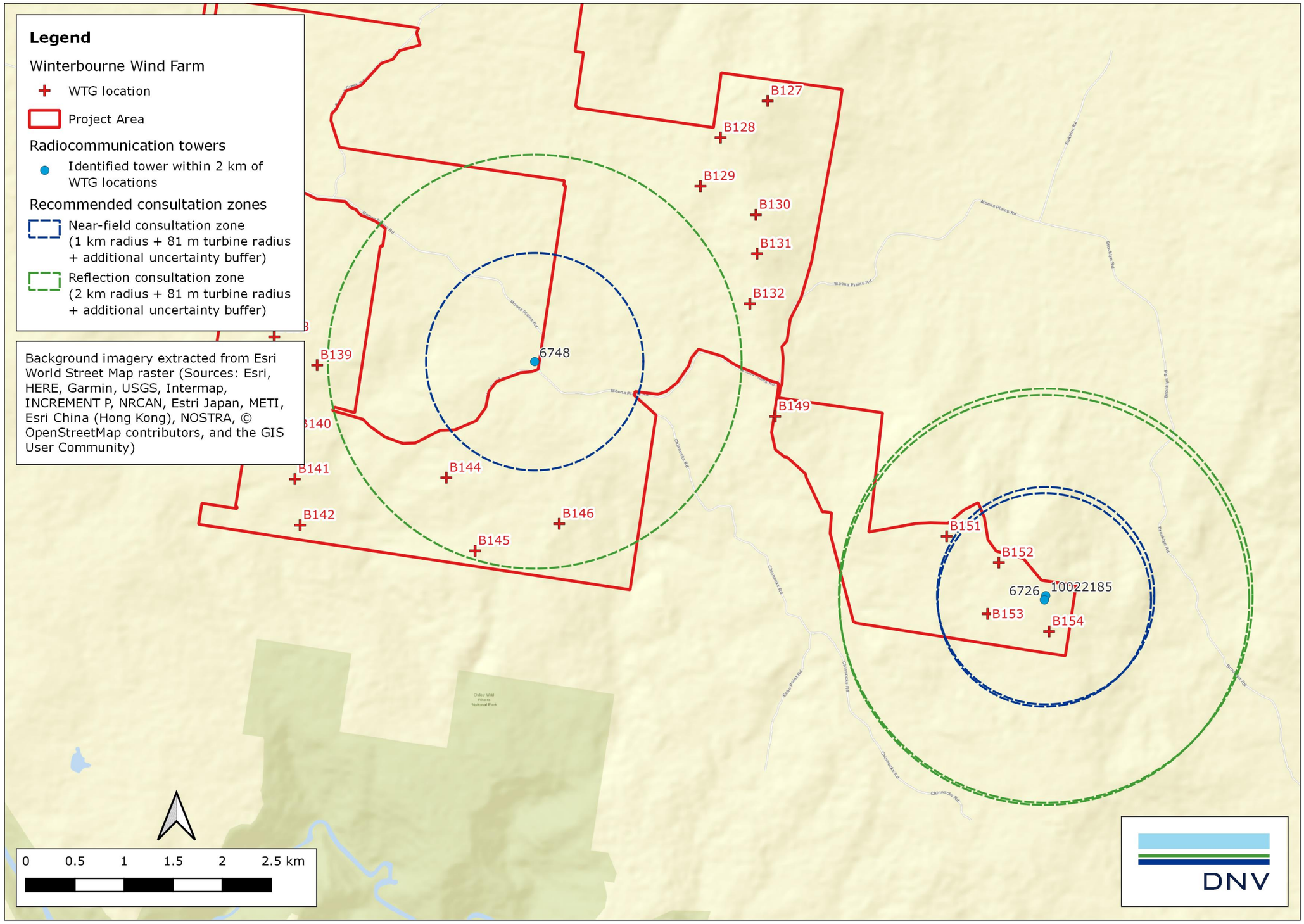

Figure 4 Identified radiocommunication sites within 2 km of the WTG locations for the Project (site IDs 6726, 6748, and 10022185)

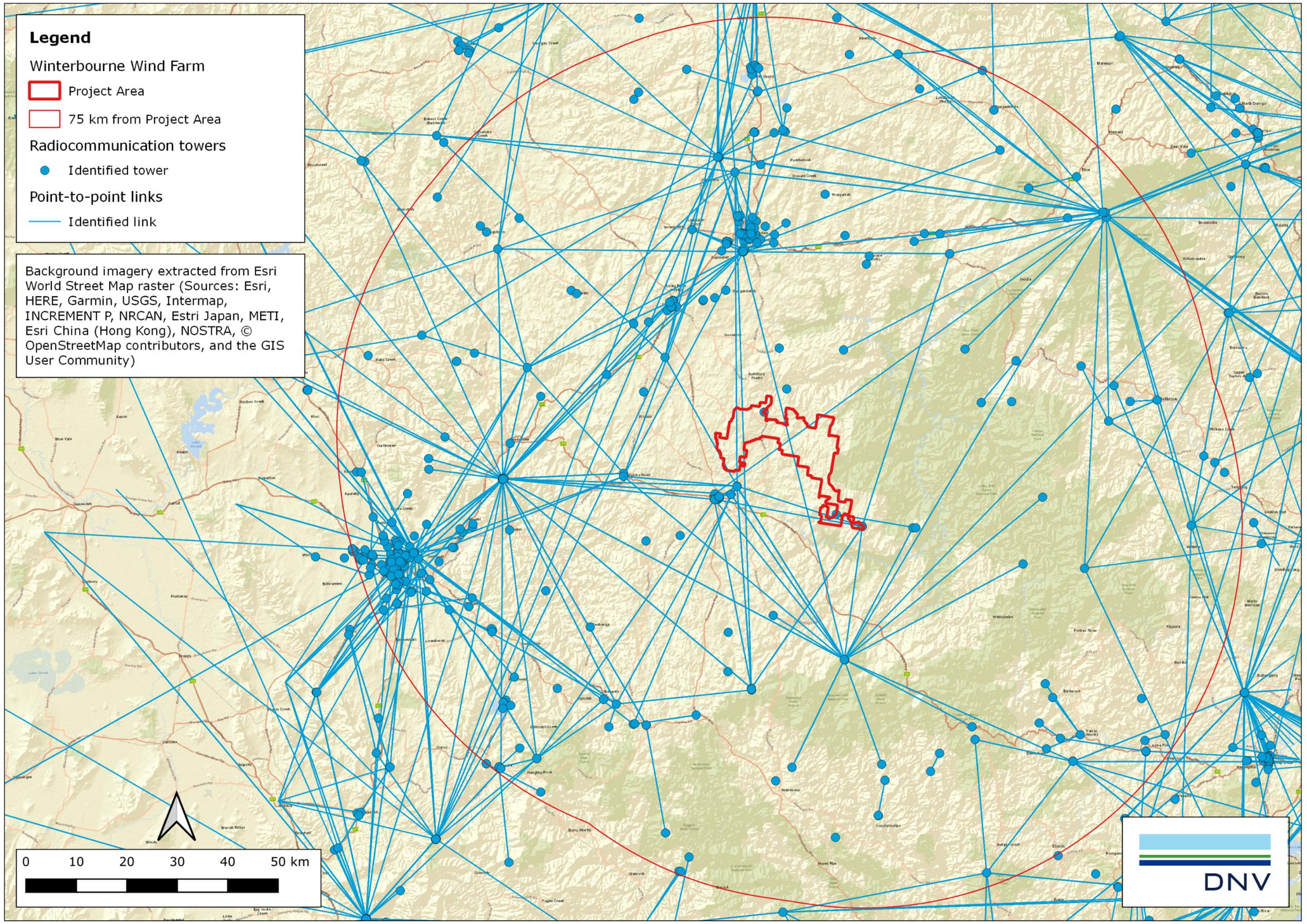

Figure 5 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the Project

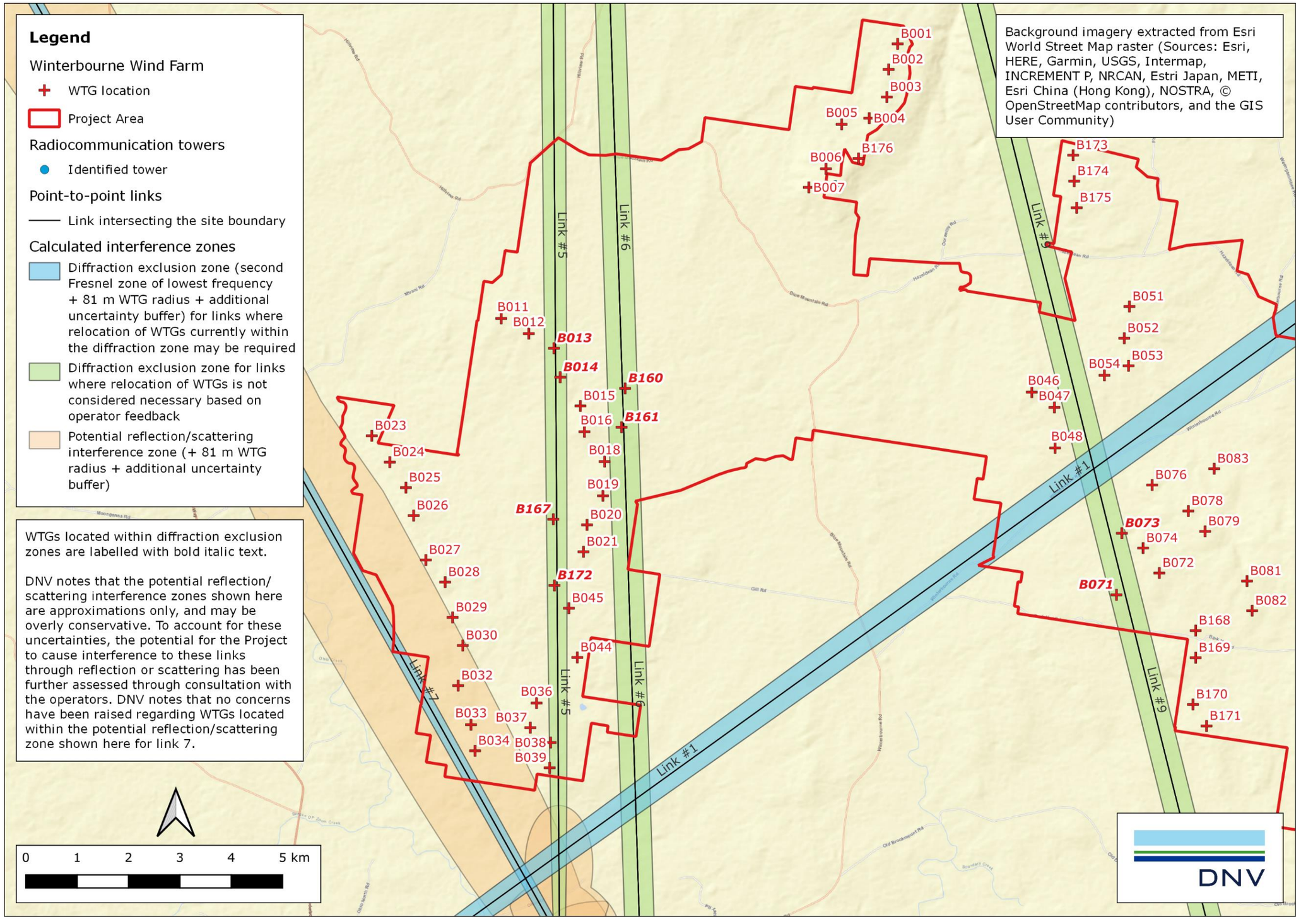

Figure 6 Identified point-to-point radiocommunication vectors crossing the Project and calculated interference zones (links 1, 5, 6, 7, and 9)

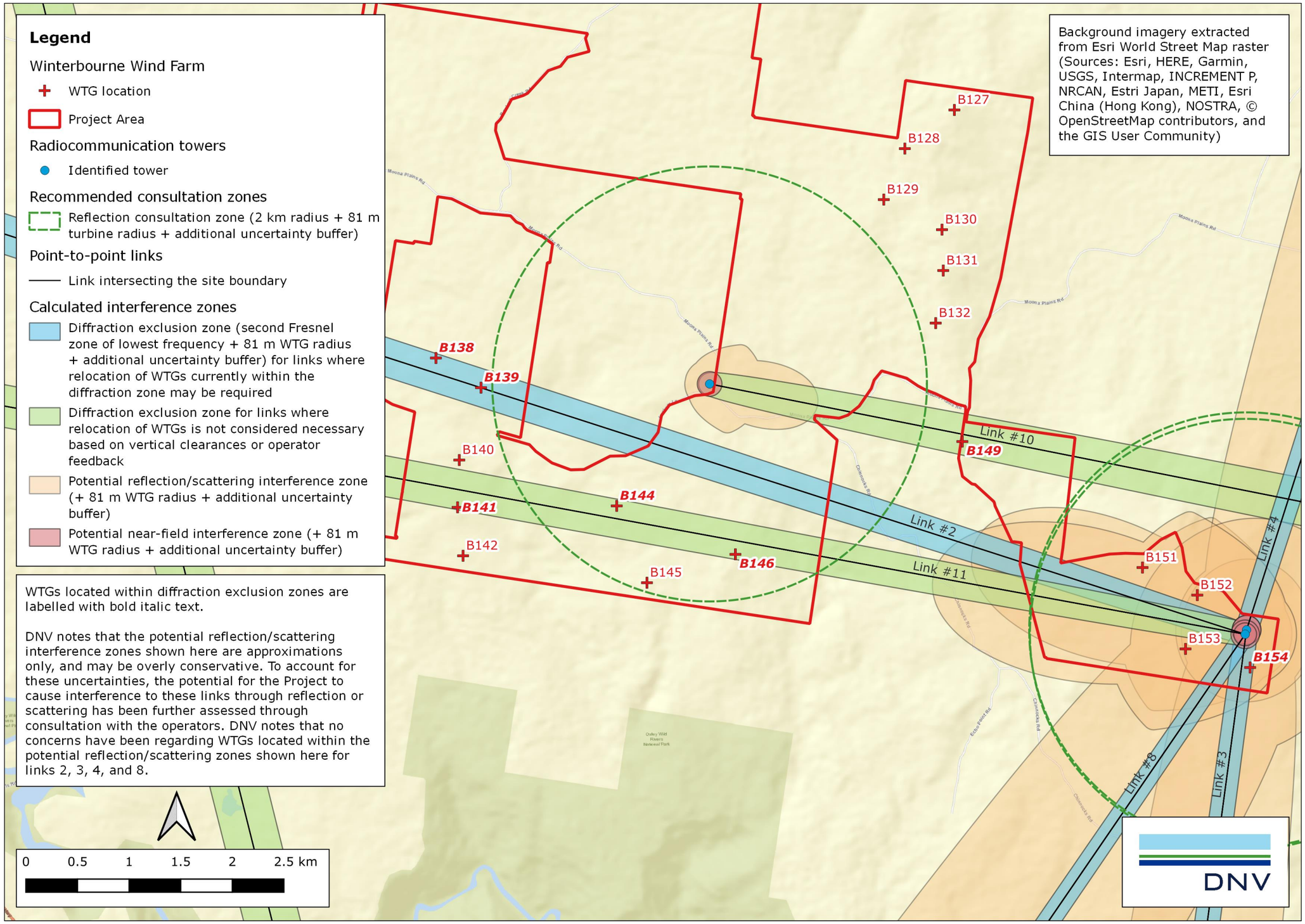

Figure 7 Identified point-to-point radiocommunication vectors crossing the Project and calculated interference zones (links 2, 3, 4, 8, 10, and 11)

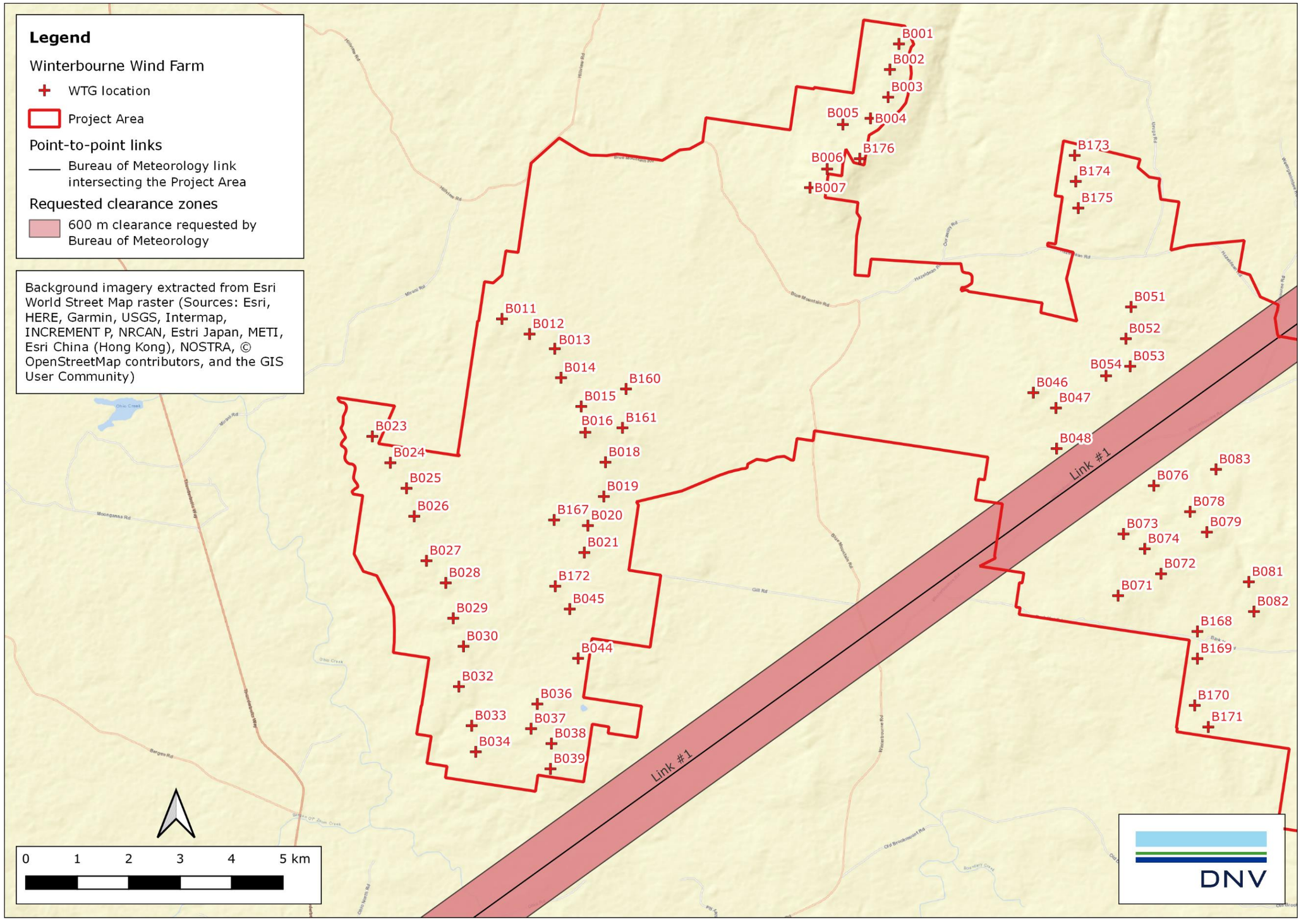

Figure 8 Identified point-to-point radiocommunication vectors crossing the Project and requested clearance zones (link 1)

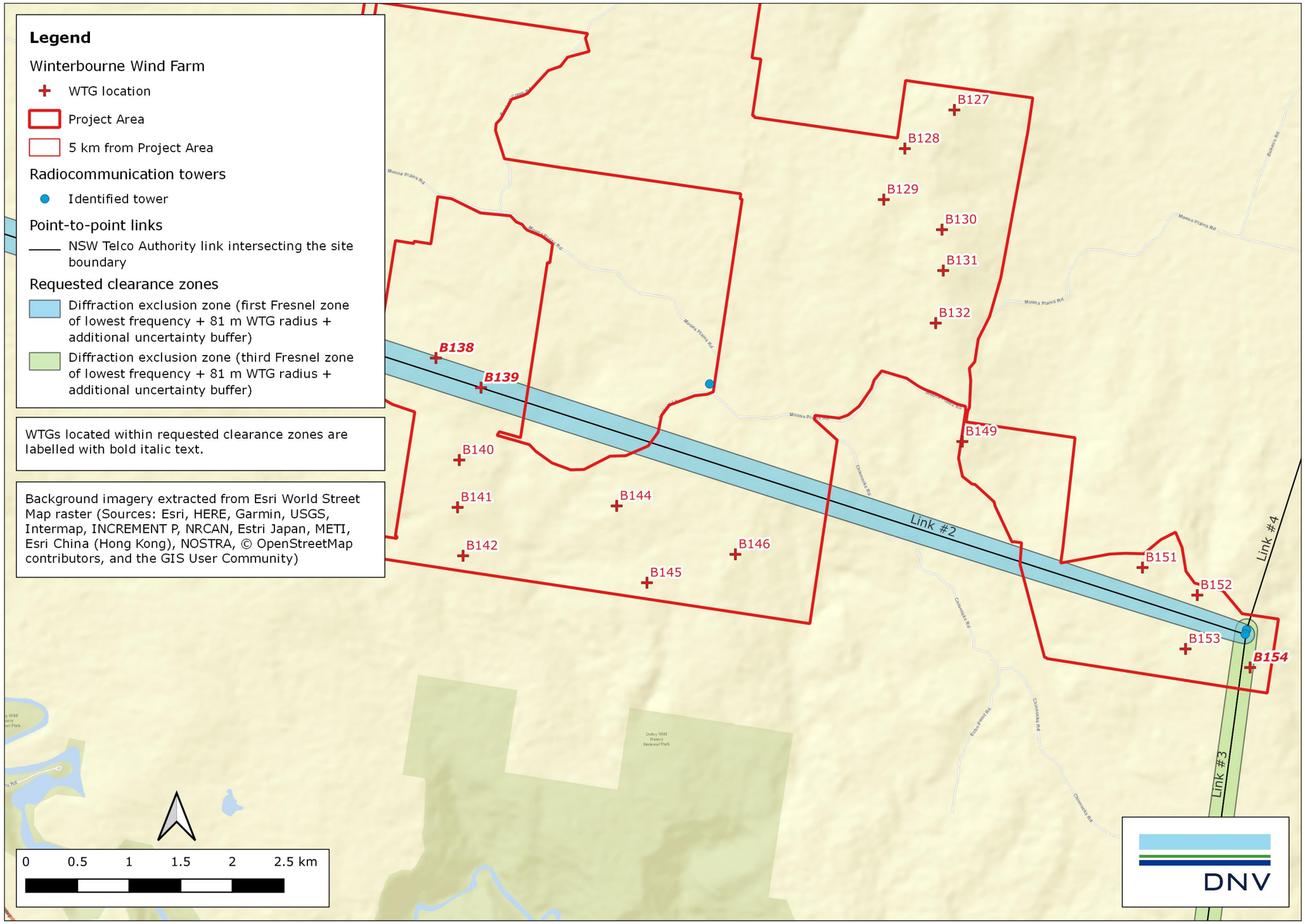

Figure 9 Identified point-to-point radiocommunication vectors crossing the Project and requested clearance zones (links 2 and 3)

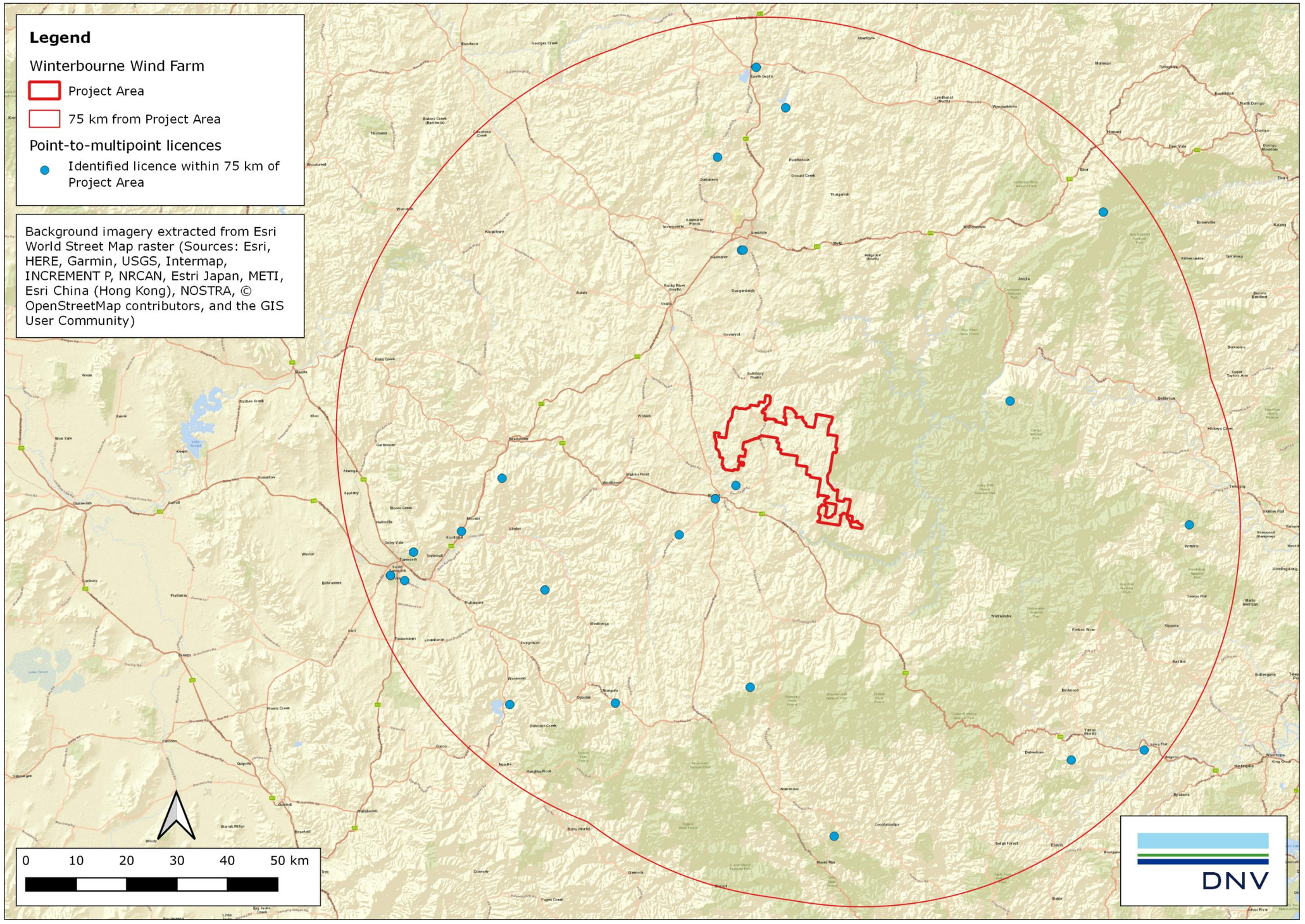

Figure 10 Location of point-to-multipoint licences in the vicinity of the Project

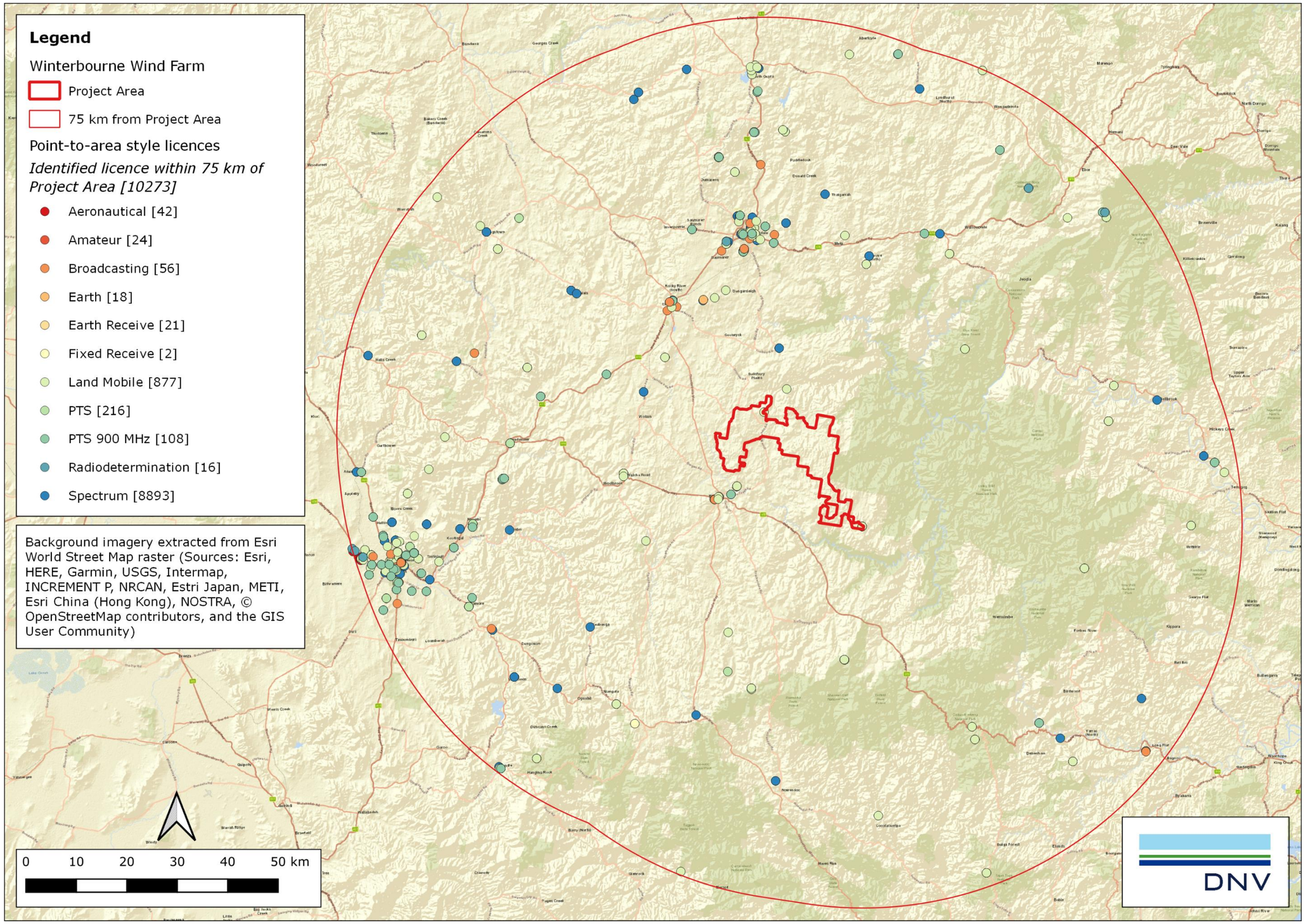

Figure 11 Location of general point-to-area style licences within 75km of the Project

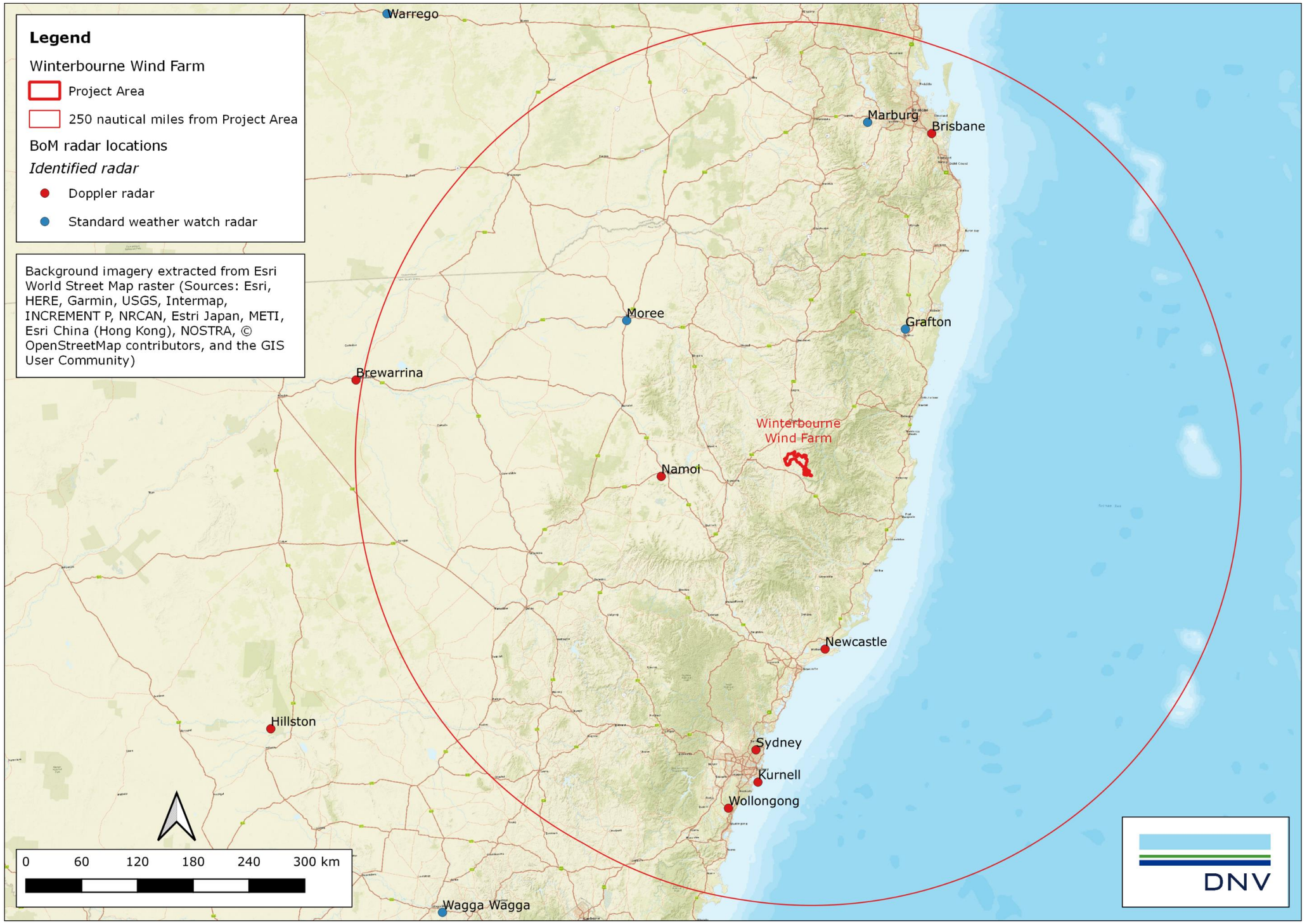

Figure 12 Location of meteorological radar sites within 250 nautical miles of the Project

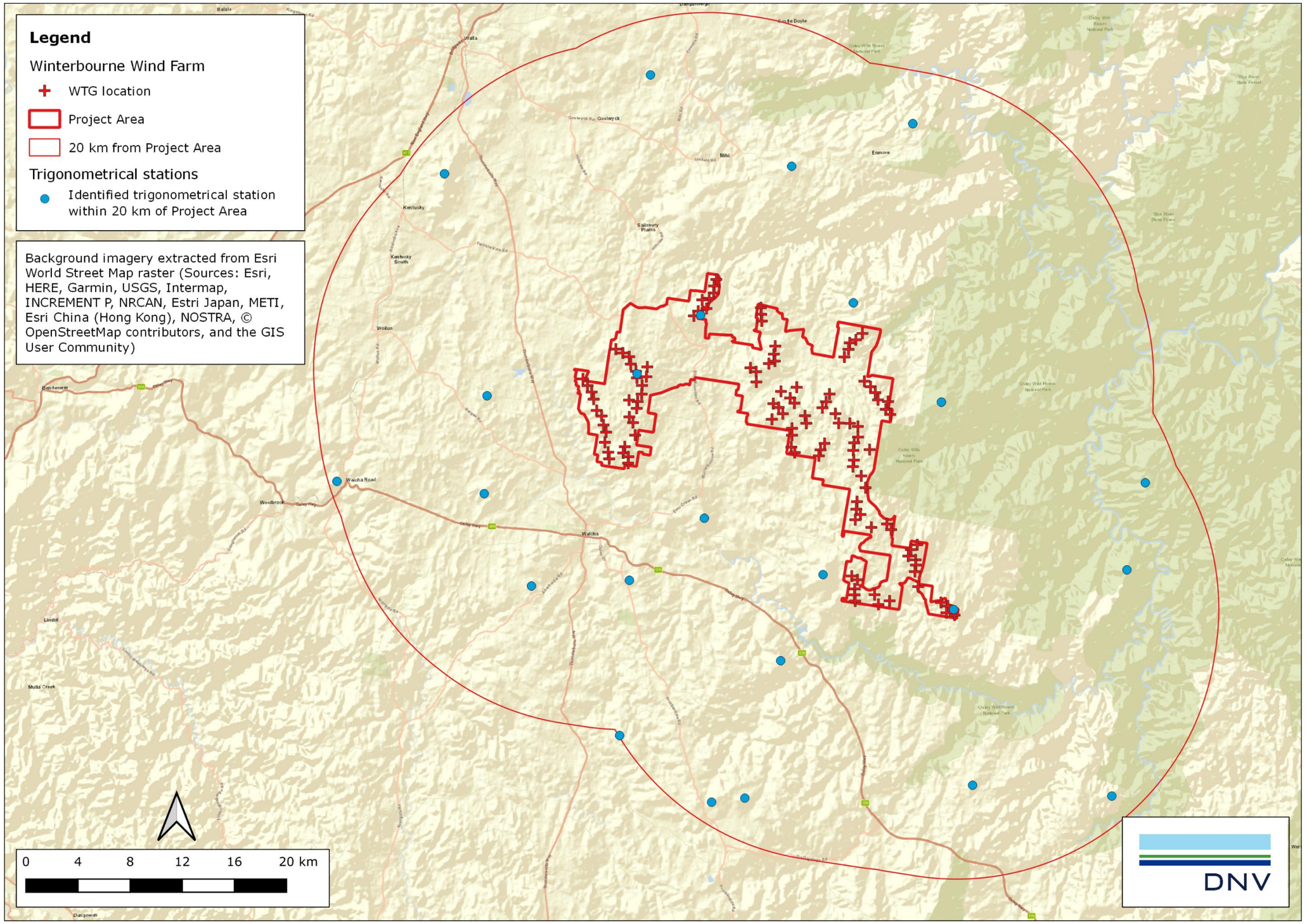

Figure 13 Location of trigonometrical stations within 20 km of the Project

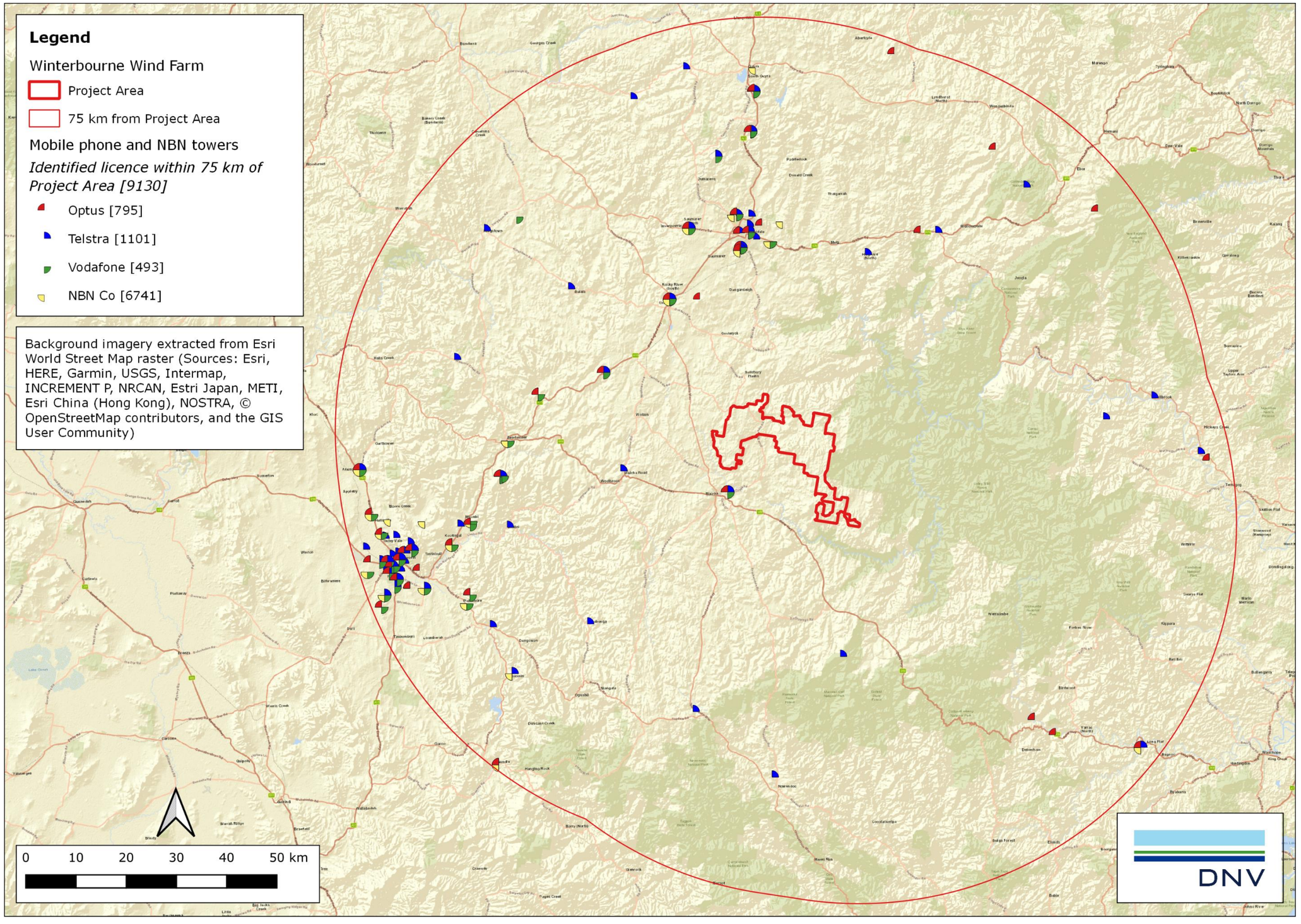

Figure 14 Location of mobile phone and NBN towers within 75 km of the Project

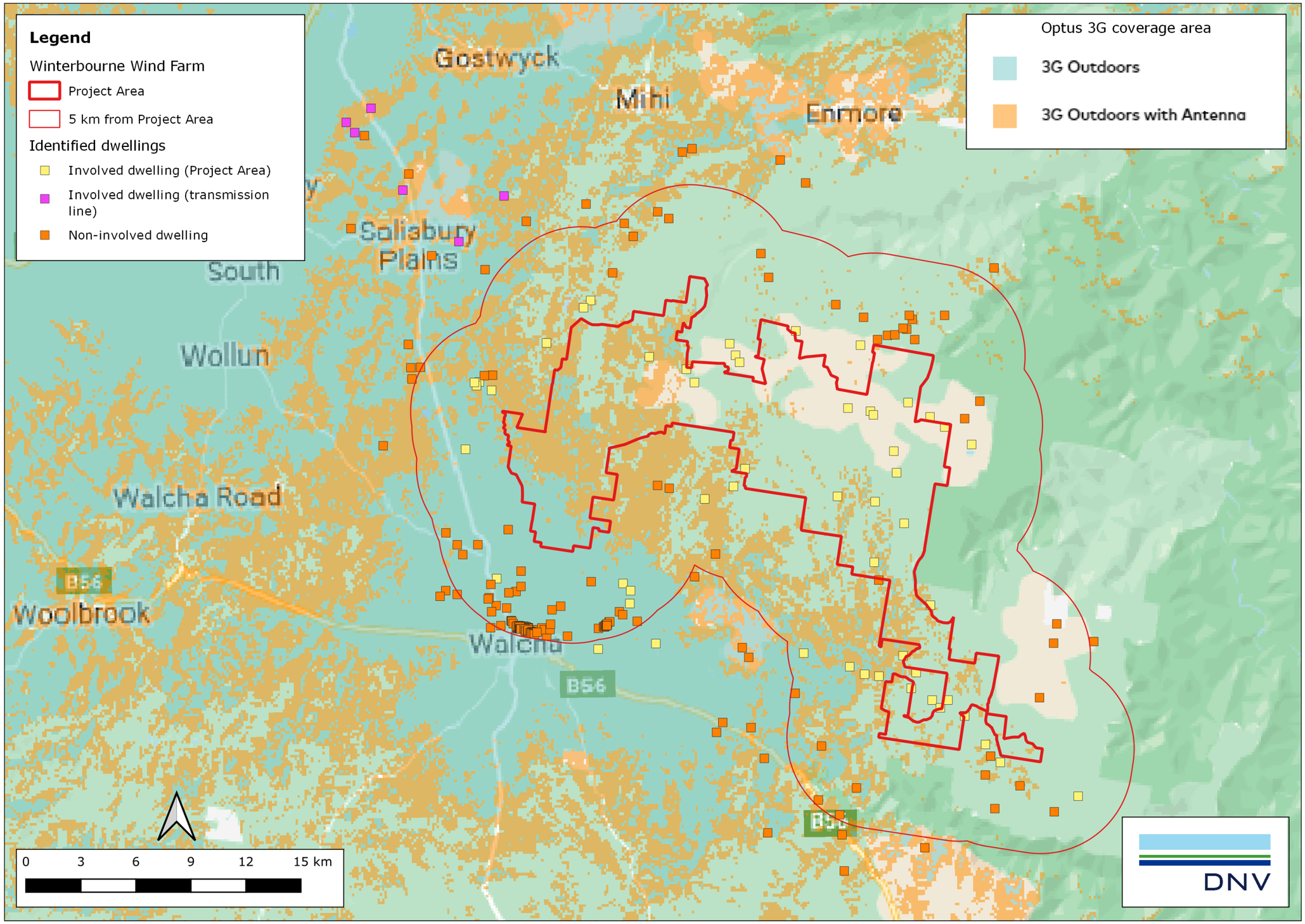

Figure 15 Optus Mobile 3G network coverage for the Project

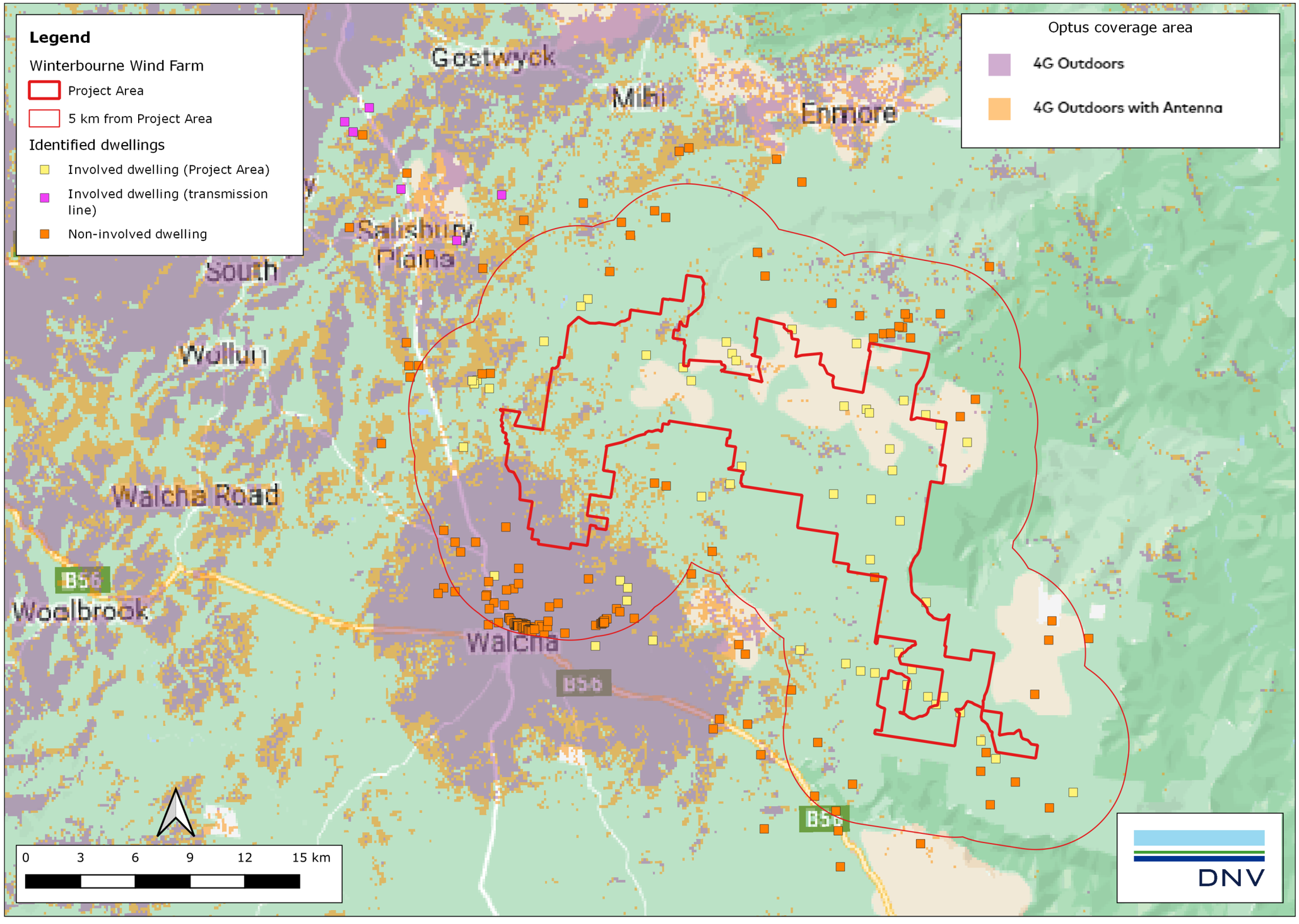

Figure 16 Optus Mobile 4G network coverage for the Project

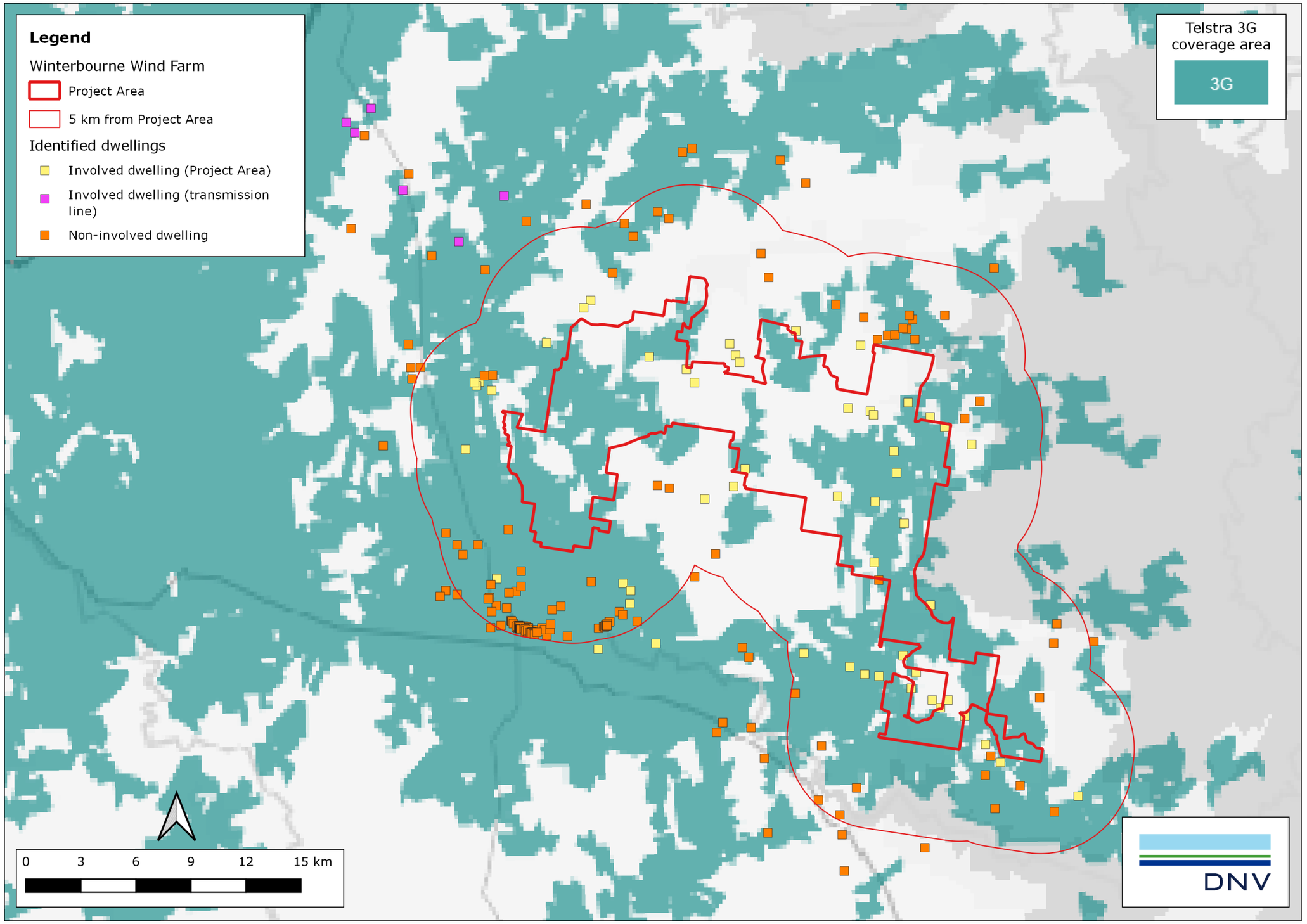

Figure 17 Telstra 3G network coverage for the Project

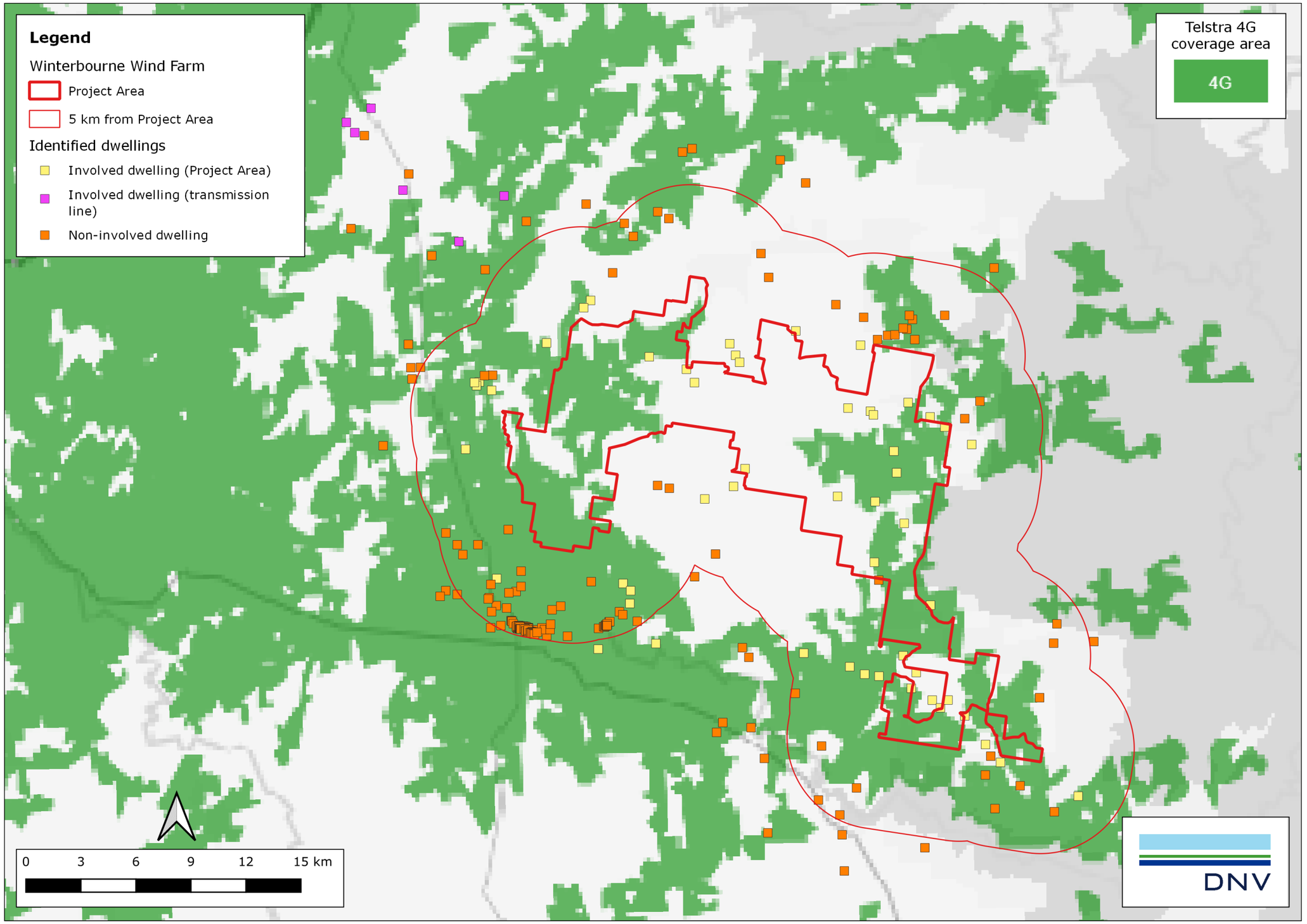

Figure 18 Telstra 4G network coverage for the Project

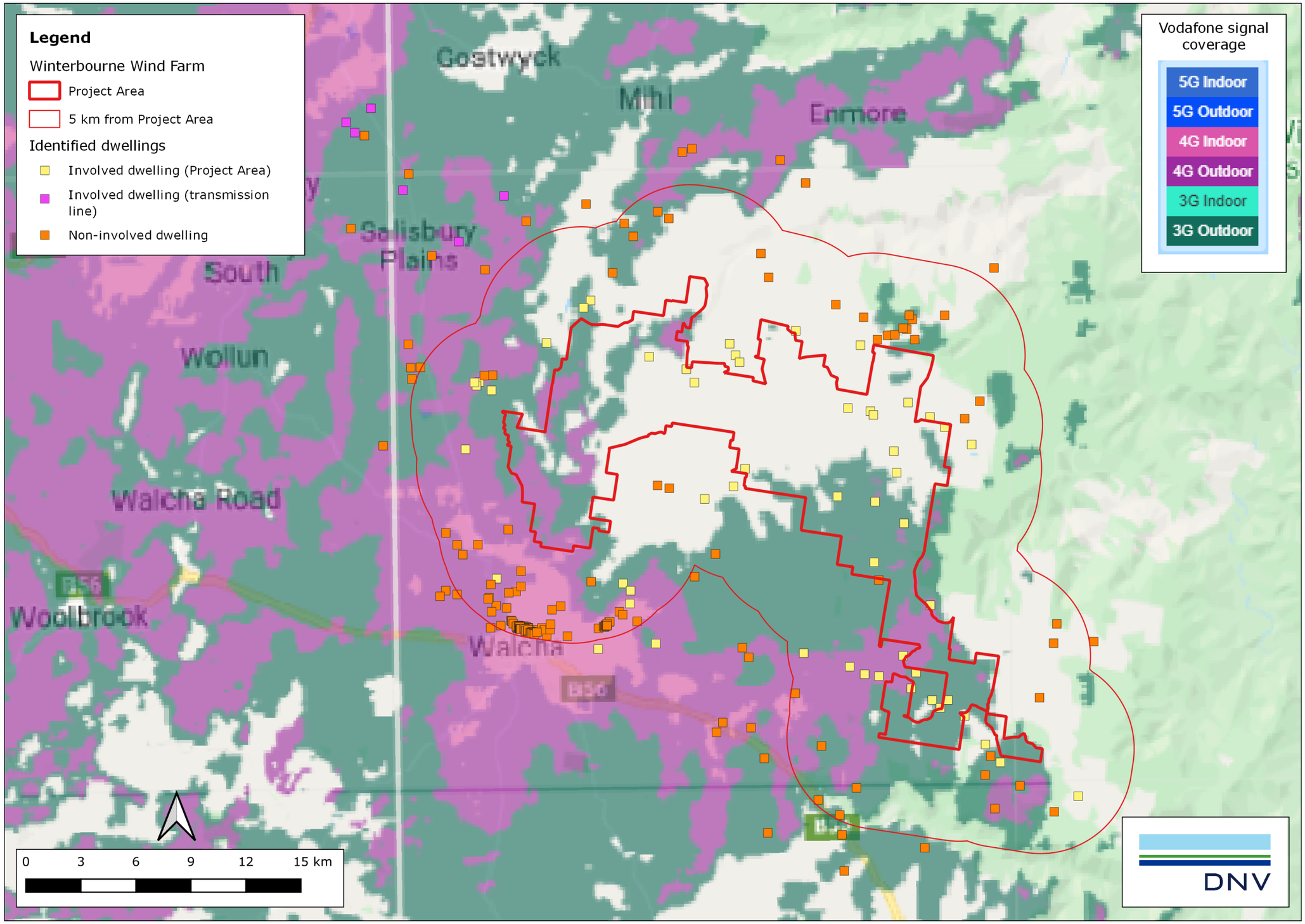

Figure 19 Vodafone network coverage (Apple iPhone 13 handset) for the Project

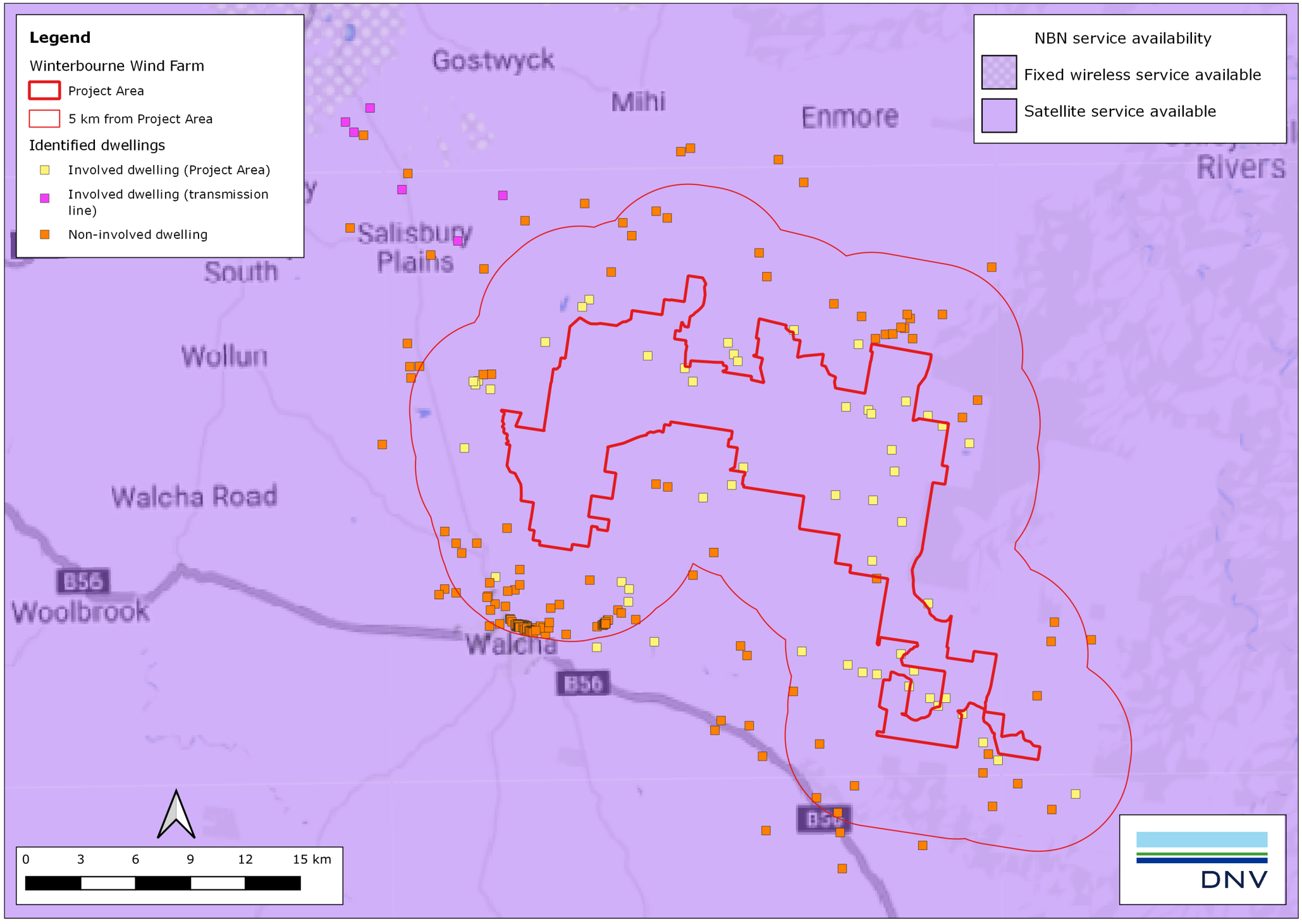

Figure 20 NBN internet coverage in the vicinity of the Project

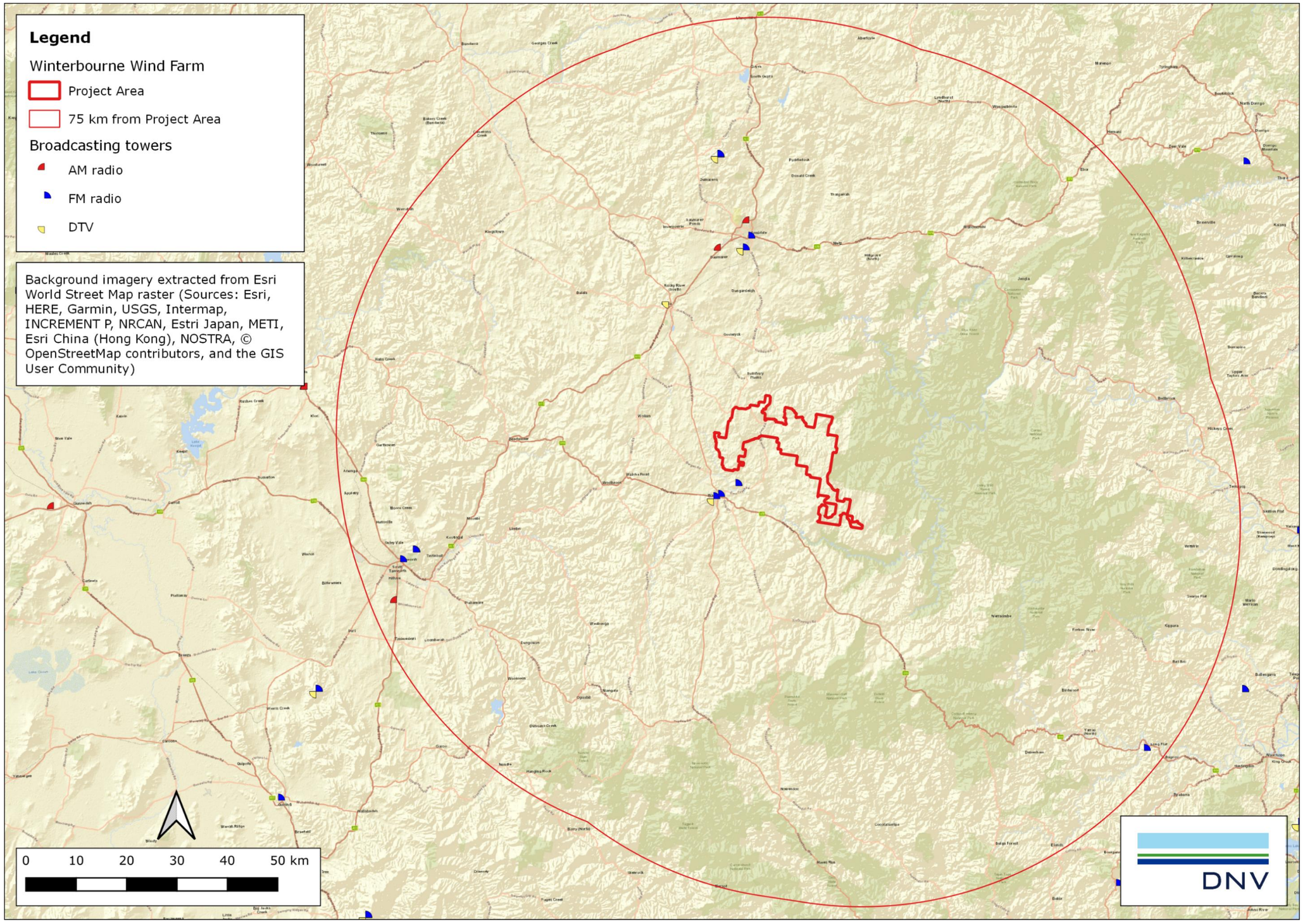

Figure 21 Location of broadcast transmitters in the vicinity of the Project

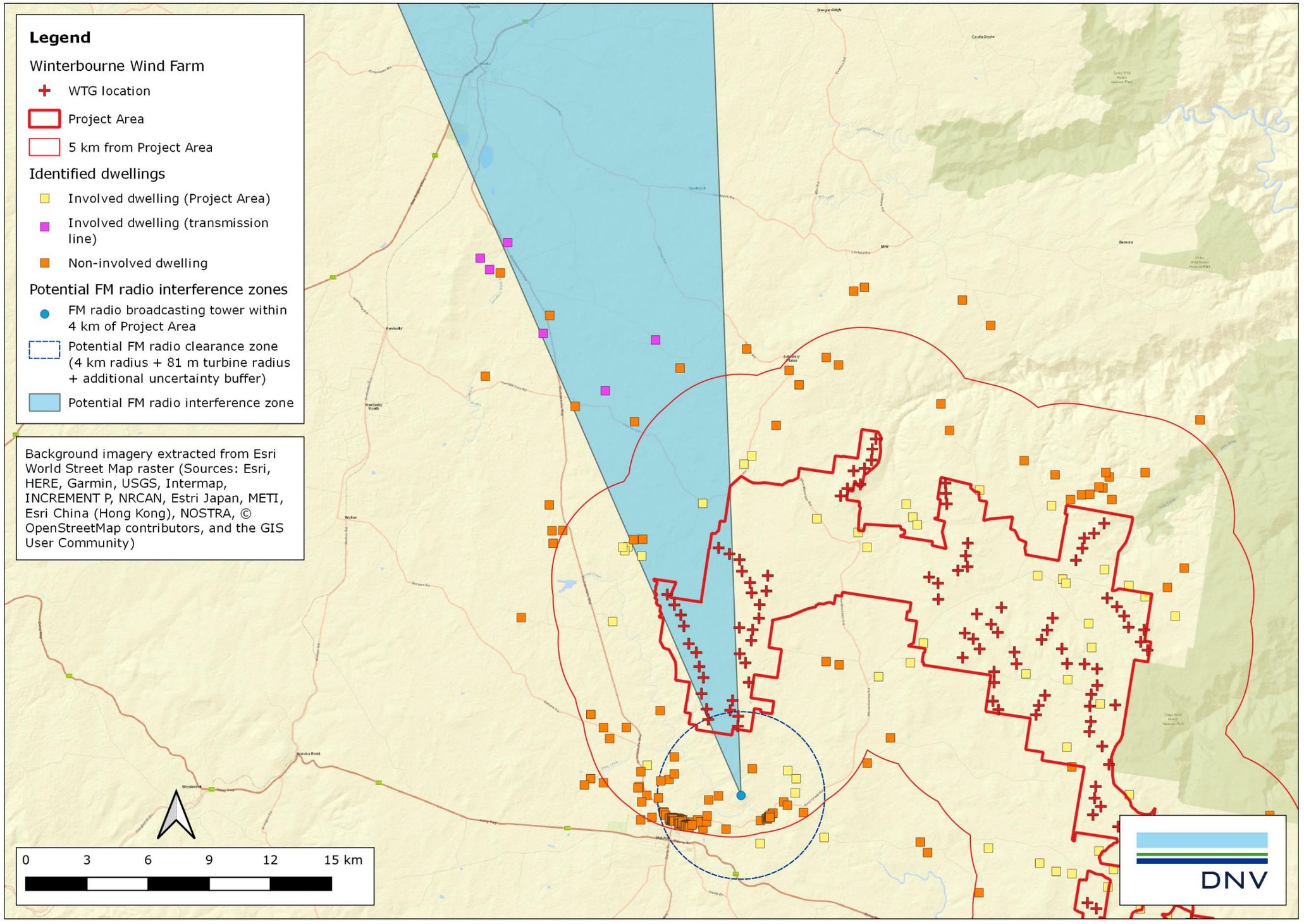

Figure 22 Potential FM radio EMI zones from the Project

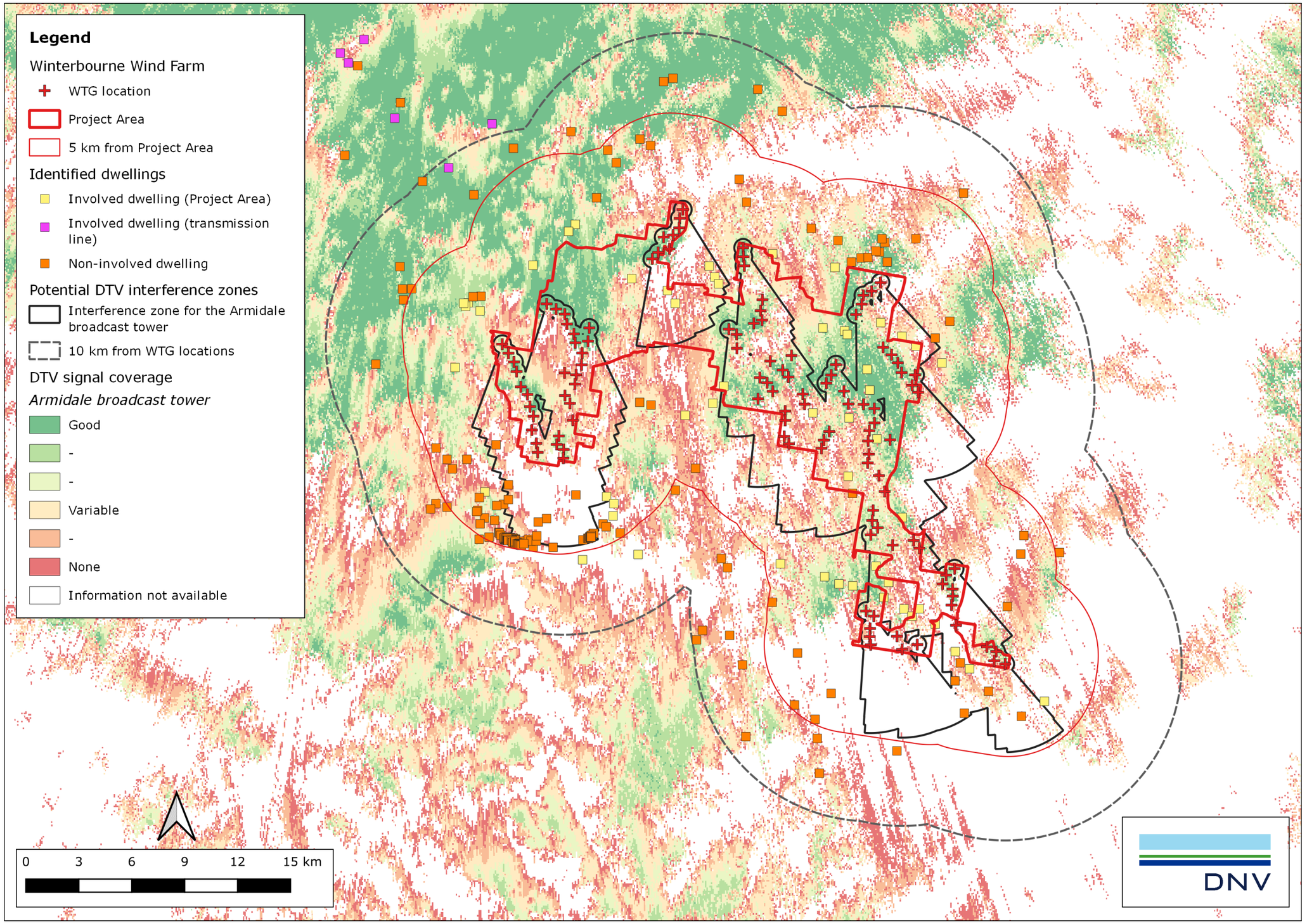

Figure 23 Potential television EMI zones for the Armidale broadcast transmitter from the Project

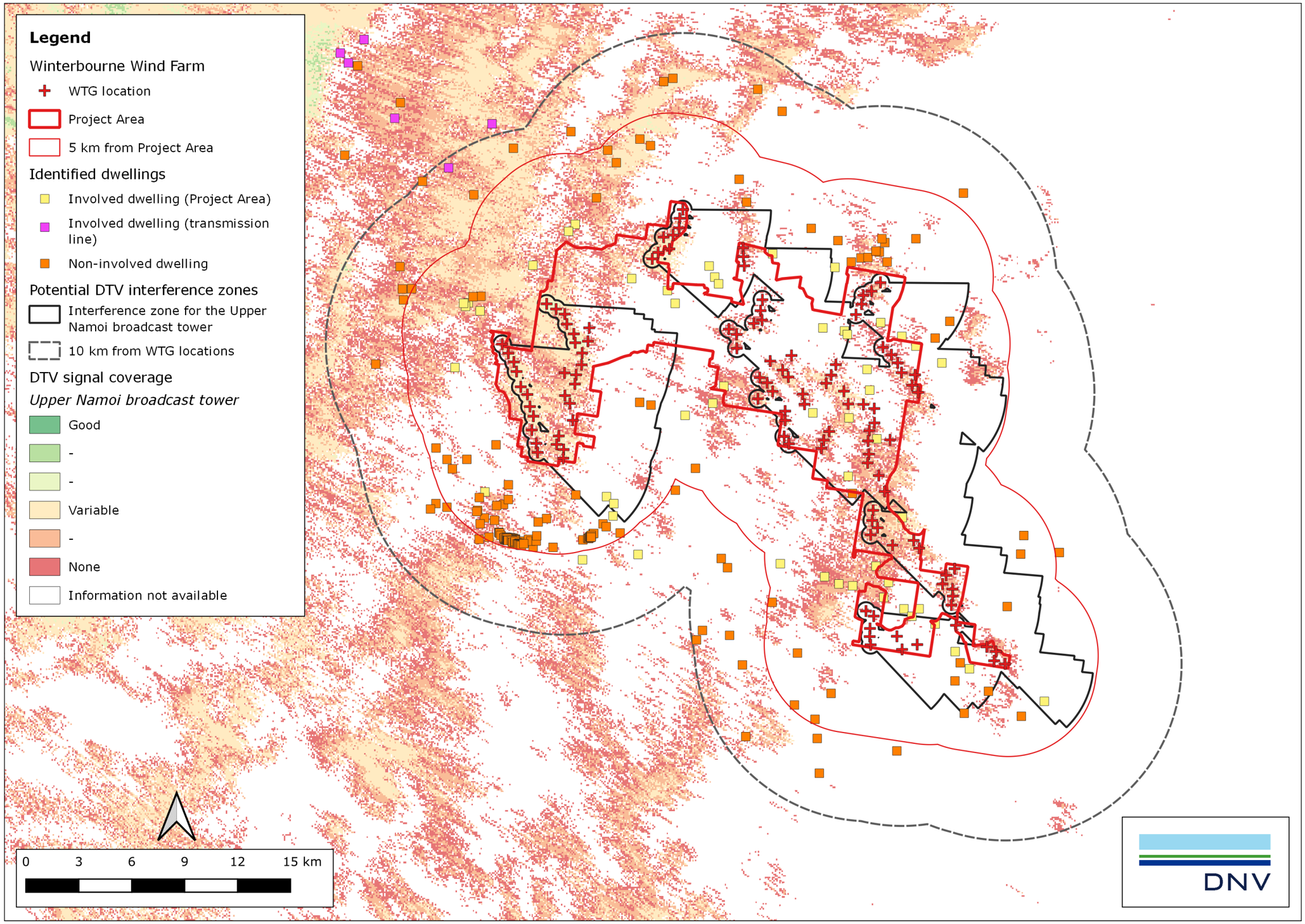

Figure 24 Potential television EMI zones for the Upper Namoi broadcast transmitter from the Project

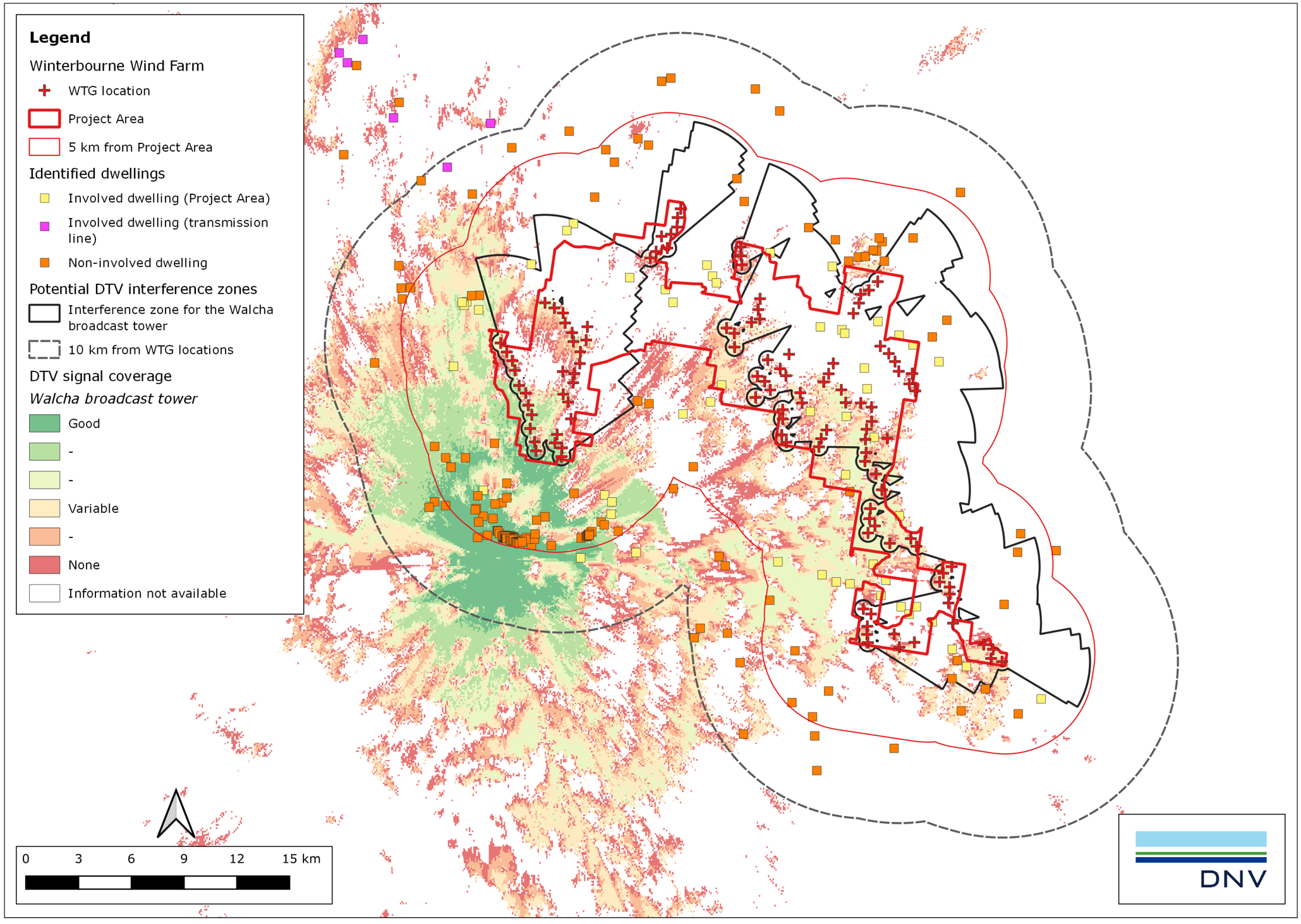

Figure 25 Potential television EMI zones for the Walcha broadcast transmitter from the Project

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.