KING ROCKS WIND FARM

EMI Assessment

Urbis Pty Ltd

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EXECUTIVE SUMMARY

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

Background and methodology

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

A Project layout consisting of 30 wind turbines with a rotor diameter of 180 m and tip height of 240 m has been considered. These dimensions represent the maximum overall tip height within the maximum rotor and tower hub height dimensions.

The locations of 10 receptors within 5 km of the Project have been provided by the Customer. The Customer has advised that one of these receptors is not a dwelling, and that receptor has therefore not been considered further in this assessment.

Outcomes of the assessment

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

Impacts to most radiocommunication services considered in this assessment are either not expected or are considered unlikely.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals and radio broadcasting, particularly in areas with poor or marginal signal coverage. If interference to these services is experienced, a range of options are available to rectify difficulties.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely impacts.

DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact. The Department of Fire and Emergency Services (DFES) have advised that there is a low potential for interference to their mobile radio operations within and to the east of the Project site, but have suggested that this can be better evaluated after construction of the Project. The DFES have also advised that, if interference to their mobile radio systems is experienced, a potential rectification measure may be to install another repeater in the vicinity of the Project. All other responses received to date indicate that the Project is unlikely to impact on nearby radiocommunication services.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radiocommunication towers	No towers within 2 km of proposed turbine locations	Unlikely to cause interference	Consultation not considered necessary	None required
Fixed point-to-point links	No links crossing Project boundary	None	Consultation not considered necessary	None required
Fixed point-to-multipoint links	16 assignments within 75 km of Project boundary No base stations within 20 km of Project boundary	Potential for interference if link paths cross the Project near turbines, although DNV considers this to be unlikely	Water Corporation: No concerns raised Western Power: No concerns raised	If required – relocate turbines to be outside interference zones, reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	-	-	-
Emergency services	Point-to-point links: No links crossing boundary Mobile telephony systems: unlikely to be affected	Unlikely to cause interference	Department of Fire and Emergency Services: Low potential for interference to mobile radio operations within and to east of Project, to be evaluated after construction St John Ambulance Australia: No concerns raised Western Australia Police: No response received to date	Point-to-point links: none required Mobile telephony systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

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

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Meteorological radar	Nearest radar: "Newdegate", 92 km from Project	Potential for interference if turbines at the Project are visible to radars	Impacts are expected to be manageable	Notify the Bureau of Meteorology (BoM) prior to any planned shutdown of the Project to allow calibration of their systems, collaborate with the BoM in the event of severe weather conditions
Trigonometrical stations	Unlikely to be affected	Unlikely to cause interference	Landgate: No concerns raised Geoscience Australia: No concerns raised	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	No concerns raised	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	Potential service providers: Telstra, CRISP Wireless, NBN Co NBN: available as a satellite service only	Unlikely to cause interference	NBN Co: No concerns raised Telstra: No concerns raised CRISP Wireless: No concerns raised	Mobile phone networks: as for mobile phones NBN: none required
Satellite television and internet	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Radio broadcasting	AM and FM signals: unlikely to be affected Digital radio signals: Project is outside the intended coverage area	Unlikely to cause interference to AM and FM signals	Consultation not considered necessary	AM signals and digital radio: none required FM signals: if required – install higher-quality antenna at affected location

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

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Television broadcasting	Not available in vicinity of Project	None	Consultation not considered necessary	None required

1 INTRODUCTION

Urbis Pty Ltd ("the Customer") on behalf of SynergyRED ("the Proponent") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed King Rocks Wind Farm ("the Project") in Western Australia. The results of this work are reported here. This document has been prepared in accordance with the Urbis Sub-consultant Agreement between Urbis Pty Ltd and DNV Australia Pty Ltd, dated 13 April 2022, and is subject to the terms and conditions in that agreement.

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

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

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

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The Project is located in southwestern Western Australia, approximately 35 km northeast of Hyden townsite and 350 km east of Perth. An indicative site plan provided by the Customer is presented in Figure 1. The terrain at the site is relatively simply with elevations ranging from approximately 250 m to 430 m above sea level. Ground cover on the site consists primarily of open farmland interspersed with windbreaks and small areas of trees. The eastern boundary of the site adjoins a larger area of moderately dense native vegetation.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 30 wind turbines [2]. A map of the site with the proposed turbine layout used for this assessment is shown in Figure 2, and the coordinates of the proposed turbine locations are presented in Table 2.

2.2.2 Receptor locations

The locations of 10 receptors (dwellings and other significant buildings) within 5 km of the Project were provided to DNV by the Customer [3, 4]. The coordinates of these receptors are presented in Table 3, and the receptors and Project boundary are shown in Figure 2. Two of the receptors shown in Table 3 and Figure 2 have been identified by the Customer as belonging to landowners involved with the Project.

The Customer has also advised that one of the landowner receptors shown in Table 3 and Figure 2 (receptor B, located within the Project boundary) is not a dwelling. Therefore, receptor B has not been considered further in this assessment. DNV has assumed that all other receptors are habitable dwellings.

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.

3 REGULATORY REQUIREMENTS

The development of wind farms in Western Australia is governed by the Western Australian Planning Commission's Position Statement on renewable energy facilities ("the WA Position Statement"), published in March 2020 [5]. However, the WA Position Statement does not address the potential for wind farms to cause EMI-related impacts on nearby radiocommunication services.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [1]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development.

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

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

4 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 30 wind turbines, as outlined in Table 2.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 180 m and a tip height of 240 m has been considered. These dimensions represent the maximum tip height and rotor diameter under consideration for the Project. The results generated based on this turbine configuration will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying all of the following criteria:

- a rotor diameter of 180 m or less
- an upper tip height of 240 m or less.

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

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from a copy of the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 29 March 2022 [6].

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

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a radiocommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV has consulted with 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 9.

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

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

4.1 Radiocommunication towers

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

4.1.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 94 radiocommunication towers within a nominal 75 km of the Project boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 3.

There are no radiocommunication towers located within 2 km of the proposed turbine locations.

4.2 Fixed licences of point-to-point type

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

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

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

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

There are no point-to-point links recorded in the ACMA RRL database that pass over the proposed Project boundary, and so there is no potential for the Project to interfere with point-to-point links.

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 16 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 5. The details of the licence holders as given in the ACMA RRL database are provided in Table 4.

Wind turbines can cause interference to point-to-multipoint links through the same mechanisms as described for point-to-point links in Section 4.2.1. There are no point-to-multipoint base stations within 20 km of the Project boundary, and so there is low potential for the associated link paths to cross the Project. 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 proposed Project will cause interference to their services.

Responses have been received from Electricity Networks Corporation (Western Power) and Water Corporation as summarised in Table 9, indicating that they do not expect the Project to interfere with their existing services and equipment. However, Western Power have advised that they plan to install new radiocommunication assets in the vicinity of the Project and, although they do not currently anticipate any impacts to those assets, they are unable to confirm the potential for interference until their plans are finalised. DNV recommends that the Proponent engages further with Western Power prior to the construction of the Project to confirm the potential for impacts to their operations.

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 proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 6 and Table 5.

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

The potential for interference to emergency services signals and commercial mobile telephony signals is discussed further in Sections 4.5 and 4.10 respectively, while the potential for interference to commercial national radio and television broadcasting services is considered in Sections 4.13 and 4.14. Several low power open narrowcasting (LPON) broadcasting licences have also been identified within 75 km of the proposed Project boundary. These licences are typically used for private radio and television broadcasting catering for special interest groups or special events. LPON licences are subject to signal strength, reception, and frequency limitations, and may only provide coverage within a radius of up to 2 km in residential areas and 10 km in non-residential areas [7]. The closest site registered as an LPON licence is located 23 km from the Project boundary, and so there is no potential for the Project to interfere with these services.

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

4.5 Emergency services

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

4.5.1 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 6 along with their contact details. The nearest licence is associated with a tower located approximately 13 km from the Project boundary.

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

All other licences operated by emergency services in the vicinity of the Project are mobile telephony licences used for mobile radio and paging systems. As discussed in Section 4.4, mobile telephony systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction. Reference [8] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts to these systems. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for point-to-area style services [9].

Given the distance of the emergency services mobile telephony licences from the Project, DNV considers it unlikely that the Project will cause interference to mobile radio and paging systems operated by emergency 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. Responses have been received from the Department of Fire and Emergency Services (DFES) and St John Ambulance Australia, as summarised in Table 9.

The DFES have indicated that there may be a low potential for impact to their mobile radio operations within, and to the east of, the Project. The DFES have suggested that any possible impacts to their systems can be evaluated after the installation of the wind turbines and that, if interference to their mobile radio systems is experienced, a potential rectification measure may be to install another repeater in the vicinity of the Project.

St John Ambulance Australia have indicated that they do not anticipate the Project to interfere with their services or equipment. No response has been received from Western Australia Police to date.

4.5.3 Mitigation options

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

4.6 Aircraft navigation systems and radar

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

4.7 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 [10].

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 [11, 12].

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 [13, 14], and approximately 100 km at a height of 1000 m [14]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high potential for complete or partial blockage of the radar signal and subsequent loss of weather data [15, 16]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of turbines causing reflection or scattering of the radar signals or interfering with Doppler velocity measurements. At distances of between 20 km and 45 km, the presence of a wind farm may produce radar echoes or signal clutter that can cause loss of data or be mistaken for rain. Significant impacts are generally not expected for wind farms located more than 45 km from a meteorological radar, since in most cases the turbine will 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 proposed Project should be consulted [1].

4.7.1 Locations of meteorological radars and potential for interference

DNV has identified that the BoM operates eight weather radars within 250 nautical miles of the proposed Project, with the closest radar, "Newdegate", located approximately 92 km south of the Project. The locations of these radars are shown in Figure 7 and the details of each radar are given in Table 7.

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 several conditions in writing. Broadly, the conditions proposed by the BoM request that:

- the Proponent informs the BoM of any changes to the Project design, including changes to turbine locations by more than 100 m, or changes to the turbine dimensions
- the owner or operator of the Project provides the BoM with advanced notice of any planned shutdown of the Project, to allow the BoM to calibrate their radar systems
- the owner or operator of the Project collaborates with the BoM in the event of severe weather conditions in the interest of community safety.

DNV understands that the Proponent is currently engaging with the BoM to clarify their expectations and requirements for these conditions.

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 [16], 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 turbines 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.

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 turbines. However, the potential for impact is considered low as it is likely to be possible to relocate the target to obtain an unobstructed view of the trig point. Microwave systems can measure distances up to 150 km, but such systems are not limited by the line of sight or affected by visibility [17].

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 [18]. 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) [19], 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 [20], there are 7 trig points within 20 km of the Project boundary. The details of these trig points are provided in Table 8 and their locations are illustrated

in Figure 8. There are also 52 permanent survey marks within 20 km of the Project boundary [21] as shown in Figure 9. The closest survey mark is located 293 m east of the nearest turbine.

DNV has reviewed the primary geodetic network of Australia [22] and observed that the Project is located within the third-order triangulation region. First-order triangulation depends on trigonometrical stations of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation are then used for the second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

The closest GNSS station is located approximately 32 km southwest of the Project, at Hyden [23]. 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 the Western Australian Land Information Authority (Landgate) to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

Responses have been received from Landgate and Geoscience Australia, as summarised in Table 9, and no concerns have been raised regarding the potential for EMI from the Project. However, Landgate has asked that they be advised in the event that any survey marks are destroyed or disturbed during construction of the Project.

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

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

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

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 proposed Project. The locations of these towers are shown in Figure 10. The nearest mobile phone tower is located approximately 16 km southwest of the Project boundary.

Mobile phone network coverage maps have been obtained for Telstra. There is no Optus or Vodafone network coverage in the vicinity of the Project.

Figure 11 and Figure 12 show the Telstra network coverage across the Project area [24]. Telstra 3G network coverage is available across most of the Project area, excepting an area in the southeast, and in areas to the north and southwest of the Project. Telstra 4G coverage is limited to

the centre of the Project area, and in smaller coverage patches to the north and southwest of the Project.

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

4.10.2 Stakeholder consultation and responses

DNV has contacted Telstra to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services.

The response received from Telstra indicates that they do not expect the Project to interfere with their mobile phone services. However, Telstra has noted the potential for the electrical transmission infrastructure at the Project to cause power coordination issues with their underground copper distribution cables located to the west of the Project. DNV recommends that the Proponent engages further with Telstra to determine the potential for power coordination issues and establish and understanding of how any such issues may be mitigated through the electrical design for the Project.

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 Telstra. 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 wind turbine intercepts the signal between a receiver and the tower.

DNV has also been made aware that CRISP Wireless has recently received approval for construction of a new radiocommunication tower at Kondinin [25]. DNV understands that the proposed tower is to be located approximately 80 km from the Project, and is to serve as a repeater for wireless

broadband services to extend the coverage of CRISP Wireless's fixed wireless network in the area. While DNV considers that the Project is unlikely to impact services from the proposed tower due to the large distance between the Project and the tower site, CRISP Wireless may have other plans for future equipment to be installed in the region closer to the Project.

4.11.1.2 Stakeholder consultation and responses

DNV has contacted Telstra to seek feedback regarding the potential for interference to their services. DNV has also contacted CRISP Wireless to seek their feedback on the potential for impacts to their services from the new radiocommunications tower, and to request further information on the locations of potential future equipment and licences.

The response received from Telstra is discussed in Section 4.10.2. Specifically, no concerns have been raised regarding the potential for impacts to services provided by Telstra's mobile phone network.

A response has been received from CRISP Wireless stating that they do not anticipate the Project to interfere with their existing or planned services and equipment. Based on an indicative map provided by CRISP Wireless, the nearest proposed CRISP Wireless tower is located approximately 14 km south of the Project. The nearest fixed radiocommunication link planned by CRISP Wireless passes to the south of the Project, approximately 13 km from the nearest proposed turbine location, and there is no part of the CRISP Wireless network passing over the Project site.

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 [26]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [27].

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 [28] 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 site. It is therefore

likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. However, given that the network is only available as a satellite internet service, it is unlikely that the Project will impact residents who are currently using the NBN.

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

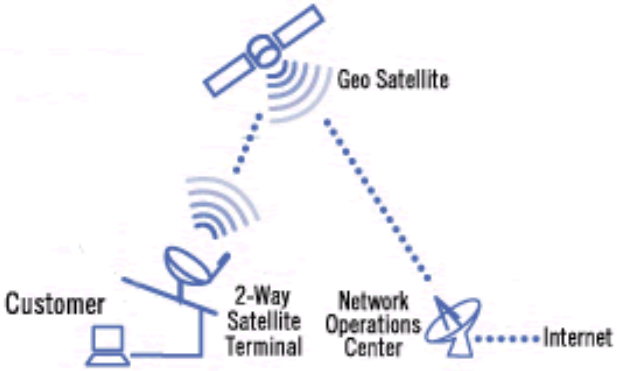
DNV has contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps. The response from NBN Co is summarised in Table 9, and no concerns have been raised.

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 [29, 30].

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 [31]

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 analysis has shown that no satellite signals to dwellings in the vicinity of the Project are expected to be intercepted by turbines.

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

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

However, as noted above, the presence of physical obstructions such as turbines is unlikely to cause significant interference to AM radio signals. Due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [32].

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 [33], and are shown in Figure 13.

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

4.13.1.2 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 wind turbines can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [34]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [32, 35].

Wind turbines located close to an FM transmitter may also present a physical obstruction to the radio signal. If the line-of-sight between the transmitter and a radio receiver is blocked by a turbine, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [34]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmitter [36].

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 [33], and are shown in Figure 13.

The closest FM broadcast transmitter is located approximately 75 km from the proposed Project boundary. Therefore, it is considered unlikely that the Project will cause interference to the FM radio signals from this transmitter.

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

4.13.2.2 Mitigation options

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

4.13.3 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 [37]. 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 [34] states that *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*. DNV has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

4.13.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [38], 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 [39]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV has experience in situations where dwellings were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

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 [33], and are shown in Figure 13. However, according to the Australian Government mySwitch website [40], there is no DTV coverage in the area immediately around the Project. Therefore, while there is no DTV coverage in the vicinity of the Project, no interference to DTV signals is possible.

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 30 wind turbine generators. DNV has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 180 m or less and an upper tip height of 240 m or less.

The results of this assessment are summarised in Table 1.

Impacts to most radiocommunication services considered in this assessment are either not expected or are considered unlikely.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals and radio broadcasting, particularly in areas with poor or marginal signal coverage. If interference to these services is experienced, a range of options are available to rectify difficulties.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely impacts.

DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact.

The Department of Fire and Emergency Services (DFES) have advised that there is a low potential for interference to their mobile radio operations within and to the east of the Project site, but have suggested that this can be better evaluated after construction of the Project. The DFES have also advised that, if interference to their mobile radio systems is experienced, a potential rectification measure may be to install another repeater in the vicinity of the Project. All other responses received to date indicate that the Project is unlikely to impact on nearby radiocommunication services.

Table 1 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radiocommunication towers	No towers within 2 km of proposed turbine locations Nearest tower: 6 km from turbines	Unlikely to cause interference	Consultation not considered necessary	None required
Fixed point-to-point links	No links crossing Project boundary	None	Consultation not considered necessary	None required
Fixed point-to-multipoint links	16 assignments within 75 km of Project boundary No base stations within 20 km of Project boundary	Potential for interference if link paths cross the Project near turbines, although DNV considers this to be unlikely	Water Corporation: No concerns raised Western Power: No concerns raised	If required – relocate turbines to be outside interference zones, reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-	-	-

Table 1 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Emergency services	Point-to-point links: No links crossing boundary Mobile telephony systems: unlikely to be affected	Unlikely to cause interference	Department of Fire and Emergency Services: Low potential for interference to mobile radio operations within and to east of Project, to be evaluated after construction St John Ambulance Australia: No concerns raised Western Australia Police: No response received to date	Point-to-point links: none required Mobile radio systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest radar: "Newdegate", 92 km from Project	Potential for interference if turbines 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 their systems, collaborate with the BoM in the event of severe weather condition
Trigonometrical stations	Seven stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Survey marks: unlikely to be affected Sight lines to other stations: may be blocked by turbines	Unlikely to cause interference	Landgate: No concerns raised Geoscience Australia: No concerns raised	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required

Table 1 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Mobile phones	Telstra 3G and 4G coverage available across parts of the Project area Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	No concerns raised	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	Potential service providers: Telstra, CRISP Wireless, NBN Co NBN: available as a satellite service only in areas surrounding the Project	Unlikely to cause interference	NBN Co: No concerns raised Telstra: No concerns raised CRISP Wireless: No concerns raised	Mobile phone networks: as for mobile phones NBN: none required
Satellite television and internet	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Radio broadcasting	AM and FM signals: unlikely to be affected Digital radio signals: Project is outside the intended coverage area	Unlikely to cause interference to AM and FM signals	Consultation not considered necessary	AM signals and digital radio: none required FM signals: if required – install higher-quality antenna at affected location
Television broadcasting	Not available in vicinity of Project	None	Consultation not considered necessary	None required

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Table 2 Proposed turbine layout for the Project [2]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
T01	707755	6431272	426	T16	705917	6433350	378
T02	708224	6430627	410	T17	705244	6427880	385
T03	706100	6429954	391	T18	705761	6428228	382
T04	706213	6428641	386	T19	705728	6431357	387
T05	706763	6431668	401	T20	705641	6430669	397
T06	707939	6430065	401	T21	708516	6429274	385
T07	706554	6429166	394	T22	708760	6429886	391
T08	707686	6429460	391	T23	704132	6433463	355
T09	707311	6432008	404	T24	704680	6427605	384
T10	706555	6430630	407	T25	707977	6427979	379
T11	706217	6432579	379	T26	704704	6432944	364
T12	706607	6433064	388	T27	707255	6430868	419
T13	705253	6433340	371	T28	705851	6432045	379
T14	704572	6433934	360	T29	707673	6427391	384
T15	708222	6428624	383	T30	706954	6429753	396

1. Coordinate system: MGA zone 50, GDA94 datum.

Table 3 Receptors in the vicinity of the proposed Project [3, 4]

Receptor ID	Easting[1] [m]	Northing[1] [m]	Landowner status[2]	Distance to nearest turbine [km]
A	*703858*	*6431265*	*Landowner*	*1.9*
B[2]	*706336*	*6429068*	*Landowner*	*0.2*
C (primary)	702778	6434616	Neighbour	1.8
C (secondary)	702763	6434782	Neighbour	1.9
D	699187	6431678	Neighbour	5.3
E	699379	6428490	Neighbour	5.4
F (primary)	701155	6425467	Neighbour	4.1
F (secondary)	701261	6425475	Neighbour	4.0
G	704838	6425301	Neighbour	2.3
H	707245	6423230	Neighbour	4.2

1. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Receptors belonging to landowners for the Project are indicated by *italic underlined text*.
3. The Customer has advised that this receptor is not a dwelling, and so it has not been considered further in this assessment.

Table 4 Details of point-to-multipoint licences within 75 km of the proposed Project

Assignment ID	Site ID	Licence no.	Latitude[1]	Longitude[1]	Distance to Project [km]	Licence owner
8373822	28824	11345711/1	-32.2348	118.8546	29	Electricity Networks Corporation Western Power GPO Box L921 Attn: Comms Operations & Maintenance Perth WA 6842
8373823	28824	11345711/1	-32.2348	118.8546	29	
1234770	29325	1568080/1	-31.7966	118.9503	50	
1234769	29325	1568080/1	-31.7966	118.9503	50	
8373843	10027170	11345716/1	-32.7680	119.2047	55	
8373842	10027170	11345716/1	-32.7680	119.2047	55	
1250126	54018	1607568/1	-32.4459	118.8911	32	Water Corporation PO Box 100 (Dinesh Raghu) Leederville WA 6902
1250129	54018	1607568/1	-32.4459	118.8911	32	
1251247	54018	1962686/1	-32.4459	118.8911	32	
1251244	54018	1962686/1	-32.4459	118.8911	32	
1250348	602222	1616899/1	-32.5332	118.5860	62	
1250351	602222	1616899/1	-32.5332	118.5860	62	
4003621	10011245	10491402/1	-32.7955	119.5160	65	
4003624	10011245	10491402/1	-32.7955	119.5160	65	
1250419	602559	1619177/1	-32.8419	119.5462	71	
1250422	602559	1619177/1	-32.8419	119.5462	71	

1. Coordinate system: Lat/Lon GDA94 datum.

Table 5 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
700 MHz Band	Spectrum	42
800 MHz Band	Spectrum	38
Aeronautical Assigned System	Aeronautical	6
Ambulatory System	Land Mobile	2
Land Mobile System - > 30MHz	Land Mobile	175
Narrowcasting Service (LPON)	Broadcasting	6
National Broadcasting	Broadcasting	2
PMTS Class B	PTS	14

Table 6 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Department of Fire and Emergency Services of WA	Department of Fire and Emergency Services of WA DFES - Radio Communications Manager PO Box P1174 Perth WA 6844	13
St John Ambulance Australia (Western Australia) Inc.	St John Ambulance Australia (Western Australia) Inc. PO Box 183 Belmont WA 6104	23
Western Australia Police	Western Australia Police Radio & Electronic Services Unit 2 Swanbank Road Att: Phillip Manna Maylands WA 6051	34

Table 7 BoM radar sites in the vicinity of the proposed Project

BoM radar site	Radar type	Latitude[1]	Longitude[1]	Distance to Project [km]
Newdegate	Doppler	-33.097	119.009	92
South Doodlakine	Doppler	-31.777	117.953	124
Kalgoorlie	Doppler	-30.783	121.455	268
Perth Ap	Standard weather watch	-31.927	115.976	302
Esperance	Doppler	-33.830	121.892	304
Perth	Doppler	-32.392	115.867	310
Albany	Doppler	-34.942	117.816	321
Watheroo	Doppler	-30.360	116.292	342

1. Coordinate system: Lat/Lon GDA94 datum.

Table 8 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude[1]	Longitude[1]	Distance to Project [km]
Hyden 20	AGD66, AGD84, GDA94	-32.0968	119.0765	15
Hyden 21	AGD66, AGD84, GDA94	-32.3156	119.1543	5
Hyden 22	AGD66, AGD84, GDA94	-32.3594	119.3264	14
Hyden 49	AGD84, GDA94	-32.1398	119.2739	11
Hyden 50	AGD84, GDA94	-32.0792	119.2978	18
Hyden 51	AGD84, GDA94	-32.2742	119.0044	15
Hyden 53	AGD84, GDA94	-32.2423	119.3125	8

1. Coordinate system: Lat/Lon GDA94 datum.

Table 9 Summary of service operators contacted by DNV and responses received to date

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
1	Fixed point-to-multipoint	29 km	Electricity Networks Corporation (Western Power) 1035367-AUMEL-L-01-A	Response received by email on 02/06/2022: *"…there is no apparent impact from the wind farm on our existing equipment. However, there are plans to build new radio and microwave sites in the vicinity, for which we have received ACMA license. At this stage, we can not find any issues or obstructions to our planned towers, but I can not guarantee these until the plans are finalised."*
2	Fixed point-to-multipoint	32 km	Water Corporation 1035367-AUMEL-L-02-A	Response received by email on 29/06/2022: *"We went through all radio sites in the list, and we can confirm that none of our sites is crossing the wind farm.* *The nearest site is our Hayden Ps which is 21.4 km from the wind farm boundary."*
3	Emergency service	13 km	Department of Fire and Emergency Services of W.A. (DFES) 1035367-AUMEL-L-03-A	Response received by email on 21/06/2022: *"I… don't expect there will be an impact to DFES radio except for the area within and East of the windfarm where signals would need to travel through the turbine blades. This impact would be better assessed after the installation with the potential of needing to place another repeater within the area."*
4	Emergency service	23 km	St John Ambulance Australia (Western Australia) Inc. (St John Ambulance) 1035367-AUMEL-L-04-A	Response received by email on 30/06/2022: *"I have reviewed the information regarding the proposed King Rocks windfarm and its location in relation to St John Ambulance Communications located nearby.* *I do not anticipate that the windfarm will cause interference to the St John communications that are situated within the 75km boundary of the windfarm location.* *I have no objection to the installation of the windfarm and see no need to apply any mitigation measures"*
5	Emergency service	34 km	Western Australia Police 1035367-AUMEL-L-05-A	No response received to date

Table 9 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
6	Meteorological radar	92 km	Bureau of Meteorology (BoM) 1035367-AUMEL-L-06-A	Response received by email on 05/07/2022: *"The King Rocks WF is close to two [of the] Bureau's radars… Newdegate and Doodlakine. However, the impact has been found to be manageable in normal weather condition.* *Therefore, the Bureau would like to provide its agreement should the proposed wind farm developer/owner agree with the following conditions:* *1. Informing the BoM of significant variation to the turbine layout (i.e. by more than 100m in any lateral direction, or alteration of hub height) between completion of the initial plan and construction.* *2. Provide advanced notice to the BoM of any planned shutdown events, to allow the recalibration of radar systems.* *3. Collaborate with the BoM in the event of severe weather conditions to assist in endeavours of community safety.* *A formal letter from wind farm developer would finalize this coordination request."*
7	Trigonometrical stations Global Navigational Satellite System (GNSS) stations	Trigonometrical station: 5 km GNSS station: 32 km	Geoscience Australia 1035367-AUMEL-L-07-A	Response received by email on 27/06/2022: *"Geoscience Australia do not foresee any impact to Commonwealth owned trigonometrical stations or Global Navigation Satellite System (GNSS) reference stations or associated assets from the proposed King Rocks Wind Farm development."*
8	Trigonometrical stations Permanent survey marks	Trigonometrical station: 5 km Survey mark: 293 m	Landgate 1035367-AUMEL-L-08-A	Response received by email on 25/05/2022: *"I do not believe the windfarm will in any way interfere with Landgate ground marks unless they need to be destroyed in which case please let us know.* *We have GNSS equipment now operated by GA located 30 km from the proposed farm and I have referred your question to… Geoscience Australia."*

Table 9 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
9	PMTS/spectrum (mobile phone) Wireless internet	PMTS/spectrum: 16 km	Telstra Corporation Limited (Telstra) 1035367-AUMEL-L-09-A	Response received by email on 15/07/2022: *"To provide a better understanding of potential impacts to Telstra infrastructure a simulated analysis was carried out. Based on this research, to minimise potential interference to Telstra's telecommunications network Telstra requires the developer to confirm its agreement to the conditions and matters set out below:* *1) There are no expected impacts to Telstra's Mobile network due to this wind farm based on the turbine locations provided. The nearest Telstra mobile tower is 17 km away.* *2) Based on the KMLs provided and information regarding Telstra existing point to point radio links obtained from Waypoint and maprad.io, the proposed wind farm should not impact on any of Telstra's existing point to point radio links.* *3) Based on the limited information provided there does not appear to be any power coordination issues with the Telstra copper distribution cables that are situated to the west of the proposed wind farm.* *For a detailed analysis of the full power coordination impact of the wind farm development further information is required. This includes location of the wind farm switch yard, the route and potential of any associated HV transmissions lines and the EPR [earth potential rise] impact on any Telstra plant they may affect.* *The developer also confirms its role as the proponent and ultimate owner of the proposed wind farm and that it has the authority to ensure that the conditions set out above are implemented and complied with. If the agreement of any other person or entity is required to ensure the conditions set out in this letter are complied with, the developer undertakes to obtain that agreement in writing and to provide it to Telstra prior to lodging a development application for the wind farm.* *If the proposed plans and specifications of the development are altered or amended, Telstra reserves the right to request further conditions and amendments to the development.* *Should you wish to discuss any aspect of this letter please do not hesitate to contact the undersigned. Otherwise, I would appreciate you responding to me confirming the developer's agreement to the conditions and matters set out above."*

Table 9 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
10	Wireless internet	More than 75 km from Project boundary	CRISP Wireless (CRISP)	Response received by email on 30/06/2022: *"I don't believe there is going to be any crossover of our network and the proposed wind farm.* *… so I don't see any issues."*
11	Wireless internet	More than 75 km from Project boundary	NBN Co Spectrum Pty Ltd (NBN Co) 1035367-AUMEL-L-10-A	Response received by email on 21/06/2022: *"... 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 the existing wireless customer RF Profiles or any boresight paths of existing nbn microwave links.* *… 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 King Rocks Wind Farm on NBN Co Spectrum Communication Assets* *Referring to your email dated 25th May 2022 regarding the application for the King Rocks Wind Farm.* *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 115 km of the proposed King Rocks 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."*

LIST OF FIGURES

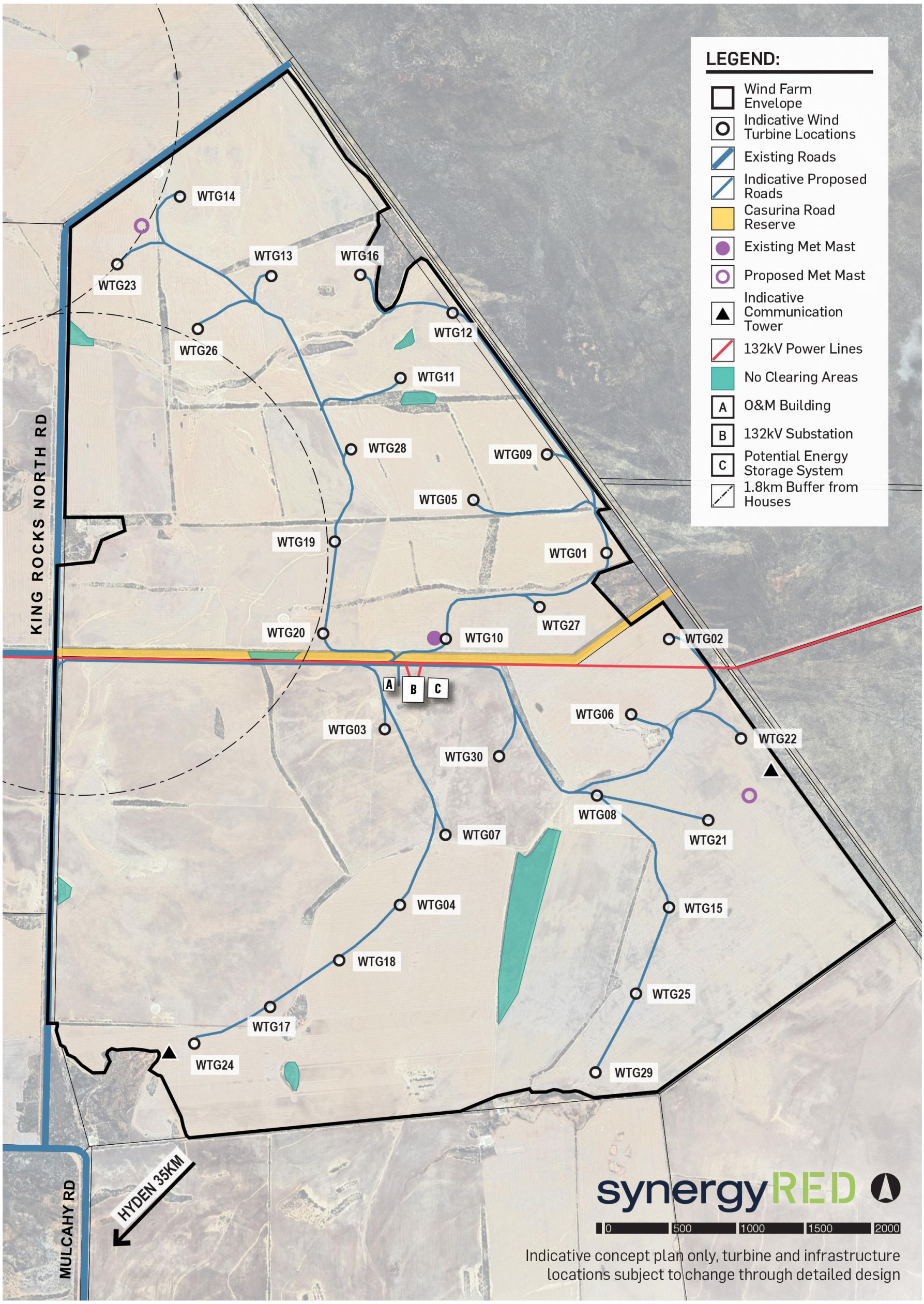

Figure 1 Site plan showing the wind farm envelope and indicative turbine and infrastructure locations, as provided by the Customer [41]

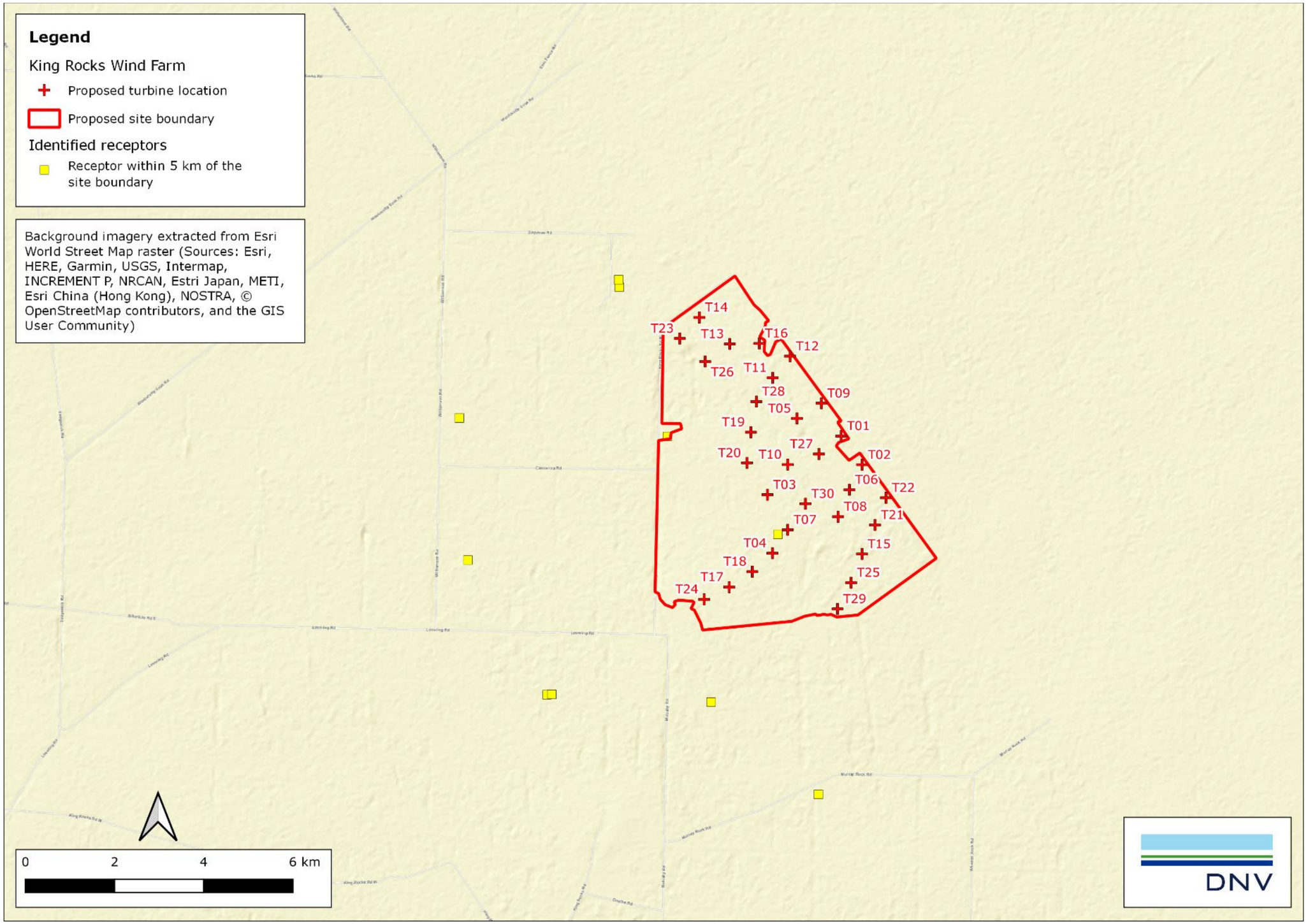

Figure 2 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby receptors

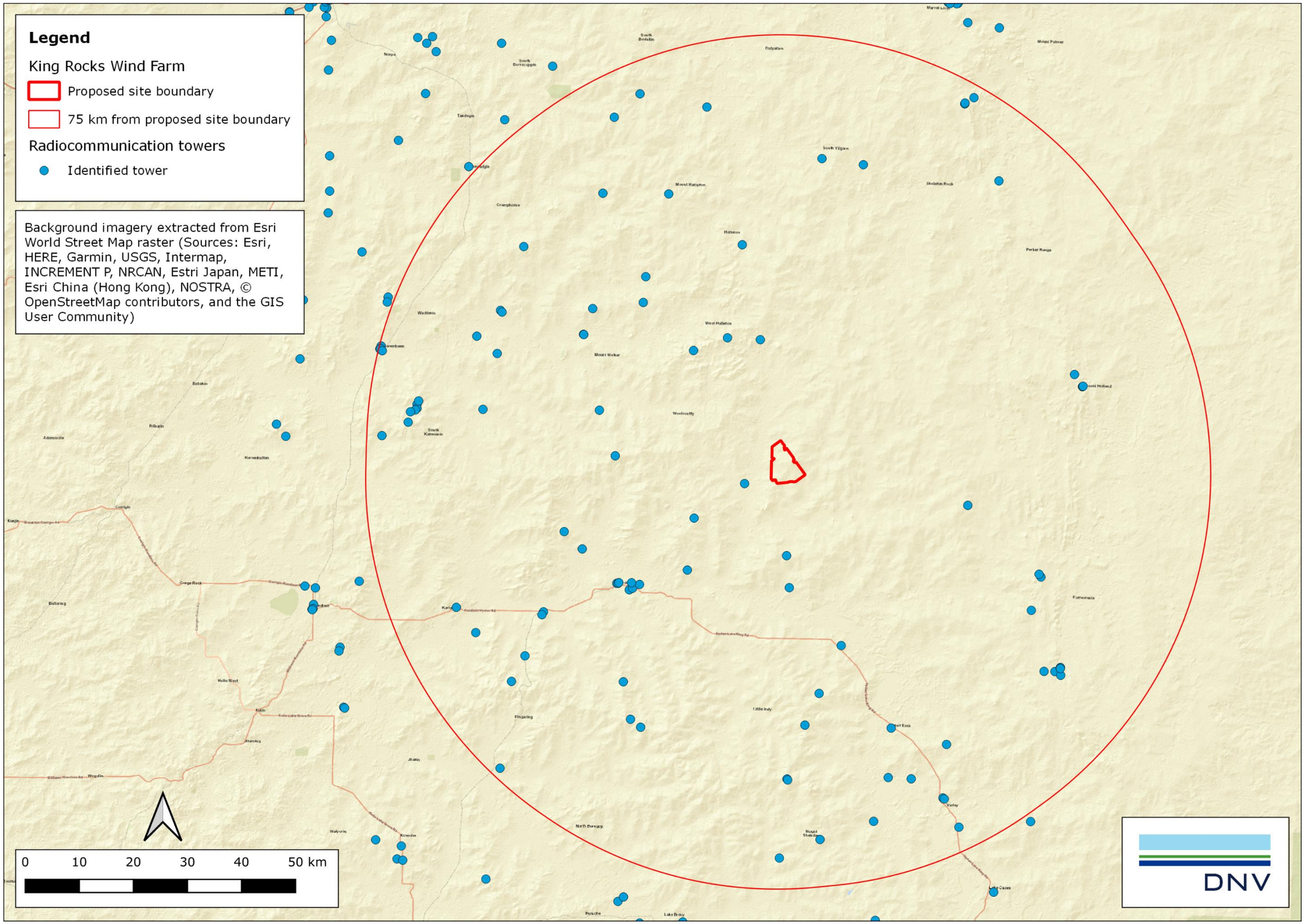

Figure 3 Location of the proposed Project and identified nearby radiocommunication sites

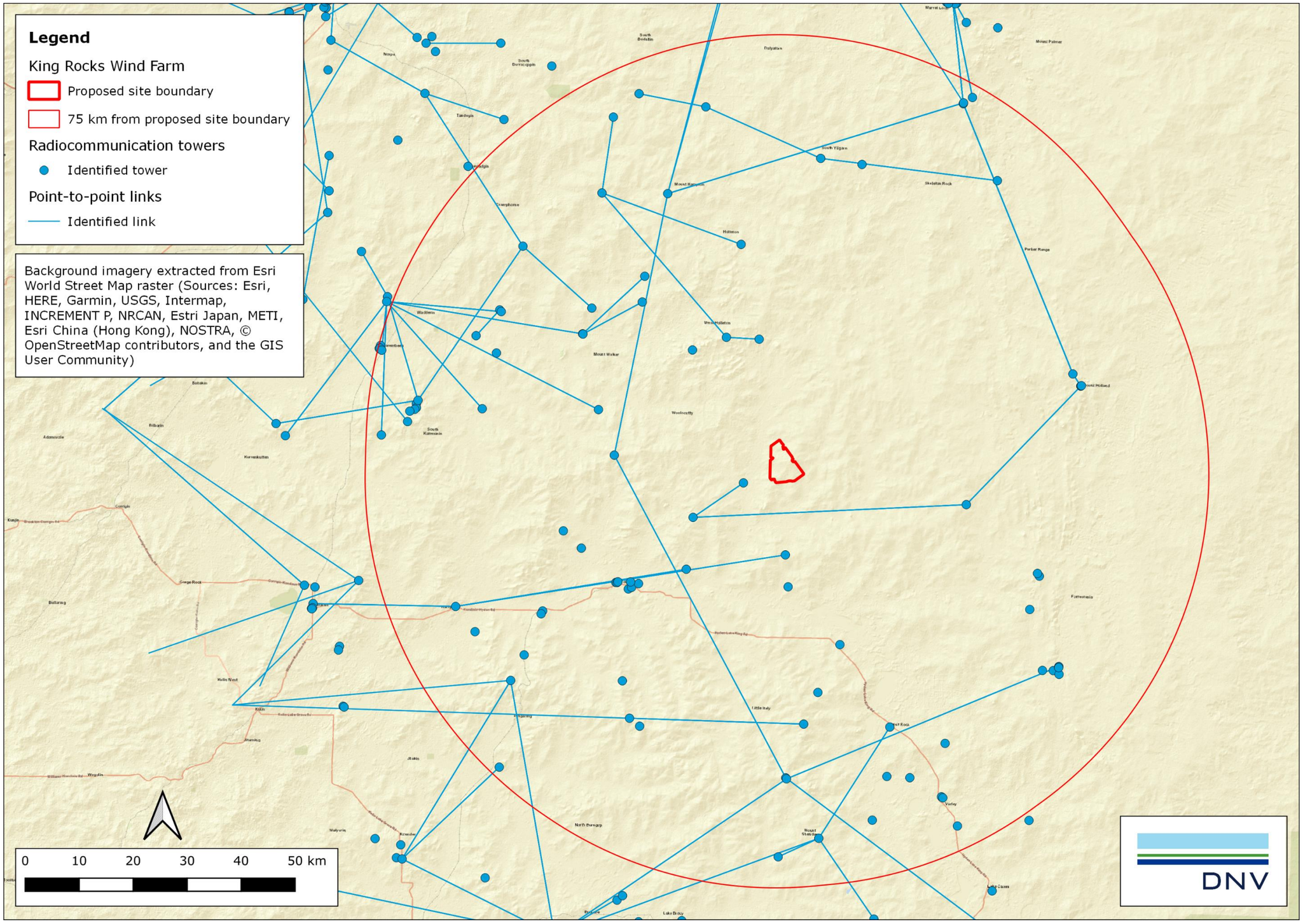

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

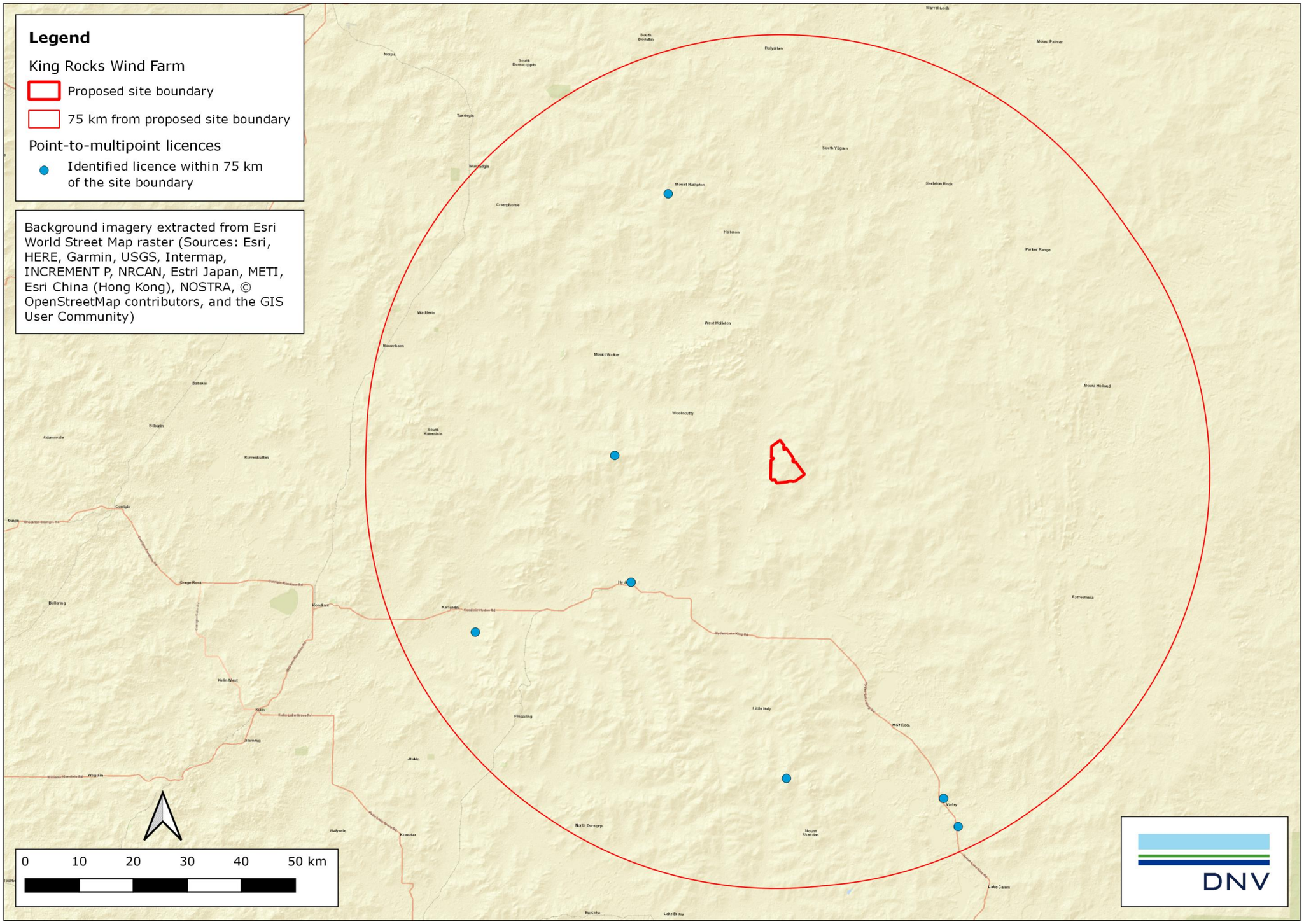

Figure 5 Location of point-to-multipoint licences in the vicinity of the proposed Project

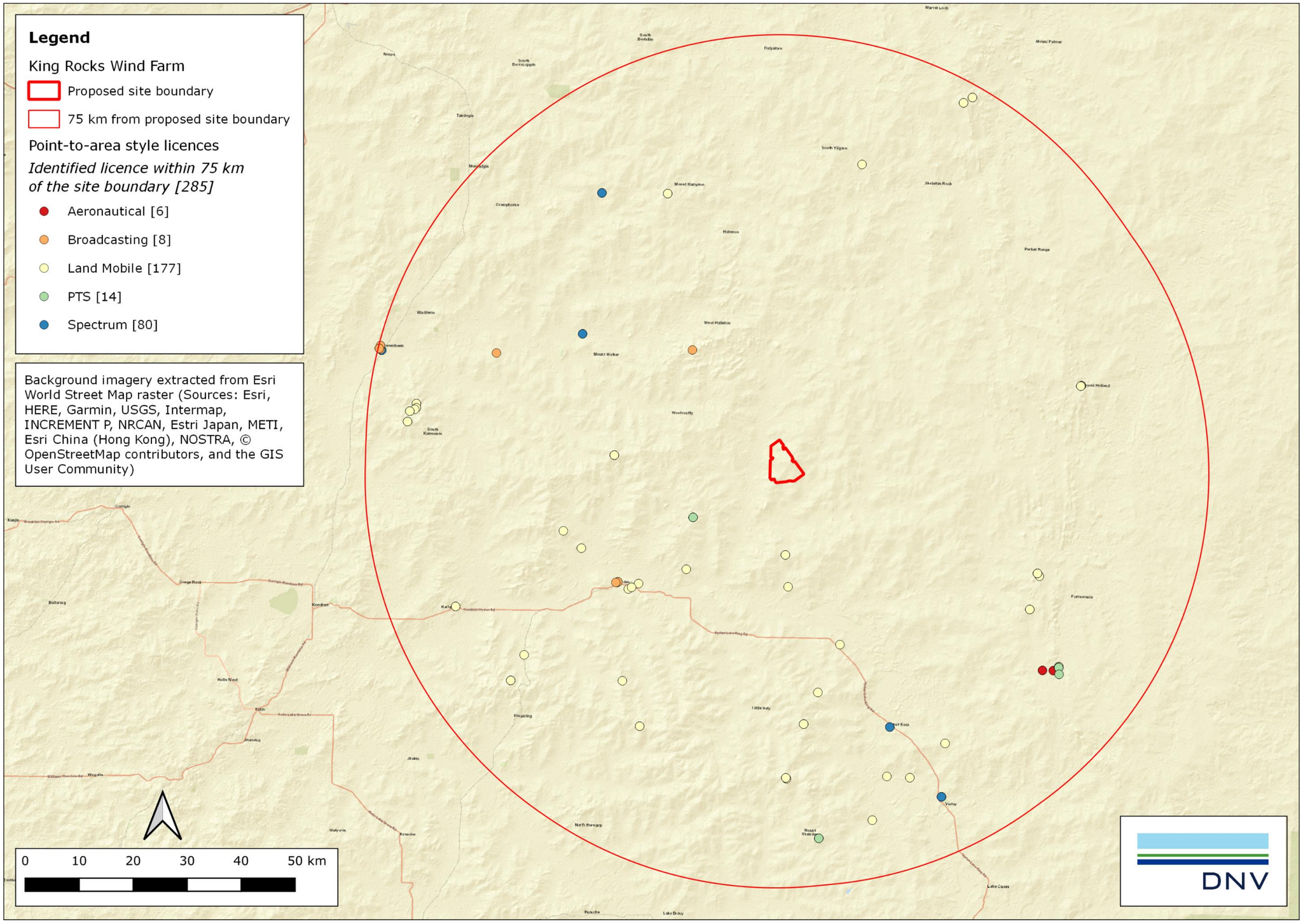

Figure 6 Location of general point-to-area style licences within 75km of the proposed Project

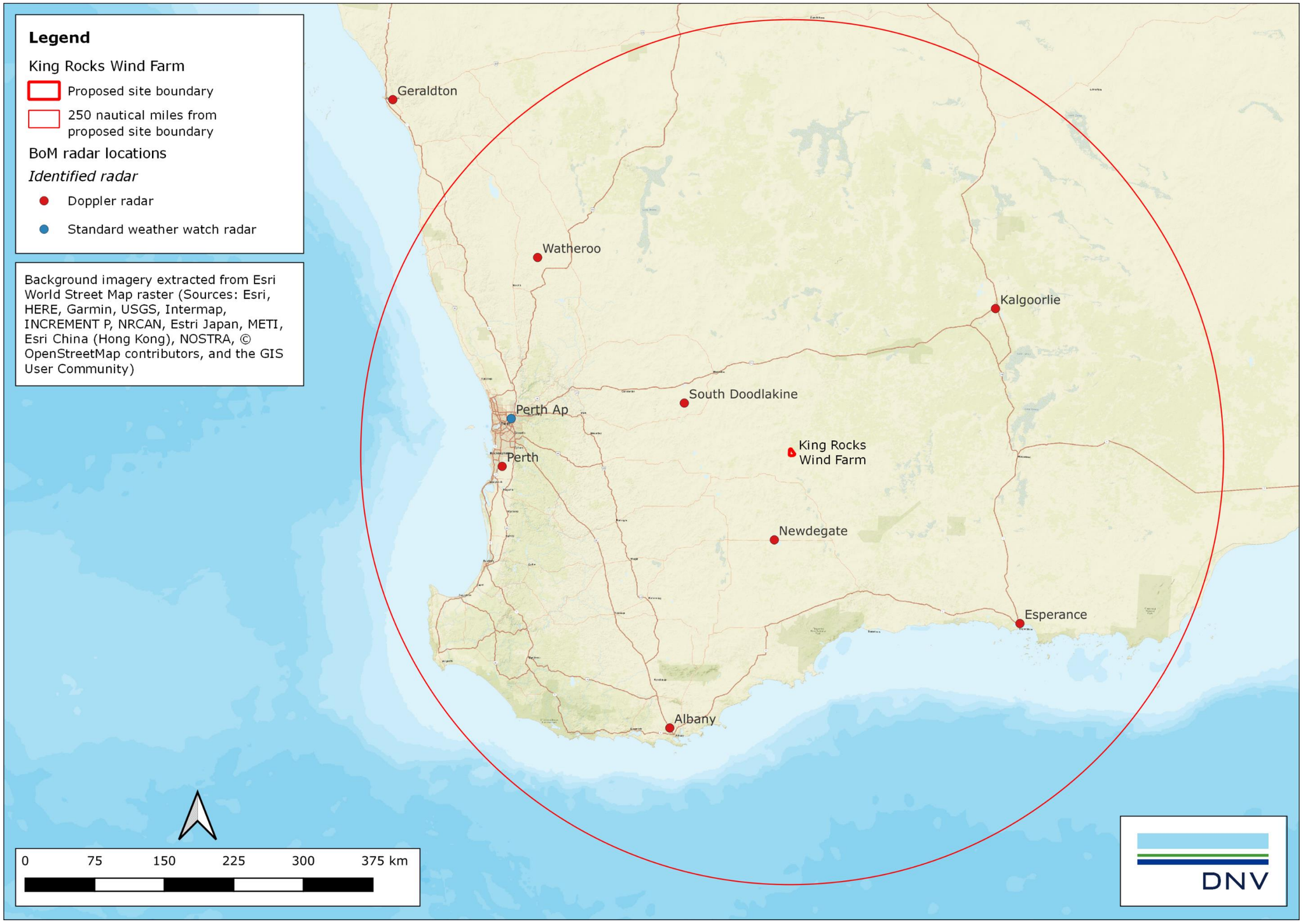

Figure 7 Location of meteorological radar sites within 250 nautical miles of the proposed Project

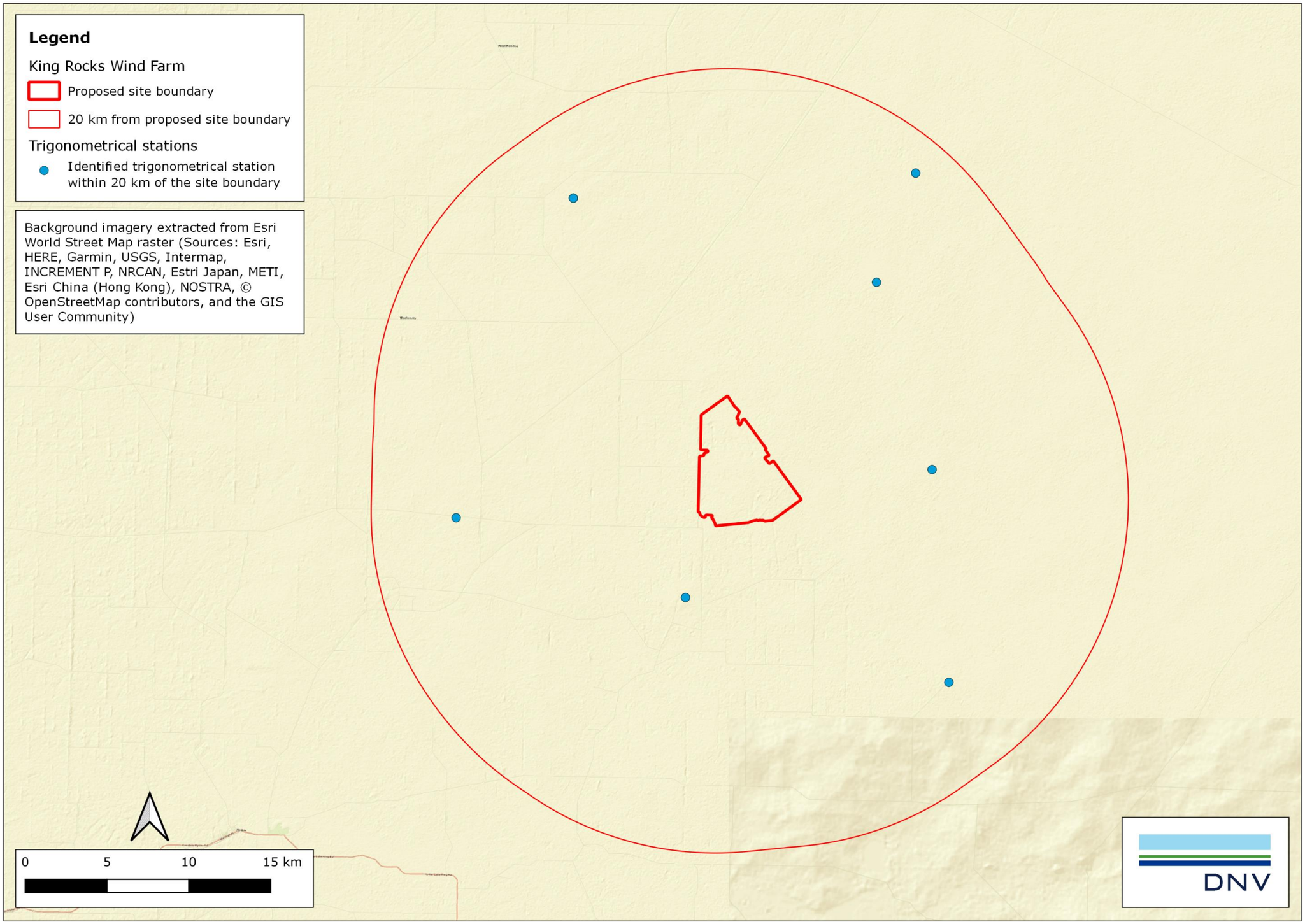

Figure 8 Location of trigonometrical stations within 20 km of the proposed Project

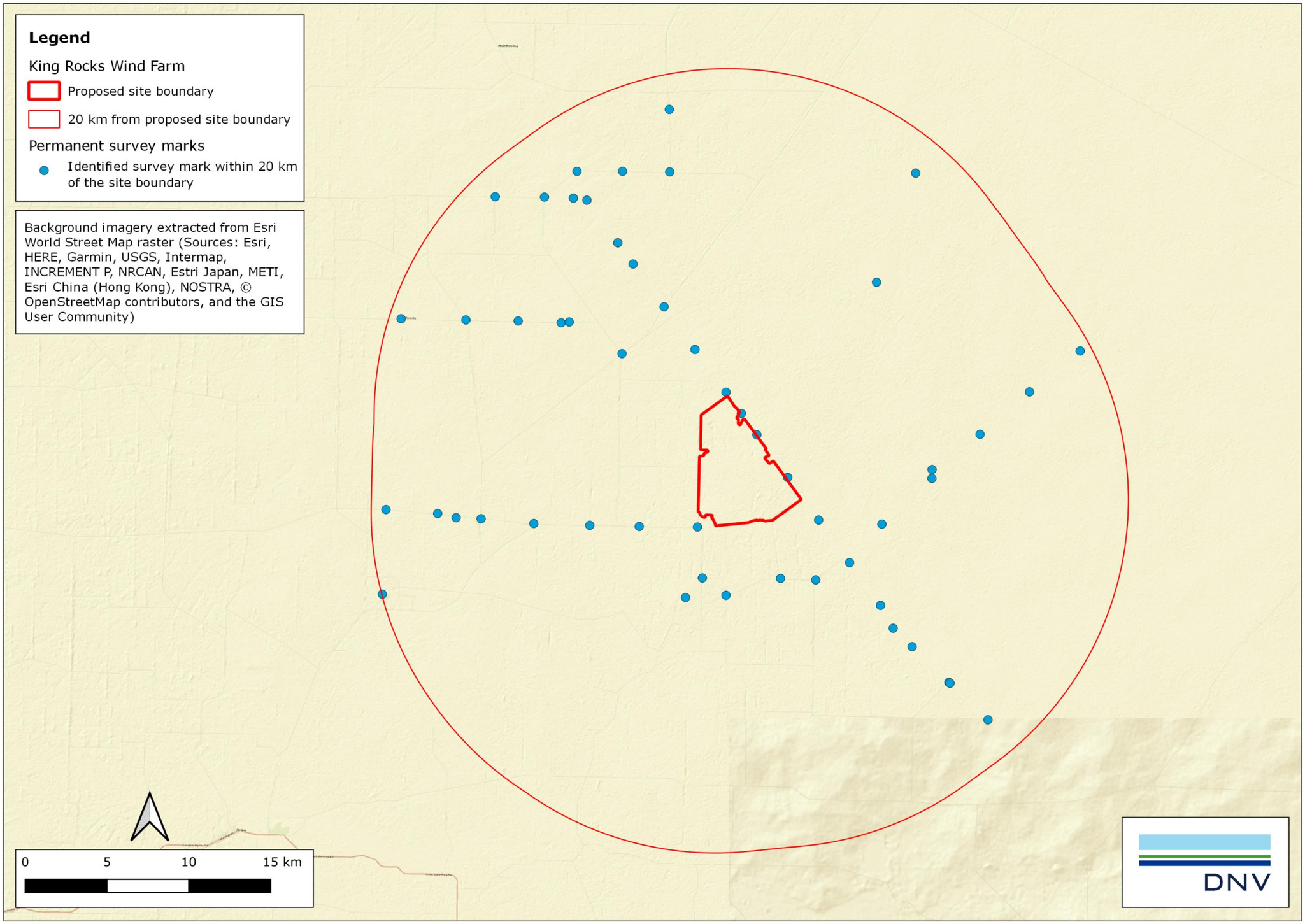

Figure 9 Location of permanent survey marks within 20 km of the proposed Project boundary

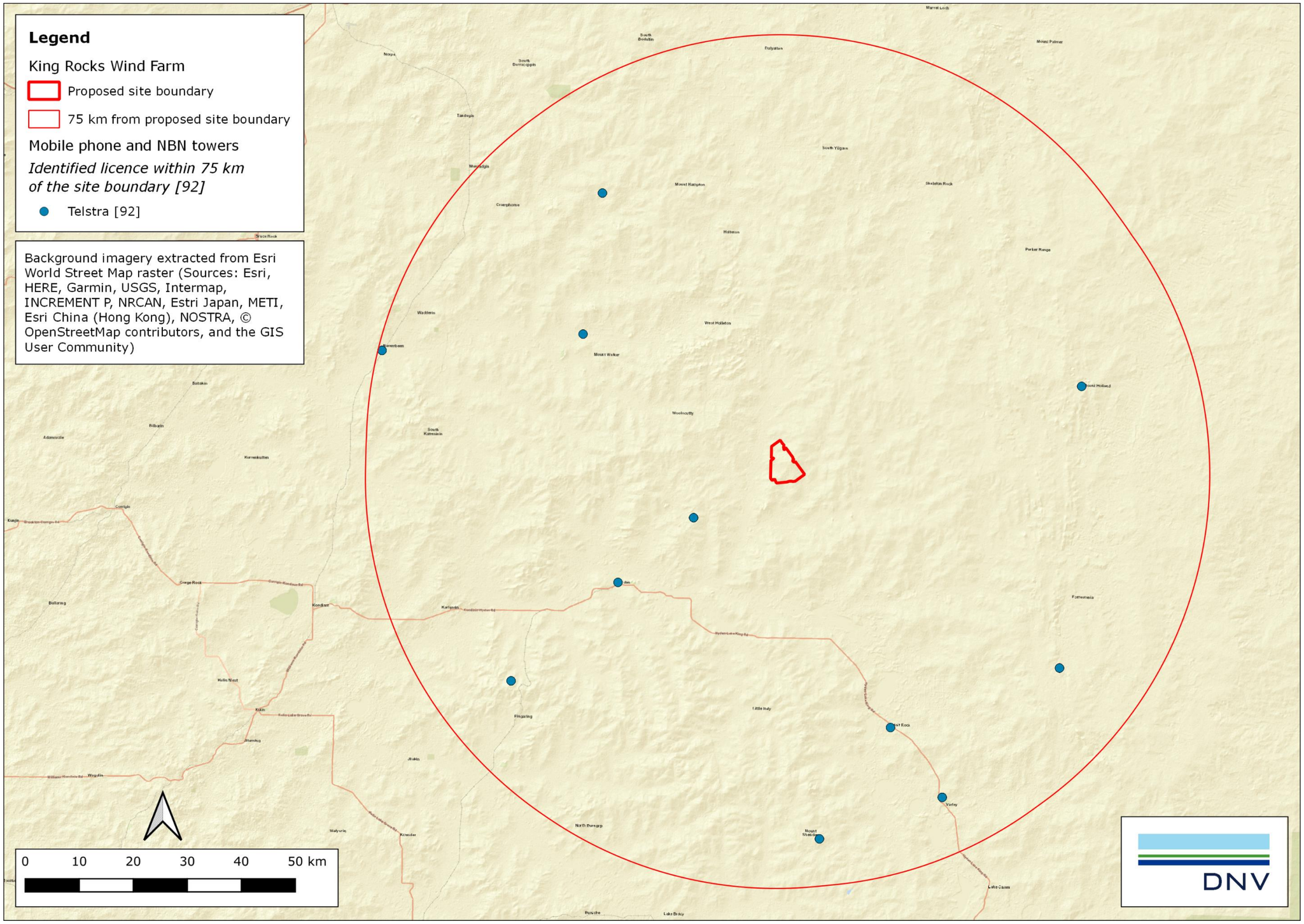

Figure 10 Location of mobile phone and NBN towers within 75 km of the proposed Project

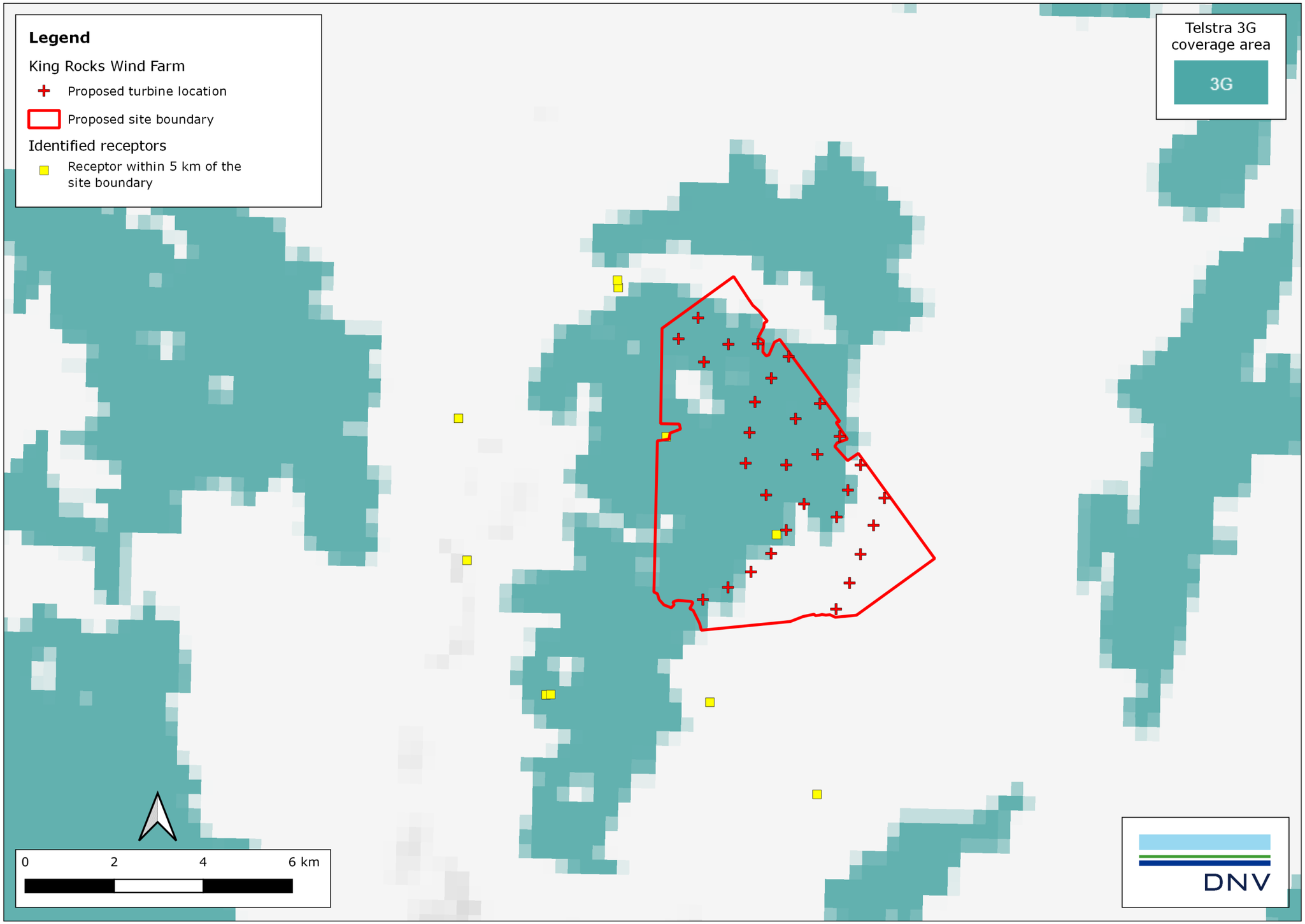

Figure 11 Telstra 3G network coverage for the proposed Project

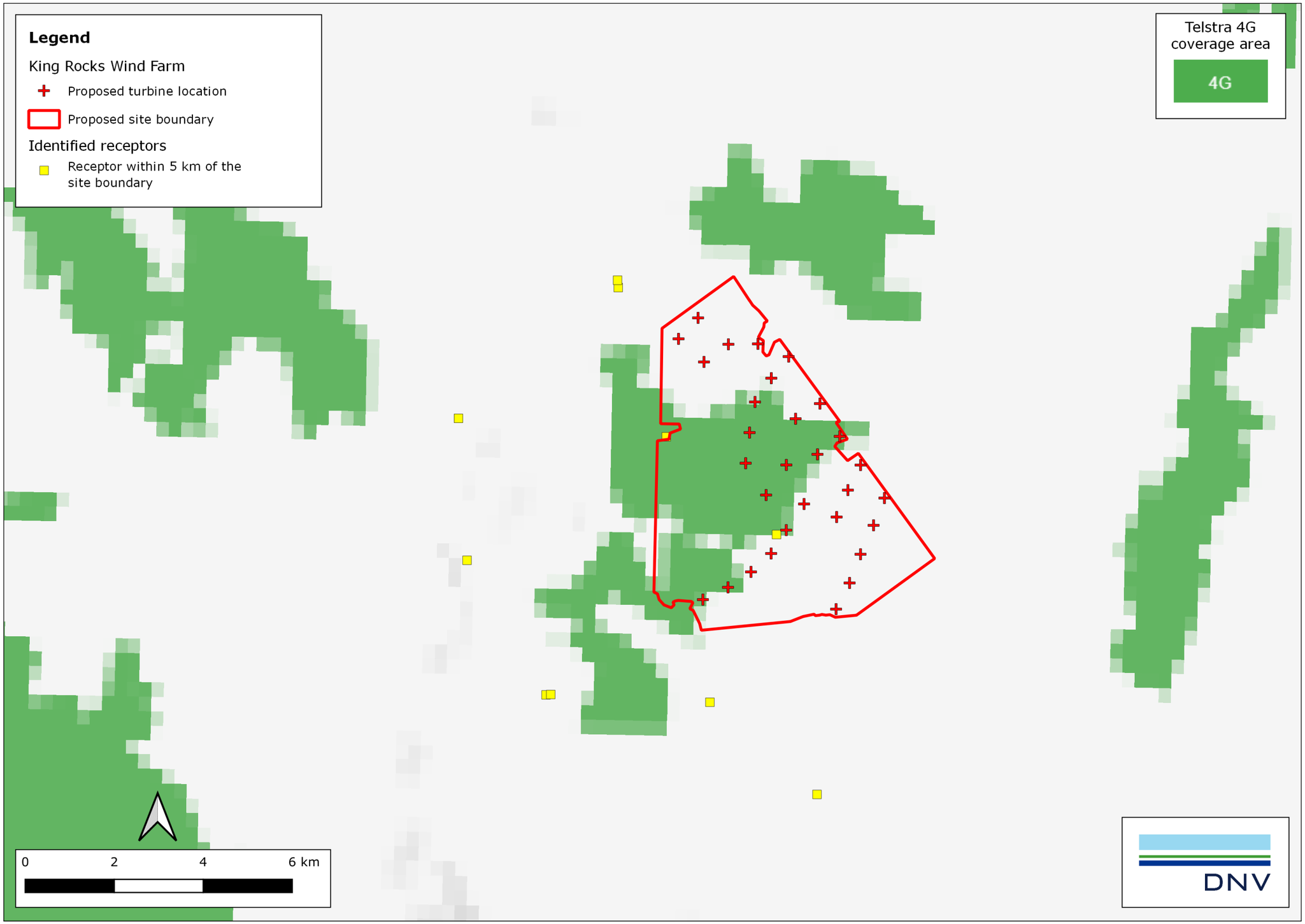

Figure 12 Telstra 4G network coverage for the proposed Project

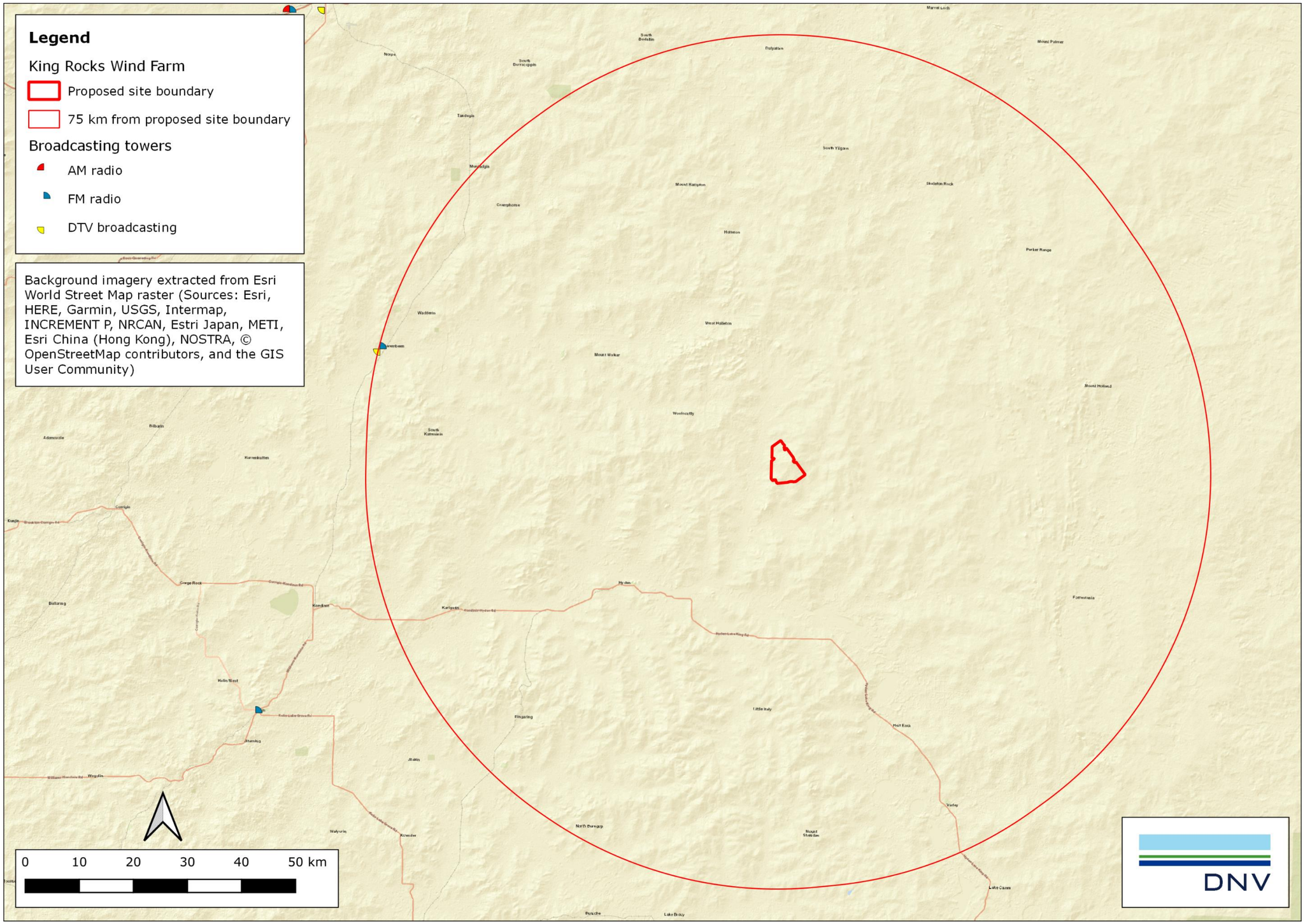

Figure 13 Location of broadcast transmitters in the vicinity of the proposed Project

About DNV

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

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

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