CLEVE WIND FARM

EMI Assessment

AECOM Australia Pty Ltd

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EXECUTIVE SUMMARY

DNV has been commissioned by AECOM Australia Pty Ltd ("AECOM" or "the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Cleve Wind Farm ("the Project") in South 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 South Australian Planning and Design Code [1] and Draft National Wind Farm Development Guidelines [2]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

A Project layout consisting of 80 wind turbines with a rotor diameter of 172 m, upper tip height of 236 m, and lower tip height of 64 m has been considered. These dimensions represent the maximum and minimum overall tip heights and maximum rotor diameter under consideration for the Project.

Outcomes of the assessment

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

There is a potential for the Project to interfere with point-to-area style communications hosted by Pringles AG-PLUS (Emmetts) and United Christian Broadcasters Australia Limited (Vision Media) at radiocommunication sites located within the Project boundary. Consultation with the operators of these services has been conducted to request feedback on the expected potential for turbines at the Project to interfere with their services. No response has been received from Emmetts and Vision Media. In the event of interference, mitigation options would need to be confirmed in consultation with the operators.

A point-to-point link by South Australia Water Corporation (SA Water) was identified to intersect the Project boundary. A diffraction exclusion zone was established by DNV for this link to determine areas to be clear of turbines for interference to be avoided. Through consultation, SA Water has advised that this link has since been decommissioned and is no longer operational. The diffraction exclusion zone previously identified for this link is therefore no longer in effect and the Project will not cause interference to the fixed point-to-point link operated by SA Water. The operators of other point-to-point links have been consulted to confirm the required clearances and potential for impact. No responses have been received to date from the remaining operators.

Spark Infrastructure Pty Ltd (SA Power Networks) and SA Water hold point-to-multipoint licences in the vicinity of the wind farm. SA Water has provided to feedback regarding potential interference to their licences and have raised no concerns. SA Power Networks however has raised concern regarding the potential for turbines at the Project to interfere with a link between their point-to-multipoint base station at Mt Neild and remote station at Rudall, and has provided details of this link for an assessment to be conducted. Three turbines are situated within the calculated interference zones established by DNV for the SA Power Networks point-to-multipoint link. To avoid potential for interference to the SA Power Networks point-to-multipoint link crossing the Project boundary, DNV recommends that turbines are moved out of a diffraction exclusion zone based on the second Fresnel zone. DNV is intending to engage further with SA Power Networks to confirm the expected potential for interference to their link.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. However, feedback received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, suggests that impacts to digital television signals are unlikely. 4G mobile phone signal reception is available at the Project area from towers at the townships of Cleve and Rudall. It is possible that the proposed wind turbines may further intercept these mobile phone signals, which are currently identified to be of poor or marginal quality at some locations within the Project boundary and to the north and east. There is also potential for the Project to interfere with signals from an FM transmitter within 4 km of a turbine to the southeast of the Project, at locations to the northwest where the signal path may be obstructed. If interference to these services is experienced, a range of options are available to rectify difficulties.

The Bureau of Meteorology has advised that impacts to their weather radar systems are expected to be manageable, and no concerns have been raised to date regarding potential impacts to emergency services operations.

Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	3 towers within 2 km of proposed turbine locations, operated by: ElectraNet Pty Limited (ElectraNet) Pringles AG-PLUS Pty Ltd (Emmetts) United Christian Broadcasters Australia Limited (Vision Media)	**ElectraNet, Emmetts and Vision Media:** No response received	**ElectraNet point-to-point link:** Unlikely to cause interference **Emmetts and Vision Media point-to-area style communications:** Potential for interference	**ElectraNet point-to-point link:** as for point-to-point links **Point-to-area style communications:** If required – install higher-quality antenna at affected location (for localised interference), increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Fixed point-to-point links	9 links with calculated interference zones intersecting the Project boundary, operated by: ElectraNet South Australia Water Corporation (SA Water) South Australian Government Radio Network (SAGRN) Optus Mobile Pty Ltd (Optus) Spark Infrastructure SA Pty Ltd (SA Power Networks) **SA Water link:** 1 turbine in calculated diffraction exclusion zone **Other links:** no turbines in calculated interference zones	**SA Water:** Identified link has recently been decommissioned **SA Power Networks:** No concerns raised **ElectraNet, SAGRN and Optus:** No response received	**SA Water:** No expected impacts **Other operators:** Unlikely to cause interference	**SA Water:** None required **Other operators:** If required – reroute affected links, install additional towers, replace affected links with alternative technologies
Fixed point-to-multipoint links	22 assignments within 75 km of Project boundary 3 base stations within 20 km of Project boundary, operated by: SA Water Telstra SA Power Networks	**SA Water and Telstra:** No concerns raised **SA Power Networks:** details provided for link crossing the Project boundary, 3 turbines in diffraction exclusion zone established by DNV	**SA Water and Telstra:** Unlikely to cause interference **SA Power Networks:** High likelihood of interference	**SA Water and Telstra:** None required **SA Power Networks:** Relocate turbines to be outside interference zone, reroute affected links, install additional towers, replace affected links with alternative technologies

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
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:** 1 SAGRN link crossing boundary (see above) **Point-to-area style communications:** unlikely to be affected	**SAGRN, St John Ambulance and SASES:** No response received	**SAGRN point-to-point link:** Unlikely to cause interference **Point-to-area style communications:** Unlikely to cause interference	**SAGRN point-to-point link:** As for point-to-point links **Point-to-area style communications:** If required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest radar: 212 km from Project	Impacts are expected to be manageable	Potential for manageable interference	To be determined through consultation with the Bureau of Meteorology if required
Trigonometrical stations	**Trigonometrical stations:** unlikely to be affected **Survey marks:** unlikely to be affected	No concerns raised	Unlikely to cause interference	None required
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Telstra:** No concerns raised **Optus:** No response received	Low likelihood of interference	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	**Wireless broadband service providers:** Connected Farms Pty Ltd, mobile phone networks **NBN:** available as a satellite service only	**Connected Farms Pty Ltd:** Consultation not considered necessary **Telstra and NBN:** No concerns raised **Optus:** No response received	**Wireless broadband services**: see findings for mobile phones **NBN:** None	**Wireless broadband services:** as for mobile phones **NBN:** none required

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Satellite television and internet	**Geostationary satellites:** no signals intercepted by turbines **Low Earth orbit (LEO) satellites:** no signals intercepted by turbines	Consultation not considered necessary	None	None required
Radio broadcasting	**FM signals from transmitter within 4 km of Project:** may experience interference in areas with marginal reception to the northwest of the Project, or in close proximity to turbines **AM and other FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	**FM radio transmitter within 4 km of Project:** No response received **Other services:** Consultation not considered necessary	**FM signals from transmitter within 4 km of Project:** potential for interference **AM and other FM signals:** low likelihood of interference **Digital radio signals:** None	**FM signals from transmitter within 4 km of Project:** if required – install higher-quality antenna at affected location, increase signal strength from affected tower, move tower to a new location, install signal repeater, install additional tower **AM and other FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** none required

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

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Caralue Bluff transmitter:** *Mixed levels of coverage around the site; ranging from 'good' at the northern areas gradually deteriorating to no signal at the south* 26 dwellings in potential interference zone **Cowell Bluff transmitter:** *'poor' to 'variable' coverage around the site* 26 dwellings in potential interference zone, although these dwellings are unlikely to be receiving signals from this transmitter **Tumby Bay Bluff transmitter:** *Mostly 'variable' coverage around the site* 14 dwellings in potential interference zone	**BAI communications:** no people predicted to be impacted	Unlikely to cause interference	If required – re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter

1 INTRODUCTION

AECOM Australia Pty Ltd ("AECOM" or "the Customer") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Cleve Wind Farm ("the Project") in South Australia. The results of this work are reported here. This document has been prepared in accordance with DNV proposal AECOM Cleve Subconsultancy Agreement dated 9 July 2024, and is subject to the terms and conditions in that agreement.

In accordance with the South Australian Planning and Design Code (SA Planning Code) prepared by the Government of South Australia Attorney-General's Department in November 2024 [1] and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [2], this assessment investigates the potential EMI impact of the Project on:

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

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

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The proposed Project site is located in South Australia, approximately 245 km northwest of Adelaide and 13 km northwest of Cleve. The site consists mainly of land cleared for agriculture, with sparse vegetation.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 80 wind turbines [3]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 5.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Customer [4].

For the purposes of this assessment, DNV has evaluated the potential for EMI-related impacts at identified dwellings within 5 km of the Project boundary. The locations of identified dwellings more than 5 km from the Project boundary have also been shown, where available, but impacts at these dwellings have not been considered in detail. The Customer has advised that 23 nearby dwellings are associated with the Project. The coordinates of these associated dwellings are presented in Table 6, and the dwellings and Project boundary 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

There are two sets of guidelines that are potentially relevant to the assessment of electromagnetic interference impacts for wind farms in South Australia.

Performance Outcome 8.1 – Interface between Land Uses (General Development Policies) of the SA Planning Code [1] states the developments in rural or remote areas should not "*unreasonably diminish or result in the loss of existing communication services due to electrical interference*".

However, although the SA Planning Code notes the importance of minimising EMI related impacts, it does not provide a detailed methodology for assessing these impacts.

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

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

DNV considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the SA Planning Code, and therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 EMI CAUSED BY THE PHYSICAL PRESENCE OF WIND TURBINES

4.1 Assessment approach

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

The Customer has asked DNV to complete this assessment based upon a layout provided for the Project consisting of 80 wind turbines, as outlined in Table 5.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 172 m, an upper tip height of 236 m, and a lower tip height of 64 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 172 m or less
- an upper tip height of 236 m or less
- a lower tip height of 64 m or more.

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

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from a copy of the Australian Communications and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 13 August 2024 [5].

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

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a radiocommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV has consulted with 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 14.

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.

4.2 Radiocommunication towers

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

4.2.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 162 radiocommunication towers within a nominal 75 km of the Project boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 2.

There are three radiocommunication towers located within 2 km of the proposed turbine locations. These towers and the consultation zones recommended by the Draft National Guidelines [2] are shown in Figure 3 based on information obtained from the ACMA RRL database, and extracted from aerial or satellite imagery. Each consultation zone includes the rotor radius for turbines with a 172 m rotor diameter, and an additional buffer of 25 m to account for potential inaccuracies in the tower locations given in the ACMA RRL database.

Details of the licences associated with these radiocommunication towers are given in Table 1**.** 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 low power radio broadcasting licences.

Table 1 Details of radiocommunication towers located within 2 km of turbines (including the turbine rotor radius) at the proposed Project

Site ID	Operator	Licence/service types	Distance to nearest turbine [m]
9023641	Pringles AG-PLUS Pty Ltd (Emmetts)	Point-to-area (land mobile)	341
142587	United Christian Broadcasters Australia Limited (Vision Media)	Point-to-area (low power radio broadcasting)	1450
9020545	ElectraNet Pty Limited (ElectraNet)	Point-to-point links	2080

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

Point-to-area style radiocommunications such as mobile radio and paging systems are typically designed to operate in a range of environments and are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation, and other forms of signal obstruction. However, interference caused by reflection or scattering of signals or near-field effects can be a problem if the turbines are located close to the transmission tower. Reference [6] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts due to reflection or scattering of signals. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for these types of services [7]. Given the proximity of the proposed wind turbine locations to site ID 9023641, there is a potential for the Project to interfere with the mobile radio point-to-area style communications operated by Emmetts 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 this tower through near-field effects.

Low power radio broadcasting licences are used for broadcasting of niche radio services where reception is limited by being targeted to a special interest group, broadcast in a limited location, or provided during a limited period or event. As discussed in Section 4.14, wind turbines may cause interference to radio broadcasting signals through reflection or scattering of the signals at locations in the immediate vicinity of the turbines. There may also be potential for turbines to interfere with radio signals through physical obstruction of the signal path from the transmitter to the receiver. However, since the nature of the radio services provided by Vision Media from the tower at site ID 9020545 is not known, further information from the operator is required to determine whether there is potential for the Project to interfere with those services.

4.2.2 Stakeholder consultation

DNV has contacted the operators of the services associated with the towers shown in Table 1 to determine the likelihood that the proposed Project will cause interference to their services through near-field effects or reflection or scattering of signals. No responses have been received to date.

4.2.3 Mitigation options

Potential mitigation options for impacts to the point-to-point links operated by ElectraNet are discussed in Section 4.3.3.

Mitigation measures to avoid potential for impacts to the point-to-area style communications operated by Emmetts and Vision Media from the towers at site ID 9023641 and 142587 would need to be determined in consultation with the operators, but may include relocating turbines, increasing the signal strength from the affected tower or alternative towers, or installing additional towers in the vicinity of the Project. In the event that localised interference to the radio services provided by Vision Media is experienced, this can potentially be rectified by installing a high-quality antenna or amplifier at the affected residence.

4.3 Fixed licences of point-to-point type

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

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

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

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

Each individual link 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 nine point-to-point links recorded in the ACMA RRL database that have interference zones which pass over the proposed Project boundary. These links are operated by South Australia Water Corporation (SA Water), South Australian Government Radio Network (SAGRN), ElectraNet, Optus Mobile Pty Ltd (Optus), and SA Power Networks. The details of the links are provided in Table 7, and the link paths are shown in greater detail in Figure 5 based on information obtained from the ACMA RRL database and extracted from aerial or satellite imagery.

The potential interference mechanisms and interference zones established by DNV for these links are described in Sections 4.3.1.1, 4.3.1.2, and 4.3.1.3, and summarised in Section **Error! Reference source not found.**.

4.3.1.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [2, 8, 9], typically defined in terms of the Fresnel zones for the link. The *n*th Fresnel zone is comprised of all points for which, if the signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n-\lambda}{2}$, where λ = wavelength.

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

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

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

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

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

The potential diffraction exclusion zones in the horizontal plane are shown in Figure 5. Each exclusion zone includes the rotor radius for turbines with a 172 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer in each case is based on the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

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

DNV has identified one turbine (T30) located within the exclusion zone for the point-to-point link operated by SA Water. The diffraction zone for this link was identified to also intersect the elevation of the turbine blades in the vertical plane. However, SA Water has advised that this link is no longer in use, and therefore no interference from the Project is expected as described in Section 4.3.2.

4.3.1.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a wind turbine will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [8].

Reference [8] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a wind turbine at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and wind turbine, and comparing this to the required C/I ratio, a potential interference zone can be defined.

For each of the identified links with a transmission tower near the proposed turbine locations, DNV has established a reflection/scattering interference zone based on the antenna gains and length of the link, the worst-case RCS for the turbine calculated according to the equation proposed in [10], and an assumed minimum C/I ratio of 20 dB [10]. The radiation patterns for the antennas were approximated using the reference radiation patterns given in the International Telecommunication Union (ITU) Recommendation F.699-8 [11].

The potential reflection/scattering interference zones are shown in Figure 5. Each interference zone includes the rotor radius for turbines with a 172 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer in each case is based on the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

There are no turbines located within the potential reflection/scattering interference zones for any of the point-to-point links passing over the proposed Project boundary. Therefore, it is not expected that the Project will cause interference to the point-to-point links through reflection or scattering of the signals.

The method used to establish the reflection/scattering interference zones shown in Figure 5 assumes that the direct path for the point-to-point link has a clear line of sight with respect to the first Fresnel zone, and that the paths for the reflected or scattered signal from the transmitter to the turbine and from the turbine to the receiver also have a clear line of sight with respect to terrain [8]. For low frequency links, the direct path between the transmitter and the receiver is often obstructed by terrain. In this situation, a signal that has been reflected or scattered from a wind turbine with a clear line of sight to the transmitter or receiver may be considerably stronger than the direct signal and therefore have greater potential to cause interference [6]. The point-to-point link crossing the Project boundary operated by SA Water does 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 5.

Nevertheless, DNV notes that the reflection/scattering interference zones shown in Figure 5 are approximations only and may be overly conservative [2]. The turbine RCS and C/I ratios used to establish the interference zones were based on recommendations developed on behalf of the United Kingdom telecommunications regulator Ofcom [10], and may not be appropriate for point-

to-point links operating in Australia. Uncertainties are also associated with the assumptions used to derive the Ofcom recommendations, and the use of ITU reference radiation patterns rather than the actual radiation patterns for the transmitting and receiving antennas. To account for these uncertainties, DNV has contacted the operators of the point-to-point links crossing the proposed Project boundary, as described in Section 4.3.2, to seek their feedback on the potential for the Project to cause interference to those links through reflection or scattering of the signals.

4.3.1.3 Interference caused by near-field effects

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

Reference [8] presents an equation for estimating the radius of the near-field zone for a point-to-point link from the properties of the transmitting or receiving antenna.

For each of the identified links with a transmission tower located near the proposed turbine locations, DNV has established a near-field interference zone based on the operating frequency and antenna gain for that link.

The potential near-field interference zones are shown in Figure 5. Each interference zone includes the rotor radius for turbines with a 172 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer in each case is based on the deviations between the tower locations given in the ACMA database and the apparent locations determined from aerial or satellite imagery.

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

4.3.2 Stakeholder consultation

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

SA Water has advised that their link (Link No. 7 in Figure 5) crossing the Project boundary has recently been decommissioned, and therefore there is no potential for interference to this link through diffraction as identified by DNV.

A response has been received from SA Power Networks, and no concerns have been raised regarding potential for interference to their point-to-point links. No response has been received to date from ElectraNet, Optus and SAGRN.

4.3.3 Mitigation options

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

4.4 Fixed licences of point-to-multipoint type

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

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

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

From the ACMA RRL database, DNV has identified 22 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 6. The details of the licence holders as given in the ACMA RRL database are provided in Table 8.

Within 20 km of the Project boundary, there are two point-to-multipoint base stations operated by SA Water and one operated by SA Power Networks. There are also several point-to-multipoint base stations located more than 20 km from the Project.

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

4.4.2 Stakeholder consultation

DNV has contacted the operators of potentially affected base stations identified within approximately 60 km of the Project, to determine the likelihood that the proposed Project will cause interference to their operations and services.

The response received from SA Water confirmed that they do not have concerns about the potential for interference to their point-to-multipoint links.

As a result of the consultation process, SA Power Networks has advised that they operate a fixed link which crosses the Project site between their point-to-multipoint base station at Mt Neild (Site ID 25118) and a remote station at Rudall. The location of the remote station at Rudall has been provided by SA Power Networks, and the path of this link is shown in Figure 7.

DNV has established diffraction exclusion zones for the link based on two clearance zones requested by SA Power Networks: 60% of the first Fresnel zone and 100% of the second Fresnel zone, both of which include the 172 m rotor diameter and an additional buffer to account for potential inaccuracies in the tower locations, as described in Section 4.3.1.1. The size of the uncertainty buffer for the SA Power Networks link is based on the deviations between the tower locations given in the ACMA RRL database, provided by the operator, and the apparent locations determined from aerial or satellite imagery.

DNV has also reviewed the link frequency and line of sight with respect to terrain and 60% of the first Fresnel zone for the SA Power Networks link. Although the frequency of the link is below 1,000 MHz, the link does not have a clear line of sight with respect to terrain. Therefore, to avoid

the potential for interference to this link, DNV recommends that turbines are kept clear of an exclusion zone based on 100% of the second Fresnel zone as described in Section 4.3.1.1.

The potential exclusion zones for the SA Power Networks link passing over the proposed Project site are also shown in Figure 7. Three turbines (T74, T75 and T76) are identified to be within both requested clearance zones. The diffraction zones for this link were identified to also intersect the elevation of the turbine blades in the vertical plane.

DNV is intending to engage further with SA Power Networks to confirm the expected potential for interference to their link.

No response has been received from Telstra regarding the expected potential for interference to their point-to-multipoint licence 45 km from the Project boundary.

4.4.3 Mitigation options

To avoid potential for interference to the SA Power Networks point-to-multipoint link crossing the Project boundary, DNV recommends that turbines T74, T75 and T76 are moved out of the second Fresnel diffraction exclusion zone established by DNV and shown in Figure 7. Alternative mitigation options would need to be determined through consultation with SA Power Networks.

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

4.5 Other licence types

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

4.5.1 Locations of other licences and potential for interference

DNV has identified a number of other licences in the ACMA RRL database within 75 km of the proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 8 and Table 9.

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

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

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

4.6 Emergency services

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

4.6.1 Locations of emergency services licences and potential for interference

DNV has reviewed the ACMA RRL database to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 10 along with their contact details. The nearest licence is associated with a tower located approximately 3 km from the Project boundary.

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

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

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

4.6.2 Stakeholder consultation

DNV has contacted the operators of potentially affected licences identified within approximately 60 km of the Project, to seek feedback on any potential impact that the Project could have on their operations and services. No responses have been received to date from St. John Ambulance, South Australia Government Radio Network (SAGRN) and South Australia State Emergency Service.

4.6.3 Mitigation options

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

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

4.7 Aircraft navigation systems and radar

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

4.8 Meteorological radar

The Bureau of Meteorology ("the Bureau") operates a network of weather radars across Australia consisting of high-resolution Doppler radars and standard weather watch or weather surveillance radars. Operation of the Bureau's part-time wind finding radar installations ceased in August 2019 [12].

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 [13, 14].

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

The optimal coverage area for a weather radar generally extends approximately 200 km from the radar installation at a height of around 3000 m [15, 16], and approximately 100 km at a height of 1000 m [16]. 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 [17, 18]. 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 Bureau also suggests that there may be potential for interference to meteorological radar operations from wind farms over much greater distances than indicated by the WMO guidelines, depending on the relative elevations of the radar and the wind farm and the intervening terrain.

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

4.8.1 Locations of meteorological radars and potential for interference

DNV has identified that the Bureau operates five weather radars within 250 nautical miles of the proposed Project, with the closest radar located approximately 212 km south-east of the Project at Buckland Park, north of Adelaide. The locations of these radars are shown in Figure 9 and the details of each radar are given in Table 11.

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

4.8.2 Stakeholder consultation

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

The response received from the Bureau indicates that the potential impact of the Project on their meteorological radars will be manageable.

4.8.3 Mitigation options

In the event that the Project obscures signals from meteorological radars once it is operational, and hence interferes with weather monitoring and predictions for the region, mitigation options would need to be determined through consultation with the Bureau.

4.9 Trigonometrical stations

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

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

The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 km to 5 km, and could be intercepted or obstructed by the presence of turbines. However, the potential for impact is considered low as it is likely to be possible to relocate the target to obtain an unobstructed view of the trig point. Microwave systems can measure distances up to 150 km, but such systems are not limited by the line of sight or affected by visibility [19].

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 [20]. 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) [21], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country, and several private and state-based GNSS CORS networks. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, or satellite communications.

4.9.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [22], there are 10 trig points within 20 km of the Project boundary. One trig point, Rudall, is located inside the Project boundary approximately 0.4 km southeast of the nearest proposed turbine location (T30). The details of these trig points are provided in Table 12 and their locations are illustrated in Figure 10.

DNV has reviewed the primary geodetic network of Australia [23] and observed that the Project is located within the second-order triangulation region. First-order triangulation depends on trigonometrical stations of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation are then used for the second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

There are also 113 permanent survey marks within 2 km of the Project boundary [24], as shown in Figure 11. The closest survey mark is located 214 m west of the nearest turbine (T59).

The closest GNSS station is located approximately 5 km southeast of the Project, at Cleve [25]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network.

4.9.2 Stakeholder consultation

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV has contacted Geoscience Australia and the Department of Planning, Transport and Infrastructure to inform them of the Project, and seek feedback regarding whether interference to their systems is possible. Responses have been received from both operators, as summarised in Table 14, and no concerns have been raised.

4.10 Citizen's band radio

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

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

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

The UHF CB radio service is unique in Australia and uses the FM (frequency modulation) transmission mode. It provides clear communication over 5–20 km and is less susceptible to power line noise. However, the UHF CB radio service requires a clear line-of-sight for a strong signal and is easily hindered by hilly terrain and forested areas. Even in the absence of physical obstructions,

UHF CB radio signals generally cannot travel beyond the effective radio horizon, which depends on elevation, antenna height, weather, and atmospheric conditions. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. However, under normal conditions on flat ground, signal range is typically limited to around 5 km. CB repeater stations are often set up on hilltops by community groups and commercial organisations to transmit signals from one channel to another.

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

4.10.1 Locations of CB radio devices and potential for interference

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

4.10.2 Mitigation options

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

4.11 Mobile phones

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

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

4.11.1 Availability of mobile phone services and potential for interference

DNV has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 12. The nearest mobile phone tower is located approximately 3 km southeast of the Project boundary.

Mobile phone network coverage maps have been obtained for Optus and Telstra. Vodafone network coverage is not found to be available for the Project area.

Figure 13 shows the Optus Mobile network coverage for the Project area [26]. Optus 4G coverage is mostly available around the Project boundary. Areas with marginal coverage marked orange in Figure 13 as '4G Outdoors with Antenna', and areas with no coverage marked white, are predominant at lower elevations of the undulating terrain.

Figure 14 shows the Telstra network coverage for the Project area [27]. Telstra 4G coverage is moderately available along the west and southern boundaries of the Project boundary. Areas with no coverage are present at a large section in northern parts of the site, and at a few smaller sections around the centre of the site.

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.

4.11.2 Stakeholder consultation

DNV has contacted Optus and Telstra to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. A response has been received from Telstra as summarised in Table 14, and no concerns have been raised. No response has been received from Optus to date.

4.11.3 Mitigation options

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

4.12 Wireless internet

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

4.12.1 Wireless broadband services

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

4.12.1.1 Availability of wireless broadband services and potential for interference

Connected Farms Pty Ltd holds point-to-area licences in the vicinity of the Project, with a base station located 29 km southwest of the Project. DNV understands that Connected Farms provides wireless services for farming operations, which are likely to be confined to a localised area and therefore are not expected to be impacted by the Project.

Residents in the vicinity of the Project may use wireless broadband services provided by Optus and Telstra. These wireless broadband services use the same networks as mobile phone services, and therefore the comments made in Section 4.11.1 are applicable here. Specifically, there is a low

theoretical potential for interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower.

4.12.1.2 Stakeholder consultation

DNV has contacted Telstra and Optus as discussed in Section 4.11.2, to seek feedback on any potential impact that the Project could have on their services. A response has been received from Telstra as summarised in Table 14, and no concerns have been raised. No response has been received from Optus to date.

4.12.1.3 Mitigation options

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

4.12.2 National Broadband Network

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

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

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a maximum range of 14 km [28]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [29].

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

4.12.2.1 Availability of NBN services and potential for interference

The NBN website [30] indicates that the network is currently available as a fixed wireless and satellite internet service in the area surrounding the Project. It is therefore likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. The locations of NBN fixed wireless internet towers within 75 km of the Project boundaries are shown in Figure 12, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 15.

The NBN fixed wireless tower servicing the Project area is located at Cleve. Based on the relative positions of this tower and the nearby dwellings, and the fixed wireless coverage areas shown in Figure 15, it is not expected that turbines at the Project will intercept the line of sight between this towers and nearby dwellings.

DNV understands that NBN Co is planning to extend the fixed wireless coverage range for some towers from 14 km to 29 km [31]. If the coverage from the tower at Cleve is extended and additional 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 at other dwellings. However, the assessment presented here is based on the current network availability, as shown in Figure 15.

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

4.12.2.2 Stakeholder consultation

DNV has contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps. A response has been received from NBN Co, as summarised in Table 14, with no concerns raised.

4.13 Satellite television and internet

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

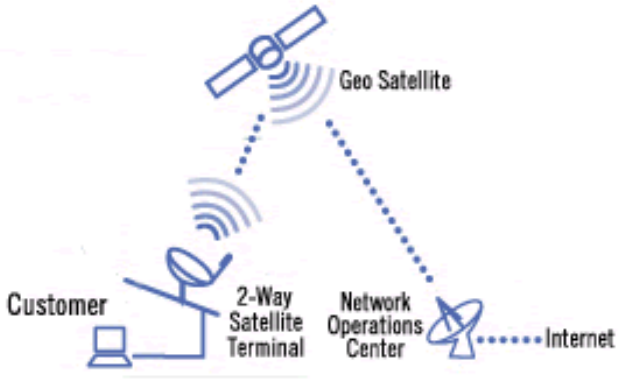
4.13.1 Geostationary satellite communication services

Geostationary satellites orbit the earth directly above the equator, at a height of 35,786 km above the Earth's surface [32]. At this altitude, the satellites travel at the same rate as the Earth's rotational speed and therefore appear to remain stationary at the same point in the sky relative to an observer at a fixed location. Additionally, due to their high altitude, each satellite can view (and therefore provide coverage to) a large portion of the Earth's surface. Geostationary orbits are typically used for weather monitoring satellites that continually observe a specific area of the Earth and for satellites that provide telecommunication services, since the satellite dish or antenna used on Earth to receive and transmit signals can be permanently pointed to the correct location in the sky. Both satellite television and satellite internet services are currently available in Australia via geostationary satellites.

Satellite television signals are delivered via a geostationary communication satellite to a satellite dish connected to a set-top box. Satellite television signals are typically transmitted to the user's antenna in one of two frequency bands: the C-band between 4 GHz and 8 GHz, or the Ku-band between 12 GHz and 18 GHz. Signals in the C-band are susceptible to interference due to radio relay links, radar systems, and other devices operating at a similar frequency. Signals in the Ku-band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. The main geostationary satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [33, 34].

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

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



Two-way connection to the internet via satellite [35]

4.13.1.1 Locations of geostationary satellite vectors and potential for interference

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

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

The analysis has shown that satellite signals to dwellings in the vicinity of the Project are not expected to be intercepted by turbines.

4.13.2 Low Earth orbit satellite communication services

Satellites in LEO occupy heights between 160 km and 1000 km above the Earth's surface [32]. At these altitudes, the satellites travel significantly faster than the Earth's rotational speed and typically compete a full orbit in approximately 90 minutes. Unlike geostationary satellites, LEO satellites do not have to follow a particular path around the Earth and their orbits are usually tilted with respect to the equator. However, due to their low altitude, each satellite can only observe or communicate with a small portion of the Earth's surface at a time and this, together with their fast movement across the sky, can limit the usefulness of LEO satellites in some situations.

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

buildings, and other structures such as wind turbines, which can unexpectedly interrupt the signal from the connected satellite and cause the service to temporarily drop out until a new satellite can be found.

4.13.2.1 Availability of low Earth orbit services and potential for interference

Starlink is the only LEO satellite internet service currently available to customers in Australia. The current Starlink LEO constellation consists of several thousand satellites orbiting the Earth at a height of approximately 550 km [36], although this may increase to tens of thousands of satellites in the future. Starlink offers two classes of satellite dish to users of their services: a standard dish that is considered suitable for most residential applications, and a high performance dish that has a wider field of view (enabling it to connect to more satellites, even in the presence of obstructions), a higher gain antenna, and improved performance under extreme environmental conditions [37, 38].

In the southern hemisphere, Starlink satellite dishes currently require a relatively clear view of the sky within a field of view of 100° tilted towards the south, with a minimum elevation angle of 25° above the southern horizon [39]. Although some obstructions can be tolerated, the impact of these obstacles will depend on their apparent size, their distance and direction relative to the satellite dish, and the proportion of the sky already obstructed. Obstacles below an elevation angle of 25° in the south, 40° in the east and west, and 40° in the north (allowing for locations where no tilt of the satellite dish is required) will not pose any obstruction to the field of view. However, as more satellites are launched and join the Starlink constellation, it is expected that the required angle of tilt towards the south will reduce until dishes can be pointed directly upwards, with elevation angles above the horizon of 40° in all directions [40], and the service will become less sensitive to obstructions due to the increased number of visible satellites at each location.

DNV has considered the potential for turbines at the Project to obstruct Starlink signals received at nearby dwellings, based on the relative locations of the dwellings and the nearby turbines, the elevations of the dwellings and turbines, and a turbine tip height of 236 m.

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

4.14 Radio broadcasting

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

4.14.1 AM radio

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

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

However, as noted above, the presence of physical obstructions such as turbines is unlikely to cause significant interference to AM radio signals. Due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [41].

4.14.1.1 Locations of AM transmitters and potential for interference

The locations of AM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [42], and are shown in Figure 16.

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

4.14.1.2 Mitigation options

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

4.14.2 FM radio

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

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

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [43]. 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 [41, 44].

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 [43]. 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 [45].

4.14.2.1 Locations of FM transmitters and potential for interference

The locations of FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [42], and are shown in Figure 16.

The closest FM transmitter, operated by Eyre Peninsula Broadcasters Pty Ltd, is located approximately 2.6 km from the proposed Project boundary or 4 km from the nearest wind turbine (T84). 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 physical obstruction from the turbines. The location of the transmitter in relation to the Project and turbine T84 is shown in Figure 17. Since the transmitter is located to the southeast of the proposed turbine locations, there is potential for interference to signals from that transmitter in locations to the northwest of the Project.

4.14.2.2 Stakeholder consultation

DNV has contacted the operator of the nearby FM broadcast transmitter, Eyre Peninsula Broadcasters Pty Ltd, to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. No response has been received to date.

4.14.2.3 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 turbines, or installing a signal repeater or additional transmitter on the opposite side of the Project.

4.14.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne, and Sydney [46]. 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 [43] states that *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*. DNV has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

4.14.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [47], the Project is outside the intended service area for digital radio broadcasts. Since it is therefore unlikely that residents in the vicinity of the Project are currently receiving digital radio signals, it is not expected that the Project will cause interference to these services.

4.15 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in Australia are now digital broadcasts [48]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV has experience in situations where dwellings were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

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

4.15.1 Availability of DTV broadcasting and potential for interference

The locations of DTV broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [48], and are shown in Figure 16. According to the Australian Government mySwitch website [49], the DTV transmitters used by residents in the vicinity of the Project are the Cowell, Caralue Bluff and Tumby Bay transmitters.

The DTV broadcast transmitters likely to be servicing the area around the Project are summarised in Table 2 below. Coverage maps for these broadcast transmitters are reproduced in Figure 18 to Figure 20.

Table 2 DTV broadcast transmitters servicing the Project area

DTV broadcast transmitter	Signal coverage in the vicinity of the Project	Figure containing coverage map
Caralue Bluff	Signal coverage is of good quality around the northwest of the Project area, gradually decreasing southwards with variable signal along the centre of the site, to no signal coverage around the southeast of the Project area. Dwellings at the township of Rudall are able to receive signals from this transmitter, whereas dwellings at Cleve are not able to.	Figure 18
Cowell	Good signal is available throughout around the eastern boundary of the Project. Variable signal is possible, although unlikely, in small areas dispersed within the Project area. There is no signal coverage for most of the Project area, and beyond the western and northwestern boundaries.	Figure 19
Tumby Bay	Variable signal is available throughout the Project area except for approximately one-third of the area at the northwest. Variable signal is also available around the south and southeastern boundary, including the township of Cleve. No signal coverage beyond the northeastern boundary, and around the southwestern boundary including the township of Rudall.	Figure 20

4.15.1.1 Interference caused by large scale effects

For broadcast signals, large scale interference can generally be avoided by placing the wind turbines at some distance from the transmitter. Broadcast transmitters may be either relay or primary transmitters. Relay transmitters are more commonly found in rural areas. Primary transmitters are higher power and are more commonly located near large urban areas. A clearance

of at least 1 km is recommended for relay transmitters, while a clearance of at least 6 km is recommended for primary transmitters [9].

The closest DTV transmitter to the Project is the Cowell primary transmitter, which is approximately 28 km away. Therefore, it is considered unlikely that the Project will cause large scale interference to signal from this transmitter.

4.15.1.2 Interference caused by reflection or scattering

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

Due to the lack of an accurate theoretical scattering model, DNV has not performed detailed scatter calculations to predict DTV interference. Instead, dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine at the Project (assuming an antenna with a sufficiently narrow beam width and sufficiently high front-to-back ratio is being used) have been highlighted using the 'keyhole' approach described in Section A.3 of Appendix A, with a forward-scatter distance of 5 km and a back-scatter distance of 500 m.

The results of the analysis can be seen in Table 13 and Figure 18 to Figure 20. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 3.

Note that if the signal received at a dwelling from the transmitter is sufficiently weak, or an antenna with insufficient directional discrimination is installed (i.e., a low gain or omni-directional antenna), interference may still occur at dwellings outside of the identified interference zones. Circumstances under which interference may occur outside the interference zones typically established using the 'keyhole' approach are discussed further in Section A.2 of Appendix A. In particular, although DNV has considered the potential for interference to DTV signals at dwellings within 5 km of the proposed turbine locations, previous advice received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, has indicated that interference to DTV broadcasting may be experienced at distances of up to 10 km from turbines. For comparison, Figure 18, Figure 19 and Figure 20 also show the area within 10 km of the proposed turbine locations. DNV has contacted BAI Communications, as discussed in Section 4.15.2 to confirm the potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

The Project is particularly located at an area where the signal coverage from each of the three DTV transmitters reaches its furthest extent. Dwellings within the calculated zones are likely to be susceptible to interference if they are currently receiving signals from these transmitters, due to the variability of signal quality, and the large distance, from the servicing transmitters.

Table 3 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
Caralue Bluff	26 (19 associated dwellings)	Mixed – dwellings in the potential interference zone are receiving signals from this transmitter in varying signal coverage levels: good, variable, and none. Areas with no signal coverage within the interference zone become increasingly widespread further southward of the Project boundary.
Cowell	26 (17 associated dwellings)	Limited to none – dwellings in the potential interference zone are unlikely to be receiving signals from this transmitter.
Tumby Bay	14 (5 associated dwellings)	Variable to none – dwellings in the potential interference zone, including those outside the Project boundary, are receiving mostly variable coverage from this 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 4.15.3.

4.15.2 Stakeholder consultation

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

BAI Communications has conducted an assessment of the potential for turbines at the Project to interfere with DTV signals from the Cowell, Caralue Bluff and Tumby Bay transmitters [49]. 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 no people are predicted to be impacted by the proposed wind turbines due to the scatter interference effects of the Project. In the event that interference to DTV signals is experienced by residents, BAI Communications have advised that they expect any necessary mitigation to be undertaken as part of the Project.

4.15.3 Mitigation options

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

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

6. Installing a television relay transmitter.

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

In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more aligned or directional antenna may not alleviate a forward scatter issue. Alternative mitigation measures to resolve issues caused by forward scatter could include tuning the antenna into an alternative signal (if one is available) or installing cable or satellite television at the affected dwelling. However, as noted in [50], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [51] 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 [52].

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 80 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 172 m or less, an upper tip height of 236 m or less, and a lower tip height of 64 m or more.

There is a potential for the Project to interfere with point-to-area style communications hosted by Pringles AG-PLUS (Emmetts) and United Christian Broadcasters Australia Limited (Vision Media) at radiocommunication sites located within the Project boundary. Consultation with the operators of these services has been conducted to request feedback on the expected potential for turbines at the Project to interfere with their services. No response has been received from Emmetts and Vision Media. In the event of interference, mitigation options would need to be confirmed in consultation with the operators.

A point-to-point link by South Australia Water Corporation (SA Water) was identified to intersect the Project boundary. A diffraction exclusion zone was established by DNV for this link to determine areas to be clear of turbines for interference to be avoided. Through consultation, SA Water has advised that this link has since been decommissioned and is no longer operational. The diffraction exclusion zone previously identified for this link is therefore no longer in effect and the Project will not cause interference to the fixed point-to-point link operated by SA Water. The operators of other point-to-point links have been consulted to confirm the required clearances and potential for impact. No responses have been received to date from the remaining operators.

Spark Infrastructure Pty Ltd (SA Power Networks) and SA Water hold point-to-multipoint licences in the vicinity of the wind farm. SA Water has provided to feedback regarding potential interference to their licences and have raised no concerns. SA Power Networks however has raised concern regarding the potential for turbines at the Project to interfere with a link between their point-to-multipoint base station at Mt Neild and remote station at Rudall, and has provided details of this link for an assessment to be conducted. Three turbines are situated within the calculated interference zones established by DNV for the SA Power Networks point-to-multipoint link. To avoid potential for interference to the SA Power Networks point-to-multipoint link crossing the Project boundary, DNV recommends that turbines are moved out of a diffraction exclusion zone based on the second Fresnel zone. DNV is intending to engage further with SA Power Networks to confirm the expected potential for interference to their link.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. However, feedback received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, suggests that impacts to digital television signals are unlikely. 4G mobile phone signal reception is available at the Project area from towers at the townships of Cleve and Rudall. It is possible that the proposed wind turbines may further intercept these mobile phone signals, which are currently identified to be of poor or marginal quality at some locations within the Project boundary and to the north and east. There is also potential for the Project to interfere with signals from an FM transmitter within 4 km of a turbine to the southeast of the Project, at locations to the northwest where the signal path may be obstructed. If interference to these services is experienced, a range of options are available to rectify difficulties.

The Bureau of Meteorology has advised that impacts to their weather radar systems are expected to be manageable, and no concerns have been raised to date regarding potential impacts to emergency services operations.

Potential EMI impacts on other services considered in this assessment, including trigonometrical stations and survey marks, and CB radio, are not expected or are considered to be minor.

Table 4 Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	3 towers within 2 km of proposed turbine locations, operated by: ElectraNet Pty Limited (ElectraNet) Pringles AG-PLUS Pty Ltd (Emmetts) United Christian Broadcasters Australia Limited (Vision Media)	**ElectraNet, Emmetts and Vision Media:** No response received	**ElectraNet point-to-point link:** Unlikely to cause interference **Emmetts and Vision Media point-to-area style communications:** Potential for interference	**ElectraNet point-to-point link:** as for point-to-point links **Point-to-area style communications:** If required – install higher-quality antenna at affected location (for localised interference), increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Fixed point-to-point links	9 links with calculated interference zones intersecting the Project boundary, operated by: ElectraNet South Australia Water Corporation (SA Water) South Australian Government Radio Network (SAGRN) Optus Mobile Pty Ltd (Optus) Spark Infrastructure SA Pty Ltd (SA Power Networks) **SA Water link:** 1 turbine in calculated diffraction exclusion zone **Other links:** no turbines in calculated interference zones	**SA Water:** Identified link has recently been decommissioned **SA Power Networks:** No concerns raised **ElectraNet, SAGRN and Optus:** No response received	**SA Water:** No expected impacts **Other operators:** Unlikely to cause interference	**SA Water:** None required **Other operators:** If required – reroute affected links, install additional towers, replace affected links with alternative technologies

Table 4 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Fixed point-to-multipoint links	22 assignments within 75 km of Project boundary 3 base stations within 20 km of Project boundary, operated by: SA Water Telstra SA Power Networks	**SA Water and Telstra:** No concerns raised **SA Power Networks:** details provided for link crossing the Project boundary, 3 turbines in diffraction exclusion zone established by DNV	**SA Water and Telstra:** Unlikely to cause interference **SA Power Networks:** High likelihood of interference	**SA Water and Telstra:** None required **SA Power Networks:** Relocate turbines to be outside interference zone, 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:** 1 SAGRN link crossing boundary (see above) **Point-to-area style communications:** unlikely to be affected	**SAGRN, St John Ambulance and SASES:** No response received	**SAGRN point-to-point link:** Unlikely to cause interference **Point-to-area style communications:** Unlikely to cause interference	**SAGRN point-to-point link:** As for point-to-point links **Point-to-area style communications:** If required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower
Meteorological radar	Nearest radar: 212 km from Project	Impacts are expected to be manageable	Potential for manageable interference	To be determined through consultation with the Bureau of Meteorology if required
Trigonometrical stations	**Trigonometrical stations:** unlikely to be affected **Survey marks:** unlikely to be affected	No concerns raised	Unlikely to cause interference	None required
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Telstra:** No concerns raised **Optus:** No response received	Low likelihood of interference	If required – increase signal strength from affected tower or alternative towers, install additional tower

Table 4 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Wireless internet	**Wireless broadband service providers:** Connected Farms Pty Ltd, mobile phone networks **NBN:** available as a satellite service only	**Connected Farms Pty Ltd:** Consultation not considered necessary **Telstra and NBN:** No concerns raised **Optus:** No response received	**Wireless broadband services**: see findings for mobile phones **NBN:** None	**Wireless broadband services:** as for mobile phones **NBN:** none required
Satellite television and internet	**Geostationary satellites:** no signals intercepted by turbines **Low Earth orbit (LEO) satellites:** no signals intercepted by turbines	Consultation not considered necessary	None	None required
Radio broadcasting	**FM signals from transmitter within 4 km of Project:** may experience interference in areas with marginal reception to the northwest of the Project, or in close proximity to turbines **AM and other FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	**FM radio transmitter within 4 km of Project:** No response received **Other services:** Consultation not considered necessary	**FM signals from transmitter within 4 km of Project:** potential for interference **AM and other FM signals:** low likelihood of interference **Digital radio signals:** None	**FM signals from transmitter within 4 km of Project:** if required – install higher-quality antenna at affected location, increase signal strength from affected tower, move tower to a new location, install signal repeater, install additional tower **AM and other FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** none required

Table 4 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Caralue Bluff transmitter:** *Mixed levels of coverage around the site; ranging from 'good' at the northern areas gradually deteriorating to no signal at the south* 26 dwellings in potential interference zone **Cowell Bluff transmitter:** *'poor' to 'variable' coverage around the site* 26 dwellings in potential interference zone, although these dwellings are unlikely to be receiving signals from this transmitter **Tumby Bay Bluff transmitter:** *Mostly 'variable' coverage around the site* 14 dwellings in potential interference zone	**BAI communications:** no people predicted to be impacted	Unlikely to cause interference	If required – re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter

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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 [43] states the following with regard to interference to DTV reception:

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

DNV has drawn two conclusions from this report:

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

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

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

A.2 Forward and back scatter of DTV signals

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

Forward scatter can occur when the transmitter, one or more turbines, and receiver are almost aligned as shown in Figure A.1. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [50]. Both of these effects can potentially degrade the DTV signal quality.

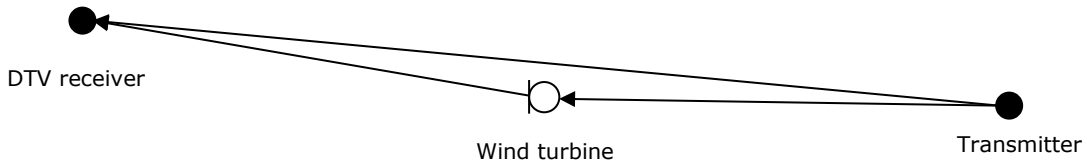

Figure A.1 Forward scatter signal path for DTV signals

Back scatter from wind turbines occurs when DTV signals are reflected from turbine towers and blades onto a receiver as shown in Figure A.2. The reflected signals are attenuated, time-delayed and phase-shifted (due to a longer path from transmitter to receiver) compared to the original signal. The reflected signals are also time-varying due to the rotation of the blades and vary with wind direction. The resultant signal at the receiver includes the original signal (transmitter to receiver) and a series of time-varying multipath signals (transmitter-turbine-receiver).

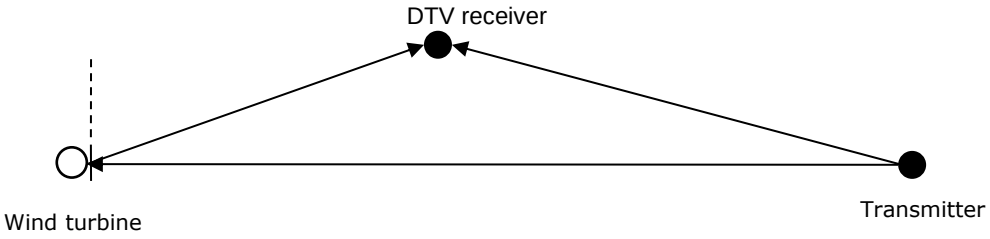

Figure A.2 Back scatter signal path for DTV signals

Interference to DTV signals from wind turbines can potentially occur in both the forward and backward scatter region. The effect of a turbine on a DTV signal can be different depending on the scattering region where the receiver is located [50].

According to Ofcom [43], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [9, 53]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the turbines [43]. 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 [9, 43], assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio, or an omni-directional antenna is used, this region is likely be larger.

The combination of the forward and back scatter regions, as shown in Figure A.3, resembles a keyhole.

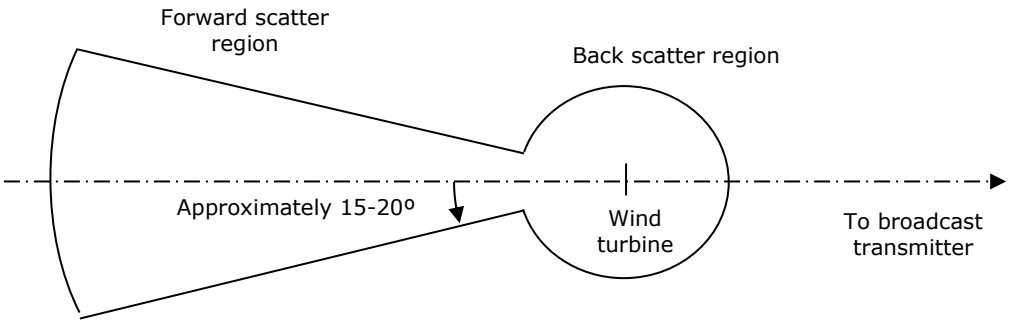

Figure A.3 Potential television interference zones around a wind turbine

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

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

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

In other words, wind turbines are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [51] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more turbines, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [51].

With regards to back scattering, the ITU states:

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

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

A.3 Theoretical models for wind turbine scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [55]. This comparison with empirical data found:

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

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

As an alternative to signal scattering models, it is common practice to identify those dwellings or areas that are most likely to experience potential television interference based on likely forward and back scatter regions. As introduced above and shown in Figure A.3, this is often referred to as the 'keyhole' approach and is an established technique for predicting where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [43]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

LIST OF TABLES

Table 5 Proposed turbine layout for the Project [3]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]
T01	619952	6284424	215	T41	632660	6283679	346
T02	620419	6284649	227	T42	633076	6284041	348
T03	620876	6284863	240	T43	633507	6284427	357
T04	621343	6285099	257	T44	633917	6284745	372
T05	621791	6285325	232	T45	628447	6281244	335
T06	622267	6285538	225	T46	629167	6281249	329
T07	622725	6285798	224	T47	629734	6281324	345
T08	623172	6286012	225	T48	630168	6281375	345
T09	623639	6286248	235	T49	630683	6281564	342
T10	624073	6286520	253	T50	631114	6281610	346
T11	624522	6286784	284	T51	631601	6281575	335
T12	624465	6287675	246	T52	632100	6281600	331
T13	624892	6288135	242	T53	632589	6281711	347
T14	625361	6288487	249	T54	633069	6281817	353
T15	625724	6288898	275	T55	633541	6282033	363
T16	625522	6285998	299	T56	633955	6282297	368
T17	626027	6286145	299	T57	634337	6282718	384
T18	628776	6287818	311	T58	634875	6282771	388
T19	625365	6284402	274	T59	628450	6278620	285
T20	626008	6283951	298	T60	628717	6279051	291
T21	626676	6284103	310	T61	629079	6279404	294
T22	627550	6284463	315	T62	629875	6279284	277
T23	628134	6284741	316	T63	630341	6279649	276
T24	629902	6285999	361	T64	631015	6279616	267
T25	630306	6286372	360	T65	631914	6279035	283
T26	630658	6286800	374	T66	632315	6279365	292
T27	631120	6287050	376	T67	632677	6279739	320
T28	622821	6276682	214	T68	635540	6280349	366
T29	623211	6276919	222	T69	635951	6280607	368
T30	623737	6277465	239	T70	636347	6280876	363
T31	624055	6277791	240	T71	629362	6275255	217
T32	624223	6278232	273	T72	635641	6277837	313
T33	624429	6279006	252	T73	636021	6278230	345
T34	625116	6279105	294	T74	630464	6273289	229
T35	625135	6279797	310	T75	630978	6273446	215
T36	625549	6280121	321	T76	631444	6273625	231
T37	625891	6281033	315	T77	631844	6273960	255
T38	626302	6281397	298	T82	636515	6276345	328
T39	631772	6283010	314	T83	636991	6276540	343
T40	632216	6283336	341	T84	637407	6276861	353

1. Coordinate system: MGA zone 53, GDA94 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Base elevations have been determined by DNV based on publicly available SRTM1 data.

Table 6 Dwellings associated with the Project [4]

Dwelling ID[1]	Easting[1] [m]	Northing[1] [m]	Distance to nearest turbine [m]
1	627769	6286335	1635
2	623327	6284128	1764
3	627498	6282847	1501
4	630040	6283665	1851
5	621871	6282621	2453
6	622990	6281148	2535
7	627265	6279944	1705
8	634288	6279281	1646
9	637757	6278441	1619
10	621114	6277485	1886
11	625532	6277477	1510
12	629090	6276992	1750
13	630845	6277349	1997
14	635178	6276281	1338
16	629889	6275416	551
17	630815	6276139	1701
18	633574	6274884	1962
21	627881	6274623	1610
22	628677	6272963	1816
23	628788	6272986	1701

1. Coordinate system: MGA zone 53, 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 7 Details of point-to-point links crossing the proposed Project

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
1	11344469/1	8372794	460575000	ELECTRANET PTY LIMITED ElectraNet SA PO BOX 7096, Hutt St Post Office ADELAIDE SA 5000
		8372795	460575000	
		8372796	451075000	
		8372797	451075000	
2	1973207/1	975375	6800000000	
		975376	6800000000	
		975377	6460000000	
		975378	6460000000	
3	1973208/1	975383	6880000000	
		975384	6880000000	
		975385	6540000000	
		975386	6540000000	
4	10978846/1	6948303	6820000000	Optus Mobile Pty Limited 4G TXN 1 Lyon park Road MACQUARIE PARK NSW 2113
		6948304	6820000000	
		6948305	6480000000	
		6948306	6480000000	
5	10978847/1	6948307	6900000000	
		6948308	6900000000	
		6948309	6560000000	
		6948310	6560000000	
6	1806978/1	861709	7704500000	SOUTH AUSTRALIAN GOVERNMENT RADIO NETWORK GPO Box 464 ADELAIDE SA 5001
		861710	7704500000	
		861711	7543500000	
		861712	7543500000	
7	1959749/1	948439	413725000	SOUTH AUSTRALIAN WATER CORPORATION SA Water Adelaide GPO Box 1751 (C/- IT Manager) ADELAIDE SA 5001
		948440	413725000	
		948441	404275000	
		948442	404275000	
8	1919626/1	886354	460500000	Spark Infrastructure SA (No2) Pty Limited SA Power Networks GPO Box 77 (C/- Louise Watts) ADELAIDE SA 5001
		886355	460500000	
		886356	451000000	
		886357	451000000	
9	1931919/1	904812	460150000	
		904813	460150000	
		904814	450650000	
		904815	450650000	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
11968435	25110	1959755/2	-33.6930	136.4978	5	SOUTH AUSTRALIAN WATER CORPORATION SA Water Adelaide 15 GPO Box 1751 (C/- IT Manager) ADELAIDE SA 5001
11968438	25110	1959755/2	-33.6930	136.4978	5	
11433100	25137	12242089/1	-33.4701	136.4136	8	
11433103	25137	12242089/1	-33.4701	136.4136	8	
948495	304334	1959756/1	-33.2833	136.1825	31	
948501	304334	1959756/1	-33.2833	136.1825	31	
948507	25127	1959757/1	-33.1537	136.3745	41	
948510	25127	1959757/1	-33.1537	136.3745	41	
960729	25127	1965806/1	-33.1537	136.3745	41	
960732	25127	1965806/1	-33.1537	136.3745	41	
948513	25090	1959758/1	-33.5555	135.7273	52	
948518	25090	1959758/1	-33.5555	135.7273	52	
11433104	10036443	12242090/1	-33.5820	135.7215	52	
11433107	10036443	12242090/1	-33.5820	135.7215	52	
11728581	25118	1430095/2	-33.6585	136.5189	3	Spark Infrastructure SA (No2) Pty Limited SA Power Networks GPO Box 77 (C/- Louise Watts) ADELAIDE SA 5001
11728584	25118	1430095/2	-33.6585	136.5189	3	
749397	24866	1148415/1	-33.5772	136.7971	28	
749400	24866	1148415/1	-33.5772	136.7971	28	
790394	25131	1323402/1	-33.1225	136.3963	45	TELSTRA LIMITED Telstra - Radio Transport Engineering Locked Bag 3501 BRISBANE QLD 4001
790397	25131	1323402/1	-33.1225	136.3963	45	
790402	25131	1323403/1	-33.1225	136.3963	45	
790405	25131	1323403/1	-33.1225	136.3963	45	

Table 9 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	80
2 GHz Band	Spectrum	18
2.3 GHz Band	Spectrum	480
2.5 GHz Band	Spectrum	36
3.4 GHz Band	Spectrum	288
700 MHz Band	Spectrum	178
800 MHz Band	Spectrum	96
850/900 MHz Band	Spectrum	86
Aeronautical Assigned System	Aeronautical	8
Amateur Repeater	Amateur	4
Ambulatory System	Land Mobile	10
CBRS Repeater	Land Mobile	2
Commercial Radio	Broadcasting	9
Commercial Television	Broadcasting	3
Fixed Receive	Fixed Receive	1
Land Mobile System - > 30MHz	Land Mobile	273
Land Mobile System 0-30MHz	Land Mobile	32
Narrowcasting Service (LPON)	Broadcasting	11
National Broadcasting	Broadcasting	4
PMTS Class B	PTS	48
Paging System - Exterior	Land Mobile	7
Paging System - Interior	Land Mobile	1

Table 10 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
South Australian Government Radio Network	South Australian Government Radio Network GPO Box 464 Adelaide SA 5001	3
South Australian State Emergency Service	South Australian State Emergency Service State Emergency Service West Region GPO Box 2706 Adelaide SA 5001	4
St. John Ambulance Australia Incorporated	St. John Ambulance Australia Incorporated Technical Services 601-609 Blackburn Road Notting Hill Vic 3168	40

Table 11 Bureau of Meteorology radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
306141	Met Bureau Site cnr Shellgrit & Applebee Rds BUCKLAND PARK	-34.6170	138.4684	212
23280	Met Site Mount Terrible Range Road West SELLICKS HILL	-35.3296	138.5025	262
25514	Range G Transceiver Site WOOMERA	-31.1492	136.8005	267
139651	Ceduna Meteorological Office Hastings Road CEDUNA	-32.1303	133.6978	289
25292	Met Bureau Radar Site Hastings Rd CEDUNA	-32.1298	133.6966	289

Table 12 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
6131/ 1487	GDA94	-33.4945	136.4137	5
6230/ 1511	GDA94	-33.5095	136.5108	8
Darke Peak	AGD66, AGD84, GDA94	-33.4338	136.1643	17
Konanda	GDA94	-33.5192	136.1693	11
Neild	AGD66, AGD84, GDA94	-33.6598	136.5178	3
Priscilla	AGD66, AGD84, GDA94	-33.8062	136.4003	13
Rudall	GDA94	-33.6374	136.3375	Within Project boundary
Triple	AGD66, AGD84, GDA94	-33.7214	136.6382	16
Tuckey	GDA94	-33.6486	136.0879	19
Verran Park	GDA94	-33.8354	136.2326	19

Table 13 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		
			Caralue Bluff	Cowell	Tumby Bay
1	*627769*	*6286335*	*X*	*X*	*X*
2	*623327*	*6284128*	*X*	*X*	
3	*627498*	*6282847*	*X*	*X*	*X*
4	*630040*	*6283665*	*X*	*X*	*X*
5	*621871*	*6282621*	*X*	*X*	
6	*622990*	*6281148*	*X*	*X*	
7	*627265*	*6279944*	*X*	*X*	
8	*634288*	*6279281*	*X*		
9	*637757*	*6278441*	*X*		*X*
10	*621114*	*6277485*		*X*	
11	*625532*	*6277477*	*X*	*X*	
12	*629090*	*6276992*	*X*		
13	*630845*	*6277349*	*X*	*X*	*X*
14	*635178*	*6276281*	*X*	*X*	
15	*626170*	*6275881*	*X*		
16	*629889*	*6275416*	*X*		
17	*630815*	*6276139*	*X*		
18	*633574*	*6274884*	*X*	*X*	
19	*624773*	*6274322*	*X*	*X*	
20	*624814*	*6274335*	*X*	*X*	
21	*627881*	*6274623*		*X*	
22	*628677*	*6272963*		*X*	
23	*628788*	*6272986*		*X*	
58	618873	6277836		X	
59	619537	6277134		X	
93	636543	6286107			X
95	621838	6287496		X	X
96	620849	6287691		X	X
97	618446	6285819		X	
98	616885	6286745		X	
99	618486	6287284		X	
101	616251	6284489		X	
103	624741	6290353			X
104	627251	6289861			X
107	638900	6283622			X
108	636804	6282428	X		X
115	631885	6269772	X		
620	639110	6272394	X		
621	638501	6274236	X		
622	638054	6273563	X		
623	639418	6274396	X		
624	639468	6274434	X		
625	639825	6274788	X		
626	639544	6275125	X		
627	639890	6275381	X		
632	638746	6281522			X
650	620874	6290087		X	
661	632908	6286931			X

1. Associated dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 53, 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 14 Summary of service operators contacted by DNV and responses received to date

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
1	Fixed point-to-point: 3 links crossing the Project site Point-to-point #1 to #3: no turbines in exclusion zone calculated by DNV	Electranet 10519747-AUMEL-L-01-A	No response received to date
2	Fixed point-to-point: 2 links crossing the Project site Point-to-point #4 and #5: no turbines in exclusion zone calculated by DNV PMTS/spectrum (mobile phone): 5 km from Project boundary	Optus 10519747-AUMEL-L-02-A	No response received to date
3	Fixed point-to-point: 1 link crossing the Project site Point-to-point #6: no turbines in exclusion zone calculated by DNV Emergency services point-to-area: 3 km from Project boundary	South Australian Government Radio Network (SAGRN) 10519747-AUMEL-L-03-A	No response received to date
4	Fixed point-to-point: 1 link crossing the Project site Fixed point-to-point #7: 1 turbine in exclusion zone calculated by DNV Fixed point-to-multipoint: 5 km from Project boundary	South Australian Water Corporation (SA Water) 10519747-AUMEL-L-04-A	Response received by email on 27 February 2025: *"I have reviewed your report and wish to advise that the Point to Point radio link from ACMA site 25118 to site 25090 associated with licence 1959749/1 has recently been decommissioned.* *A review of repeaters in the area does not identify any with remote sites that have line of sight communications paths that the boundary of the proposed Cleve wind farm.* *We do have a repeater sites with point to multipoint communications at the following locations…* *…Currently there are no sites communicating to these repeaters that have line of sight paths that cross the Cleve wind farm boundary."*

Table 14 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
5	Fixed point-to-point: 2 links crossing the Project site Fixed point-to-point #8 and #9: no turbines in exclusion zone calculated by DNV Fixed point-to-multipoint: 3 km from Project boundary	Spark Infrastructure SA (No2) Pty Limited (SA Power Networks) 10519747-AUMEL-L-05-A	<u>Response received by email on 4 March 2025:</u> *"We have reviewed the provided document and agree with the assessment that the SA Power Networks link between Mount Neild and Tooligie Hill will not be impacted by the Turbines in southern part of the wind farm site boundary…* *… [We] have identified a link that exists between Mount Neild and one of our sites, Rudall Substation, which is impacted by the positioning of some of the turbines found in the southern part of the site boundary…* *… We would like to see an assessment of our PTMP link between Mt Nield and Rudall Substation based on guidance identified in your report. Could you please provide a report based on the provided remote sites (Rudall Substation) geographic co-ordinates and antenna height and licence details…* *…could we have an assessment of the impact based on a 100% of the Fresnel zone and the 60% suggested in the report for links of frequencies below 1000MHz…"*

Table 14 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
6	PMTS/spectrum (mobile phone): 2 km from Project boundary Fixed point-to-multipoint: 45 km from Project boundary	Telstra 10519747-AUMEL-L-06	Response received by email on 26 March 2025: *"A desktop assessment was undertaken. Based on this assessment; 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.* *2. Based on the turbine locations provided and information regarding Telstra's 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. A detailed analysis of the full power coordination impact (Low Frequency Induction (LFI) and/or Earth Potential Rise (EPR)) of the wind farm development is required. This includes location of the wind farm switch yard, the route and potential of any associated HV transmissions lines and the LFI and EPR impact on any Telstra plant they may affect.* *4. It is recommended that you contact Before You Dig Australia, so you are aware of the underground assets in the area. They will provide you with the location of Telstra's as well as any other utilities' underground assets.* *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."*
7	Emergency services point-to-area: 40 km from Project boundary	St John Ambulance 10519747-AUMEL-L-07-A	Current turbine layout provided; no response received to date

Table 14 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
8	Emergency services point-to-area: 4 km from Project boundary	South Australian State Emergency Service (SASES) 10519747-AUMEL-L-08-A	No response received to date
9	Meteorological radar: 212 km from Project boundary	Bureau of Meteorology 10519747-AUMEL-L-09-A	Response received by email on 17 April 2025: *"Our assessment of the current Cleve Wind Farm proposal has determined that, under normal atmospheric conditions, it poses a manageable risk to Bureau radar and radiocommunication assets.* *As a result, the Bureau has no objections to the proposed development proceeding, as detailed in the documentation provided for assessment.* *Any modifications to the wind farm parameters, including layout designs, turbine locations, or heights, will require a new assessment."*
10	Trigonometrical station: Within the Project boundary GNSS station: 7 km from Project boundary	Geoscience Australia 10519747-AUMEL-L-10-A	Response received by email on 26 February 2025: *"Geoscience Australia do not foresee any interference to our GNSS infrastructure or trigonometrical stations as a result of the proposed Cleve Wind Farm."*
11	Trigonometrical station: Within the Project boundary	Department of Planning, Transport and Infrastructure (DPTI) 10519747-AUMEL-L-11-A	Response received by email on 13 March 2025: *"There are two trigonometrical stations within the windfarm site. These are passive sites, meaning they do not emit signals… It appears these marks are not in the path of any planned towers. However, please contact us if they may be destroyed by other civil works or if the design changes so that we can discuss alternative options."*

Table 14 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
12	Spectrum (wireless internet): 6 km from Project boundary	NBN Co 10519747-AUMEL-L-12-A	<u>Response received by email on 27 March 2025:</u> *"I have reviewed the data provided based on the proposed wind farm location; there are no proposed tower locations inside existing nbn wireless coverage boundaries and no existing nbn customers inside the wind farm boundary. The proposed wind tower locations pose no risk of introducing a physical obstruction along any customer RF profiles…* *Once known, please provide information on any RF transmission equipment planned to be used during construction or permanently installed so a potential interference impact can be assessed. This information should include as a minimum the operating transmission frequency and transmit power, channel bandwidths, antenna types and radiation patterns as well as the exact location with antenna height, boresight azimuth and tilt [mechanical and electrical tilt].* • *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 90 km of the proposed Cleve 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."*

Table 14 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
13	DTV broadcasting: 282 km from Project boundary	BAI Communications 10519747-AUMEL-L-13-A	Response received by email on 11 April 2025: *"BAI has done a study on the proposed Cleve Wind Farm located near Cleve, South Australia.* *The impact on three digital television broadcast facilities [Cowell, Caralue Bluff, and Tumby Bay] was studied. The results show that no people are predicted to be impacted by the proposed wind turbines due to the scatter interference effects of the wind farm. However, if there is any impact, remediation to affected DTV viewers is required to form part of the wind farm project.* *No assessment has been deemed necessary for BAI FM broadcast services.* *No BAI AM broadcast services were deemed to be in close enough proximity to the wind farm and thus no assessment was deemed necessary."*
14	Land mobile: Within the Project boundary	Pringles AG-PLUS (Emmetts) 10519747-AUMEL-L-14-A	No response received to date
15	Low-power broadcasting: Within the Project boundary	United Christian Broadcasters Australia Limited (Vision Media) 10519747-AUMEL-L-15-A	No response received to date
16	FM radio broadcasting: 2.6 km from the Project boundary	Eyre Peninsula Broadcasters Pty Ltd 10519747-AUMEL-L-15-A	No response received to date

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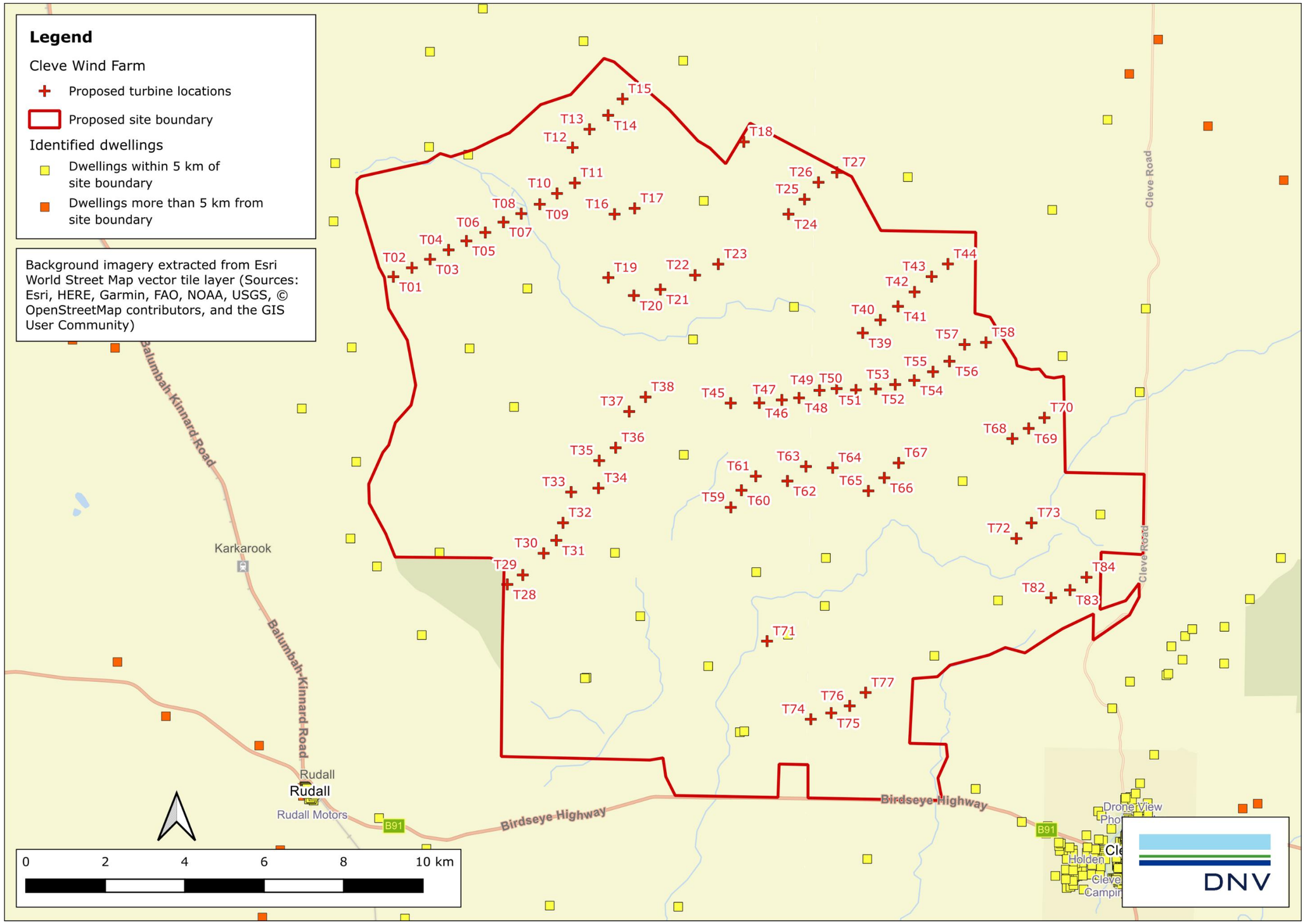

Figure 1 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby dwellings

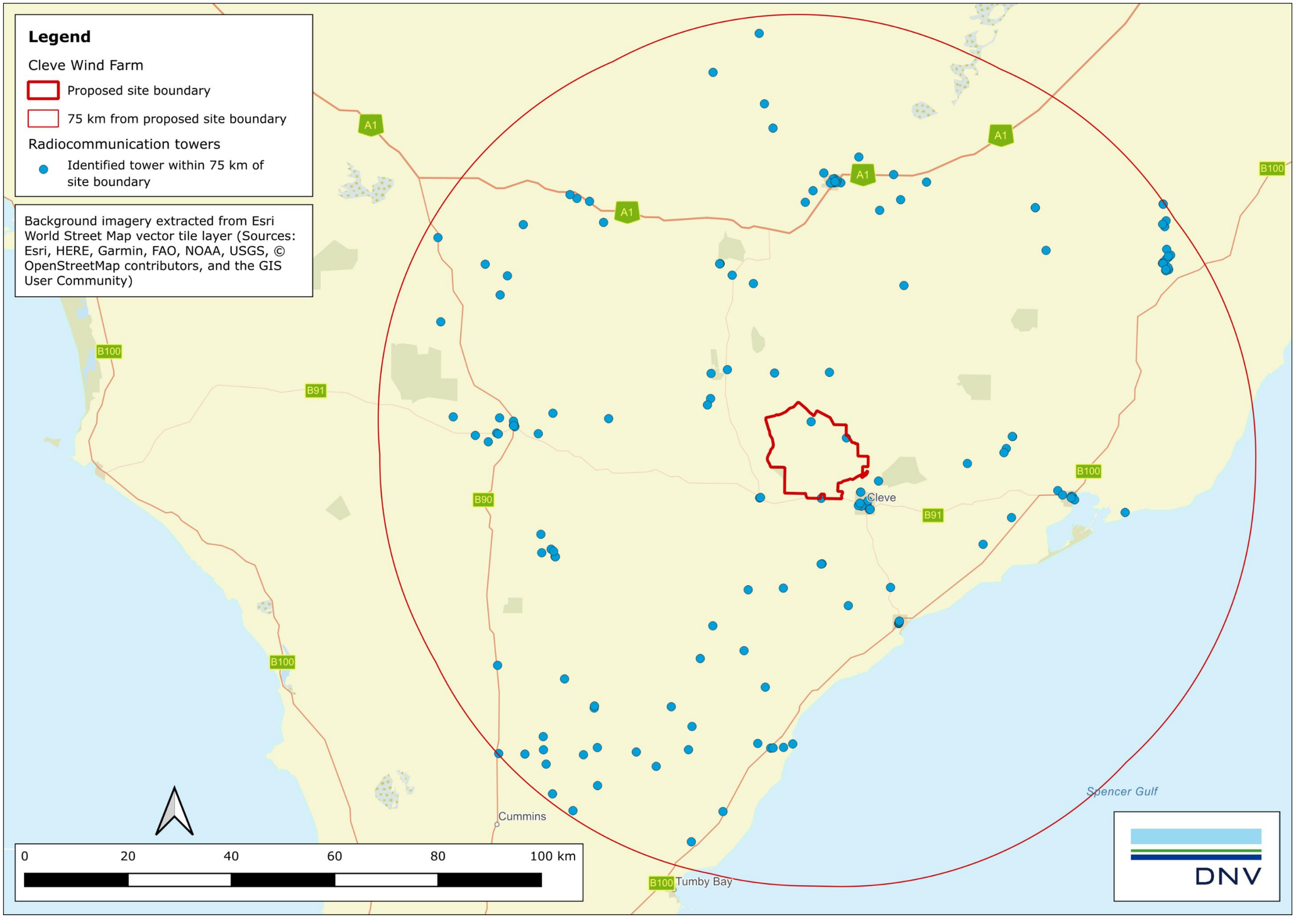

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

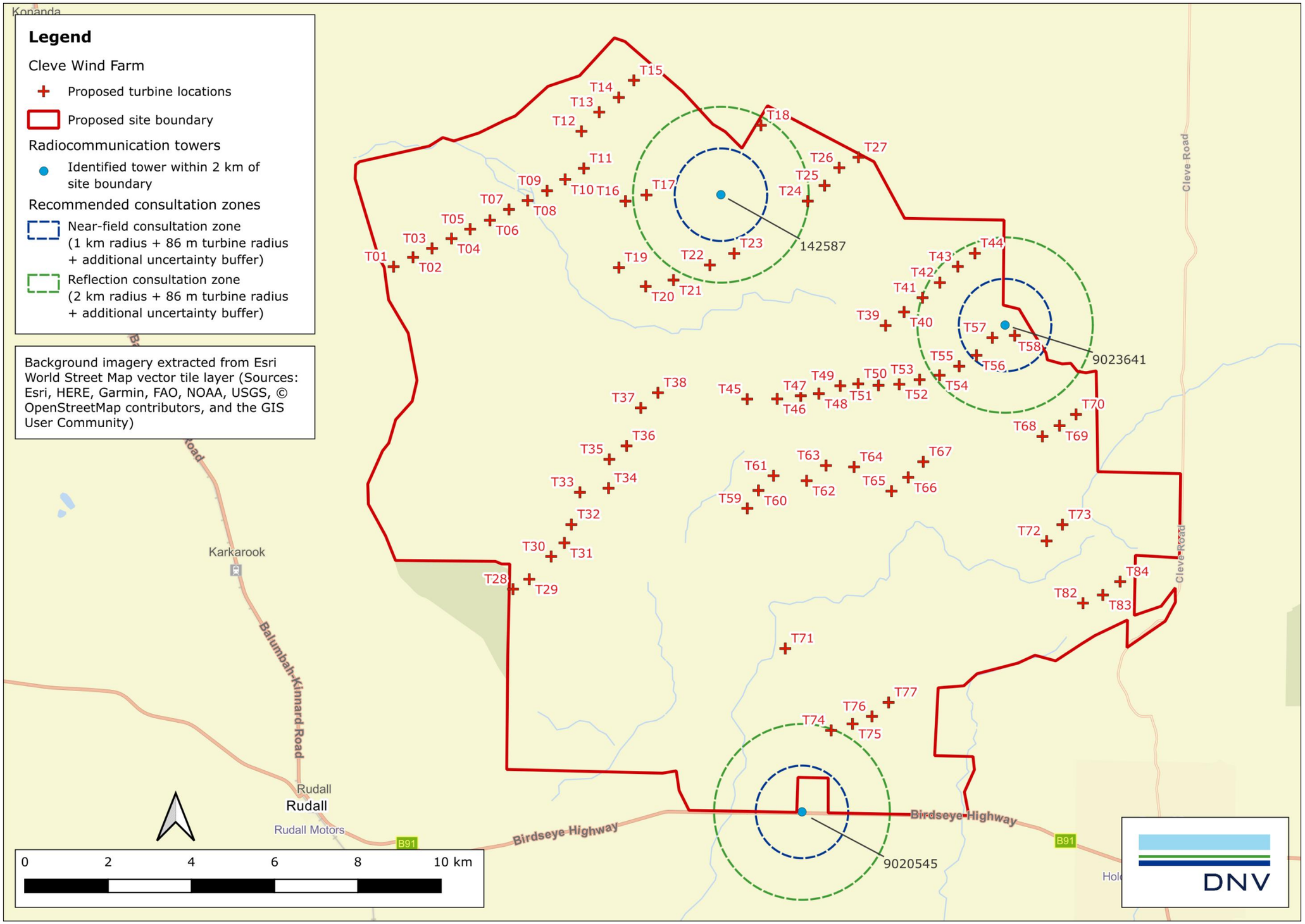

Figure 3 Identified radiocommunication sites within 2 km of the turbine locations for the proposed Project

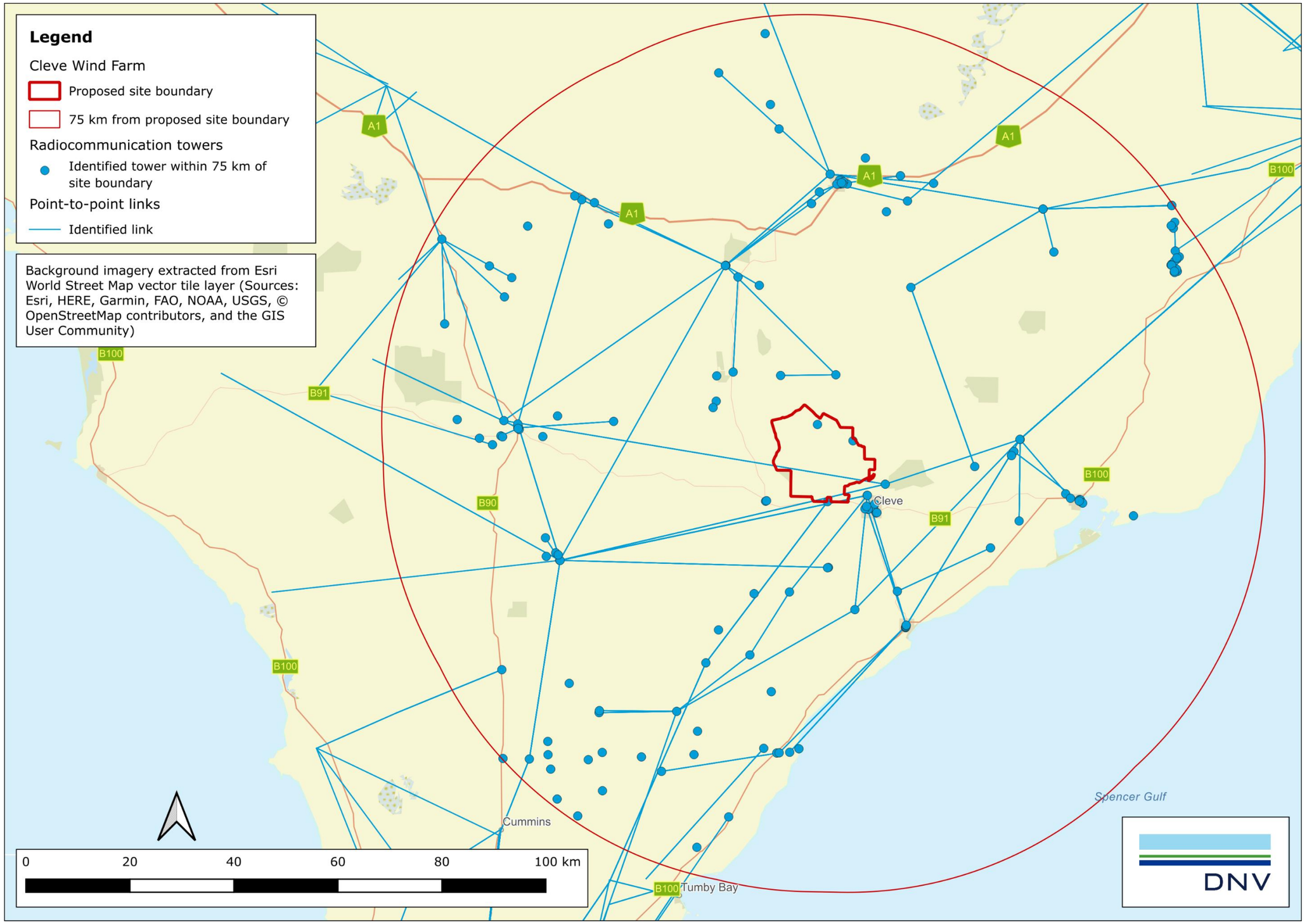

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

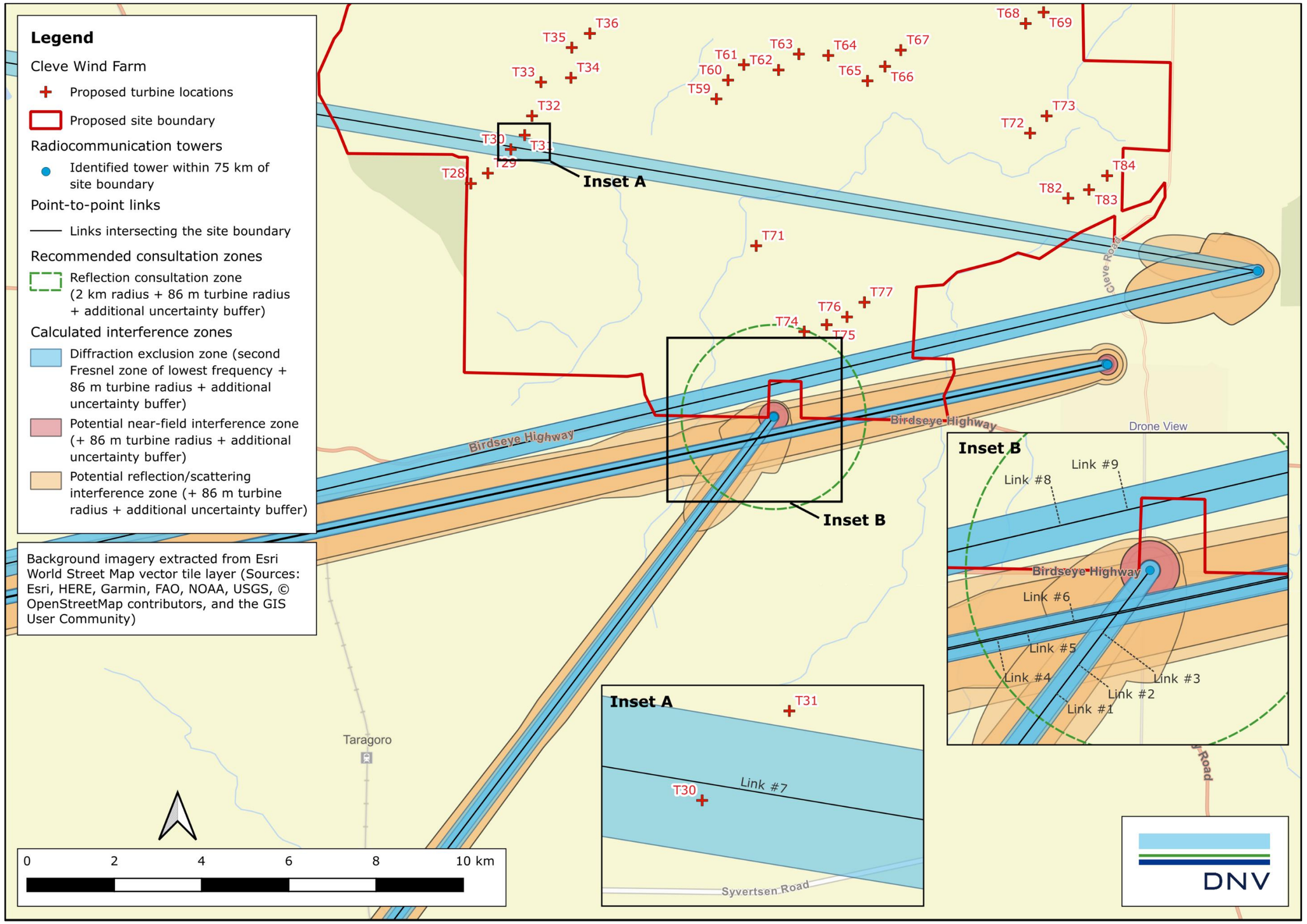

Figure 5 Identified point-to-point radiocommunication vectors crossing the proposed Project and calculated interference zones

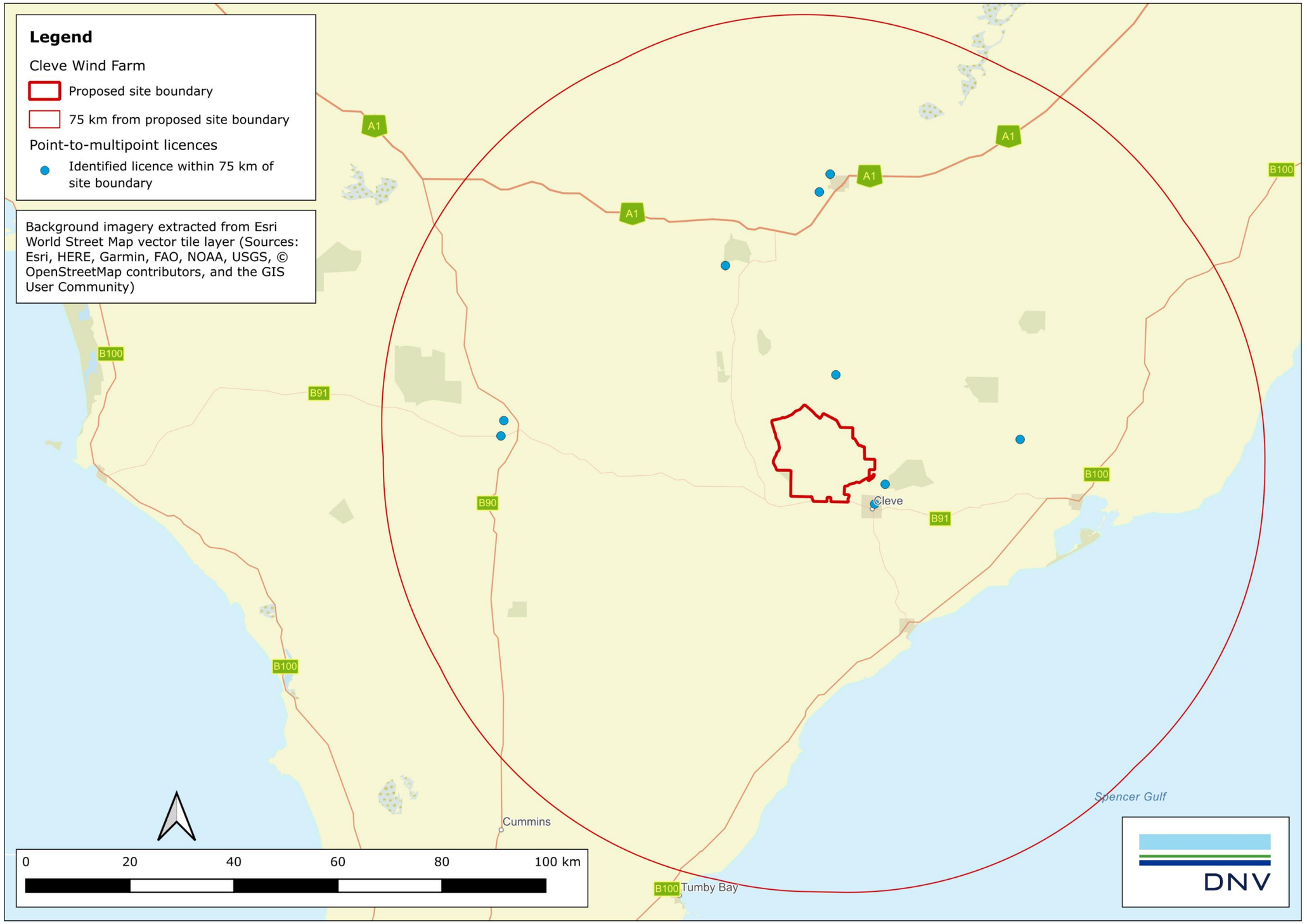

Figure 6 Location of point-to-multipoint licences in the vicinity of the proposed Project

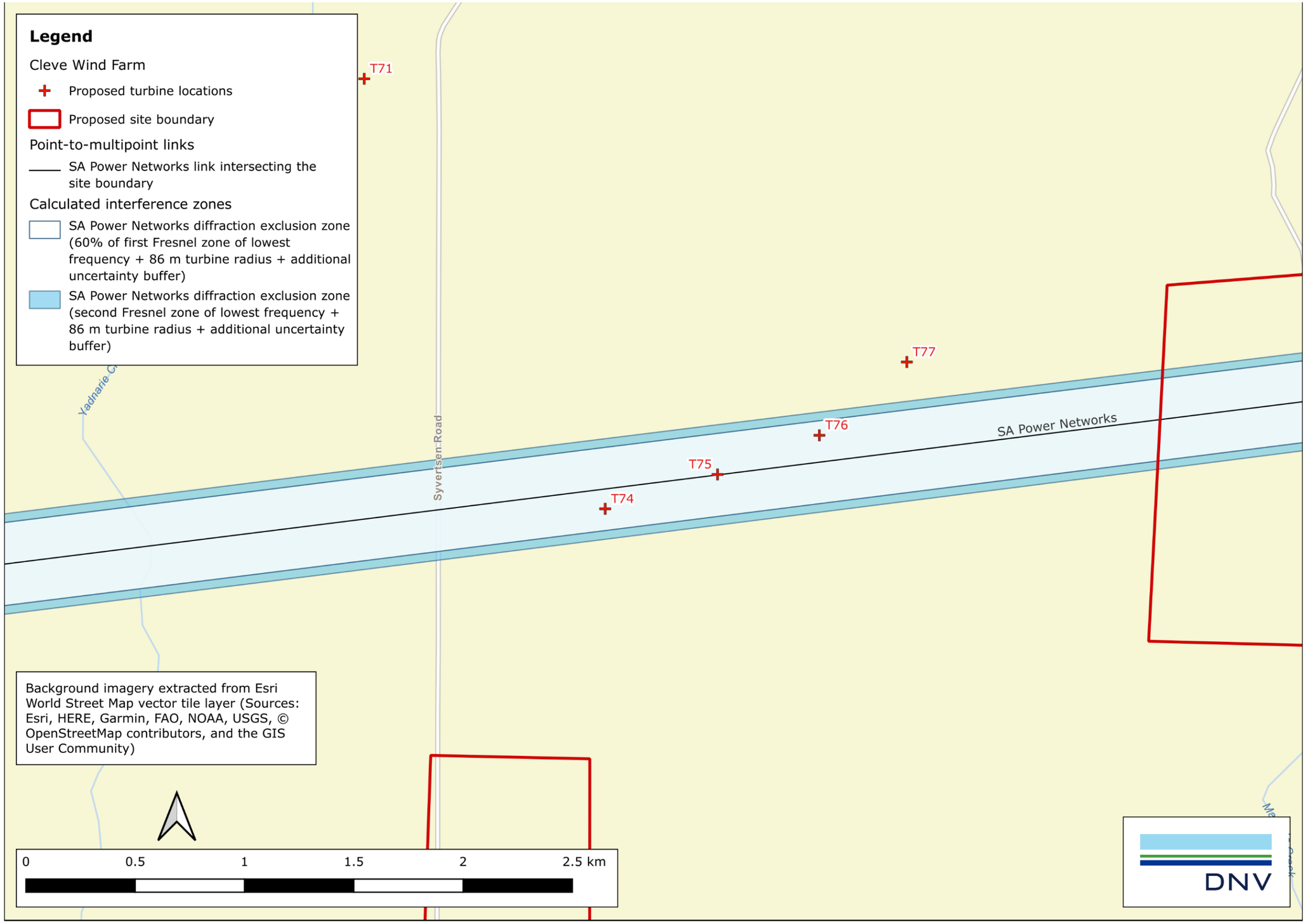

Figure 7 Calculated interference zones for the point-to-multipoint licence operated by SA Power Networks crossing the Project boundary

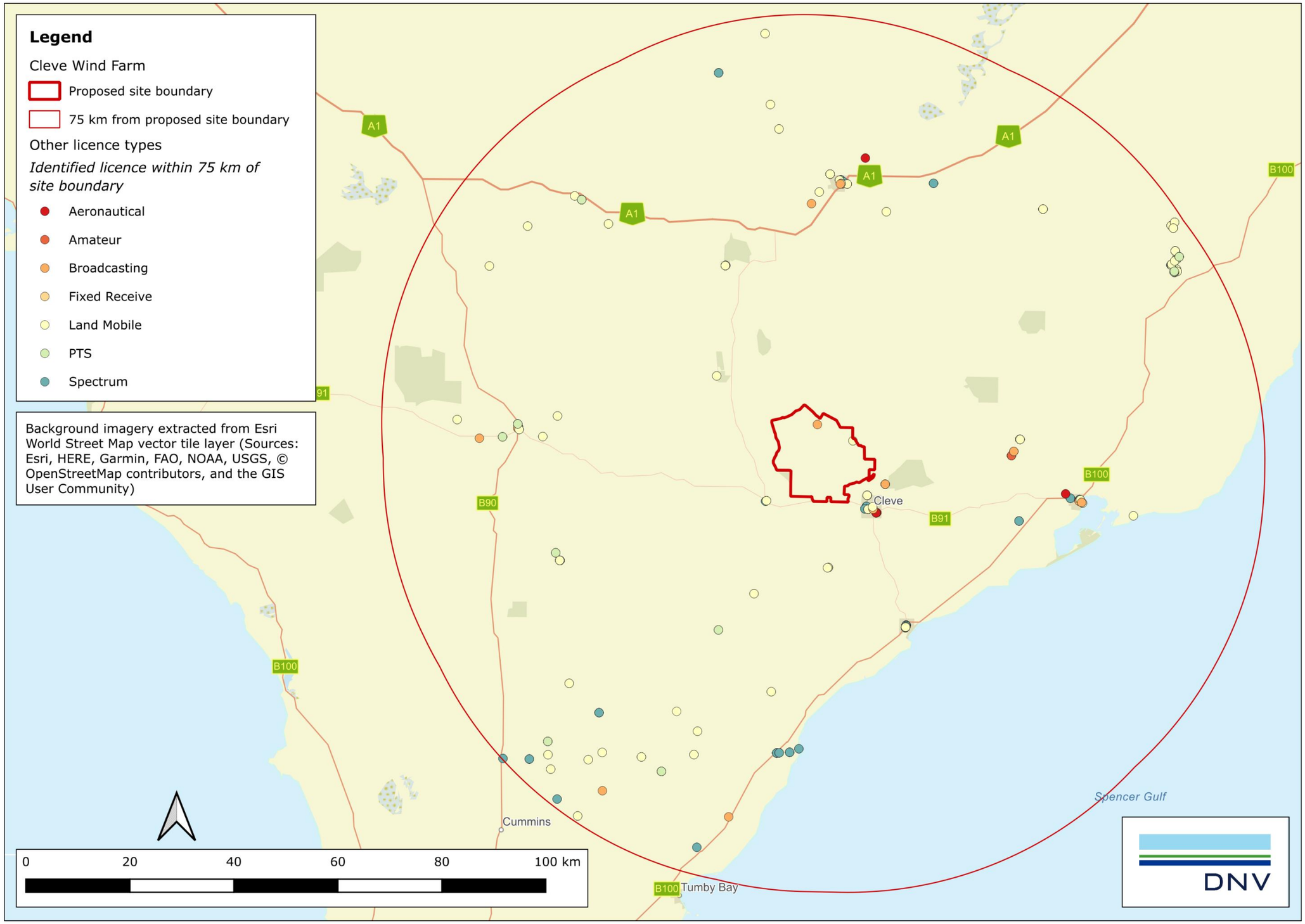

Figure 8 Location of other licence types within 75km of the proposed Project

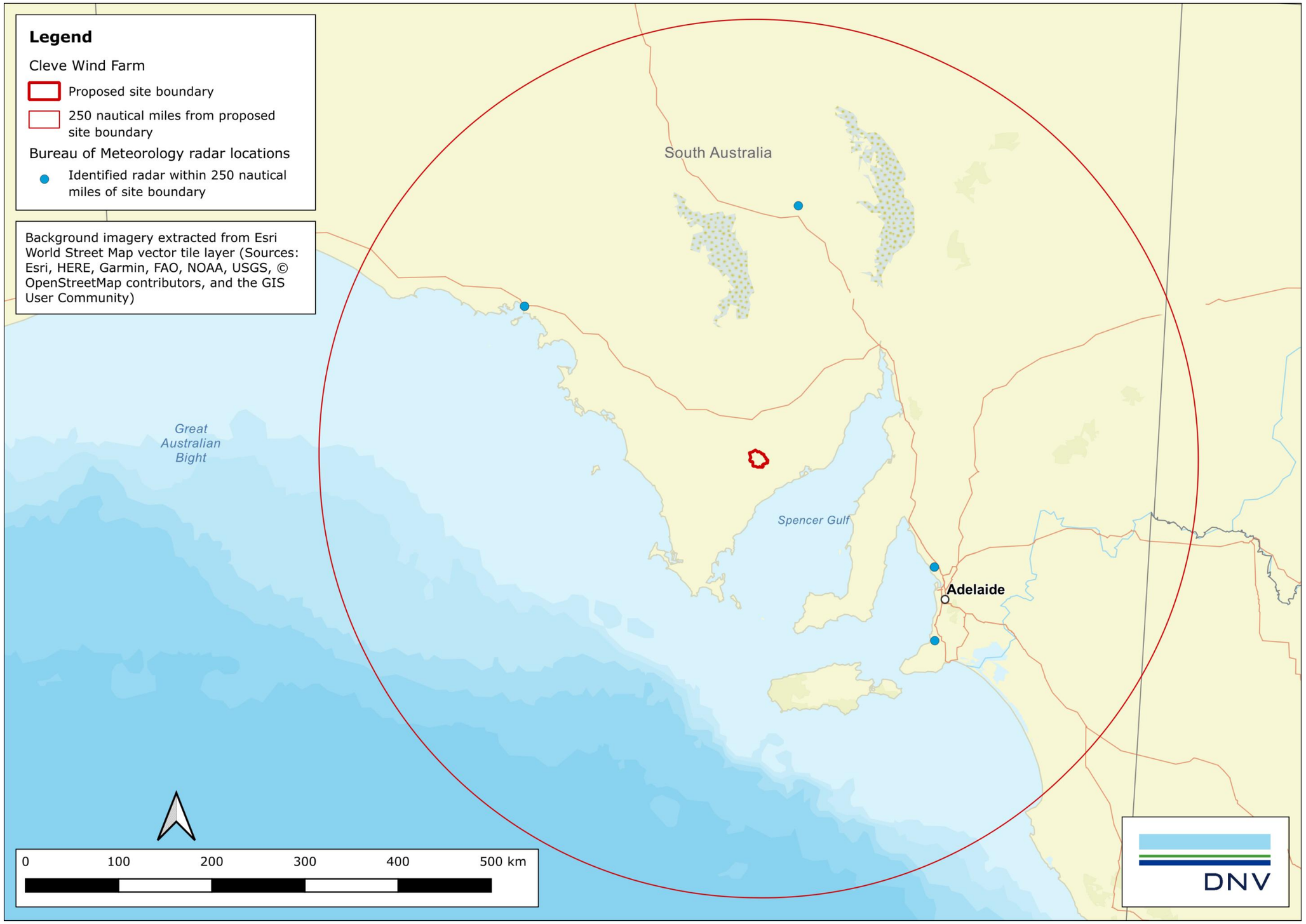

Figure 9 Location of meteorological radar sites within 250 nautical miles of the proposed Project

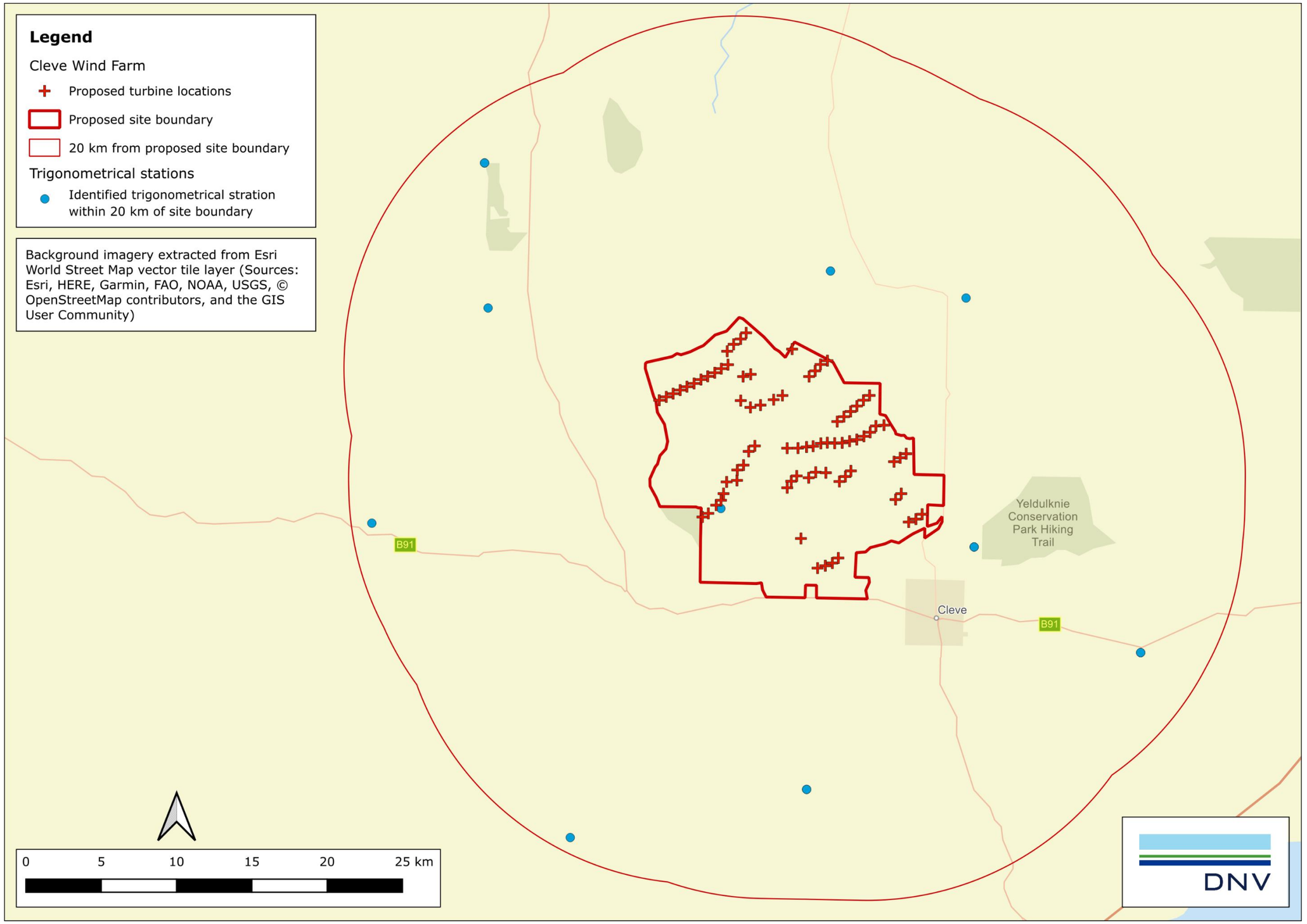

Figure 10 Location of trigonometrical stations within 20 km of the proposed Project

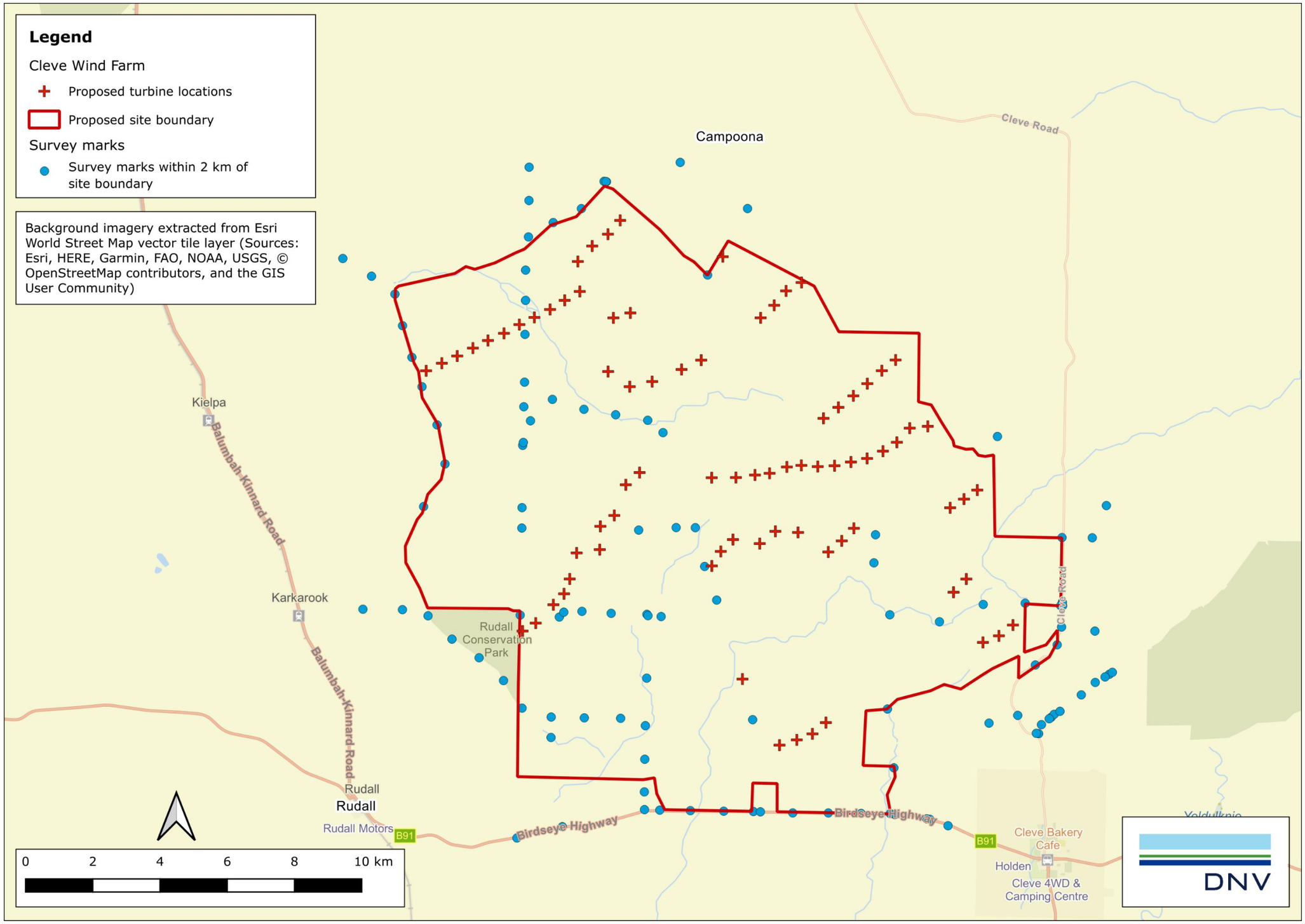

Figure 11 Location of survey marks within 2 km of the proposed Project

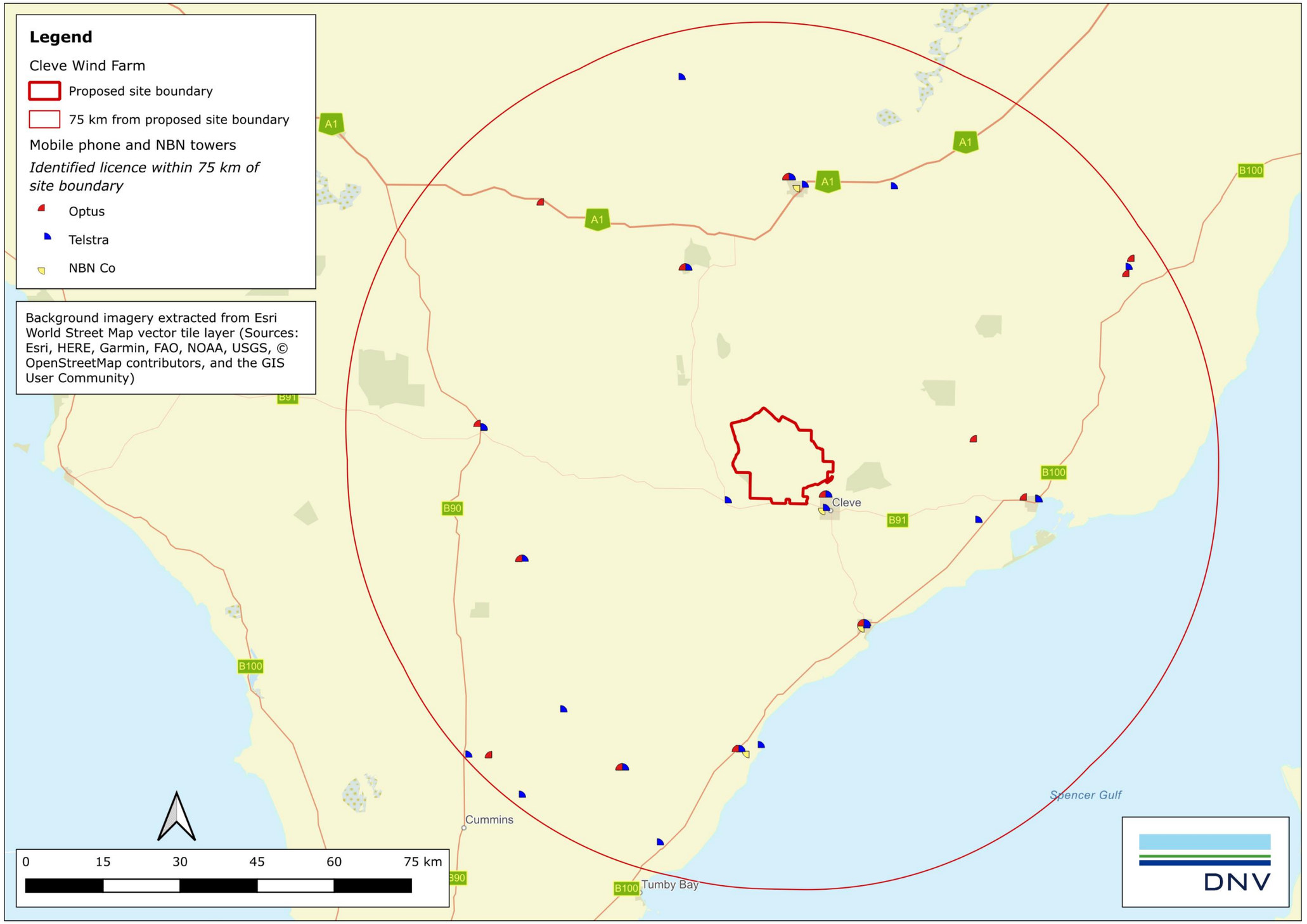

Figure 12 Location of mobile phone and NBN towers within 75 km of the proposed Project

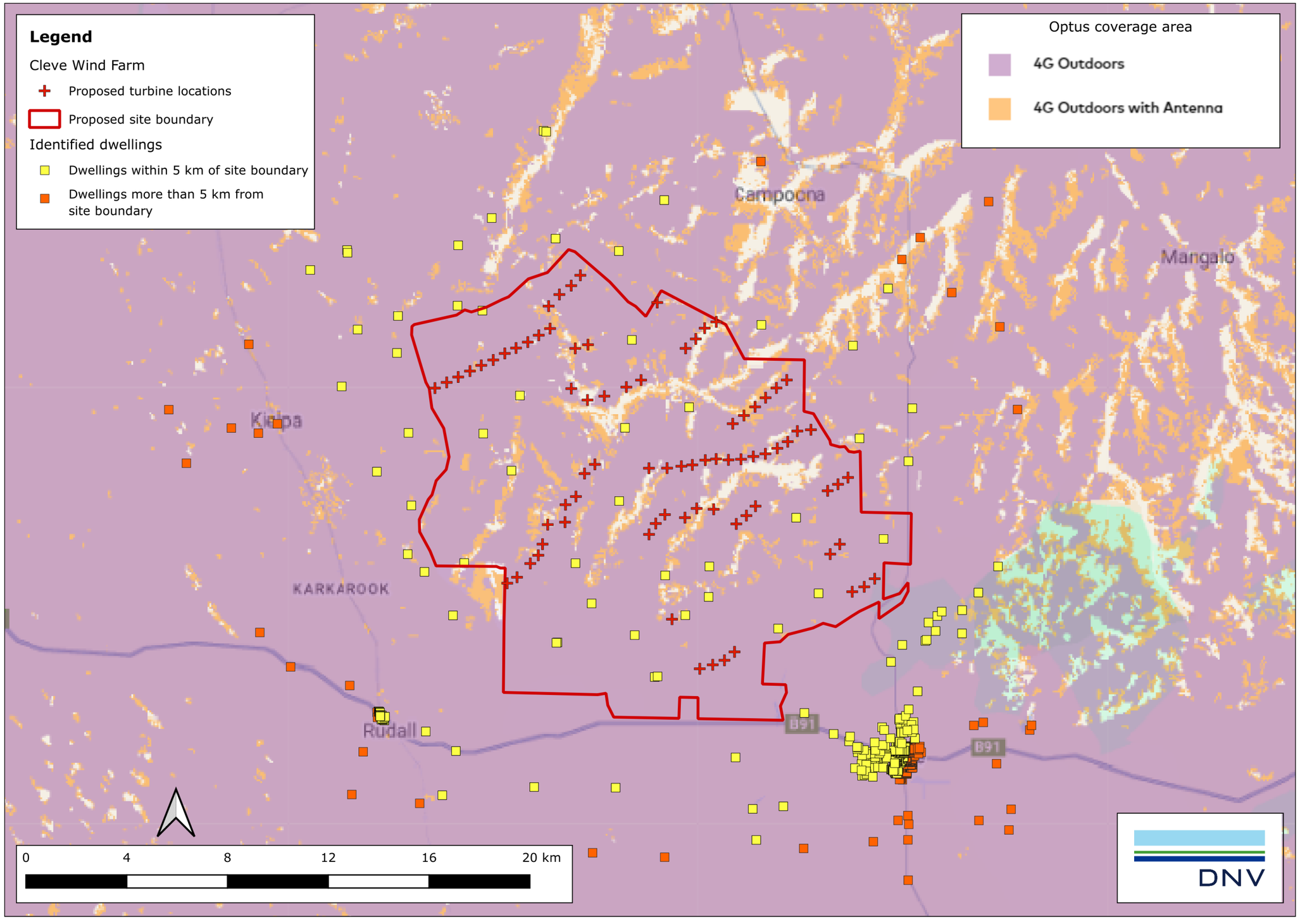

Figure 13 Optus Mobile 4G network coverage for the proposed Project

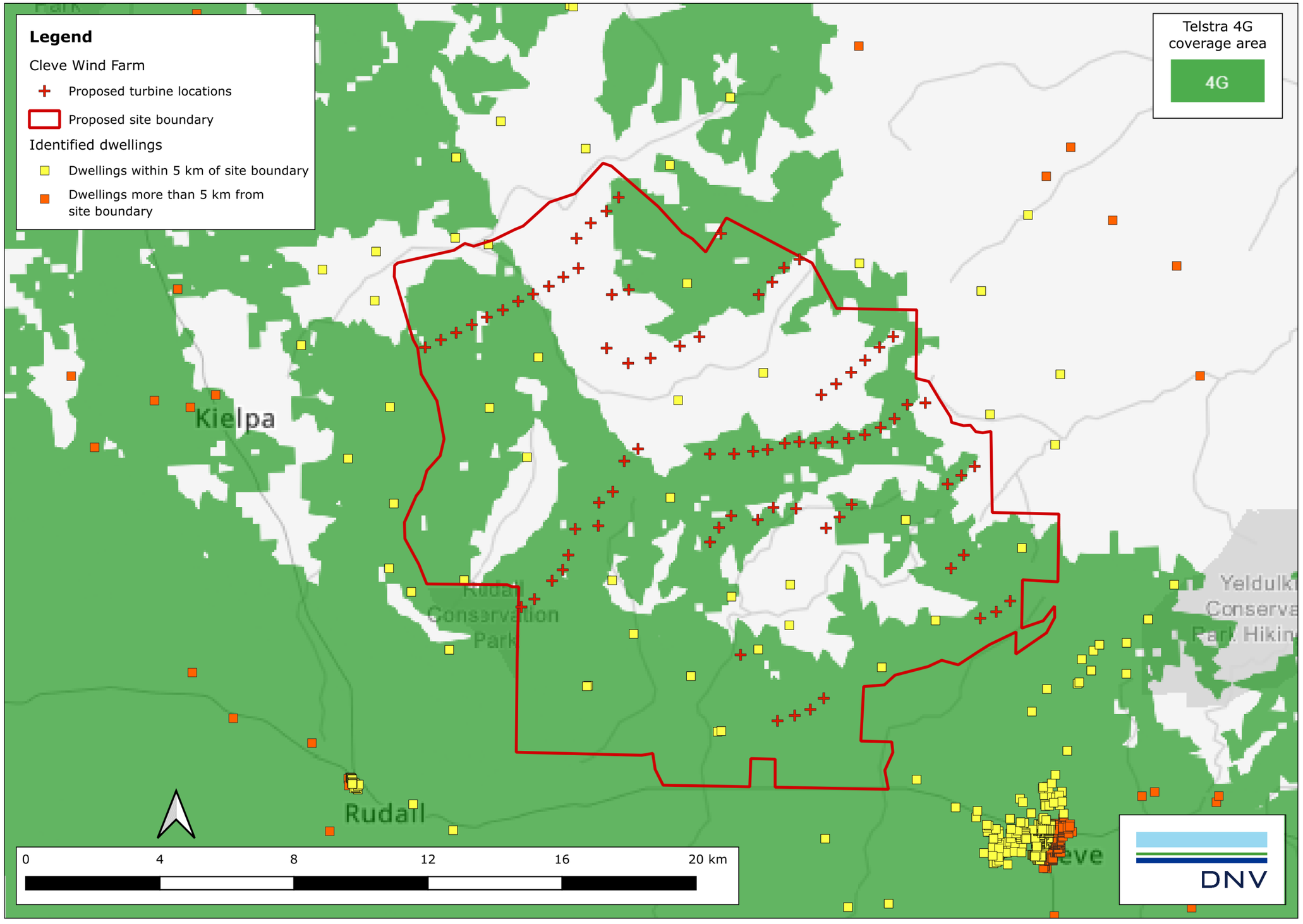

Figure 14 Telstra 4G network coverage for the proposed Project

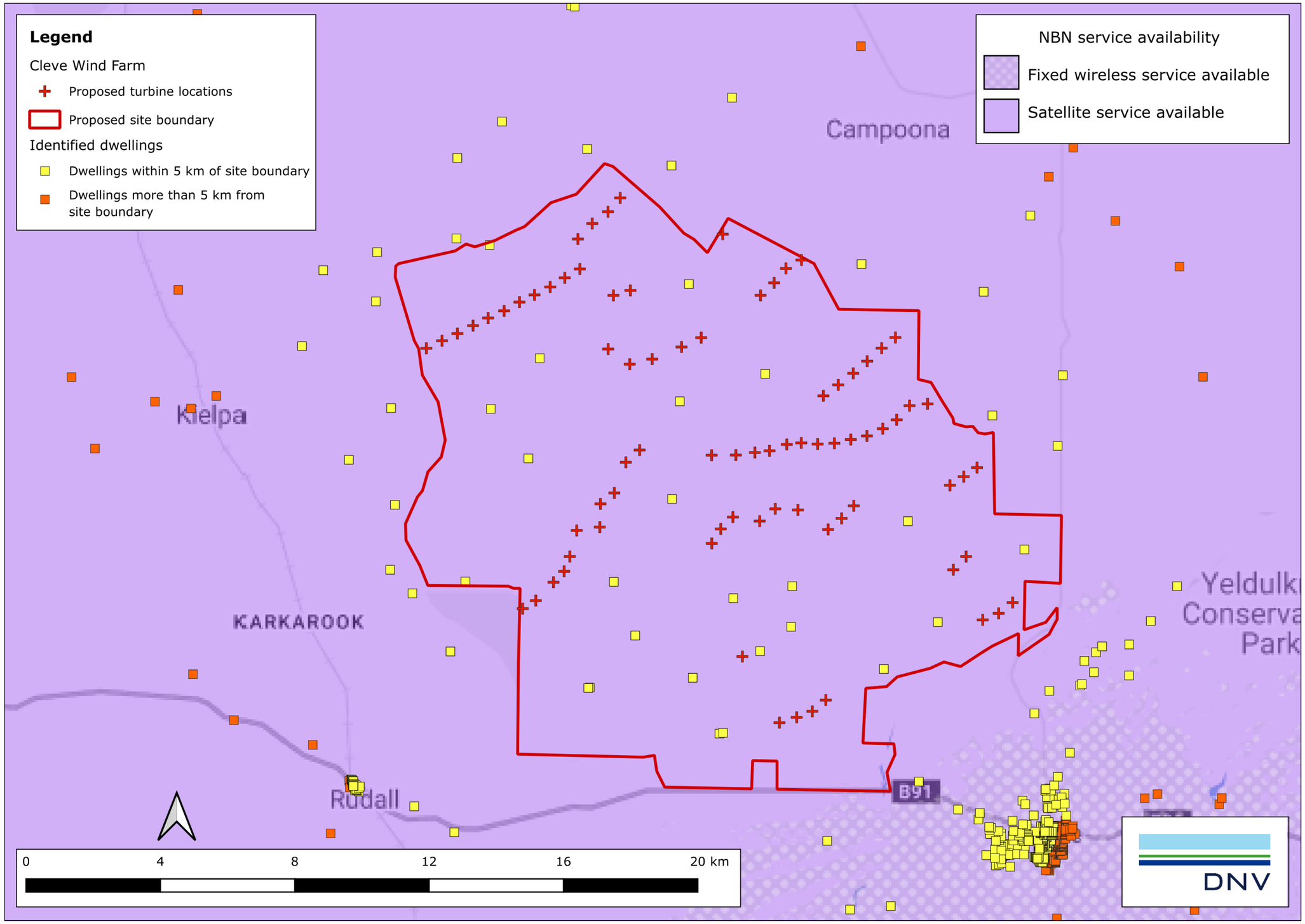

Figure 15 NBN internet coverage in the vicinity of the proposed Project

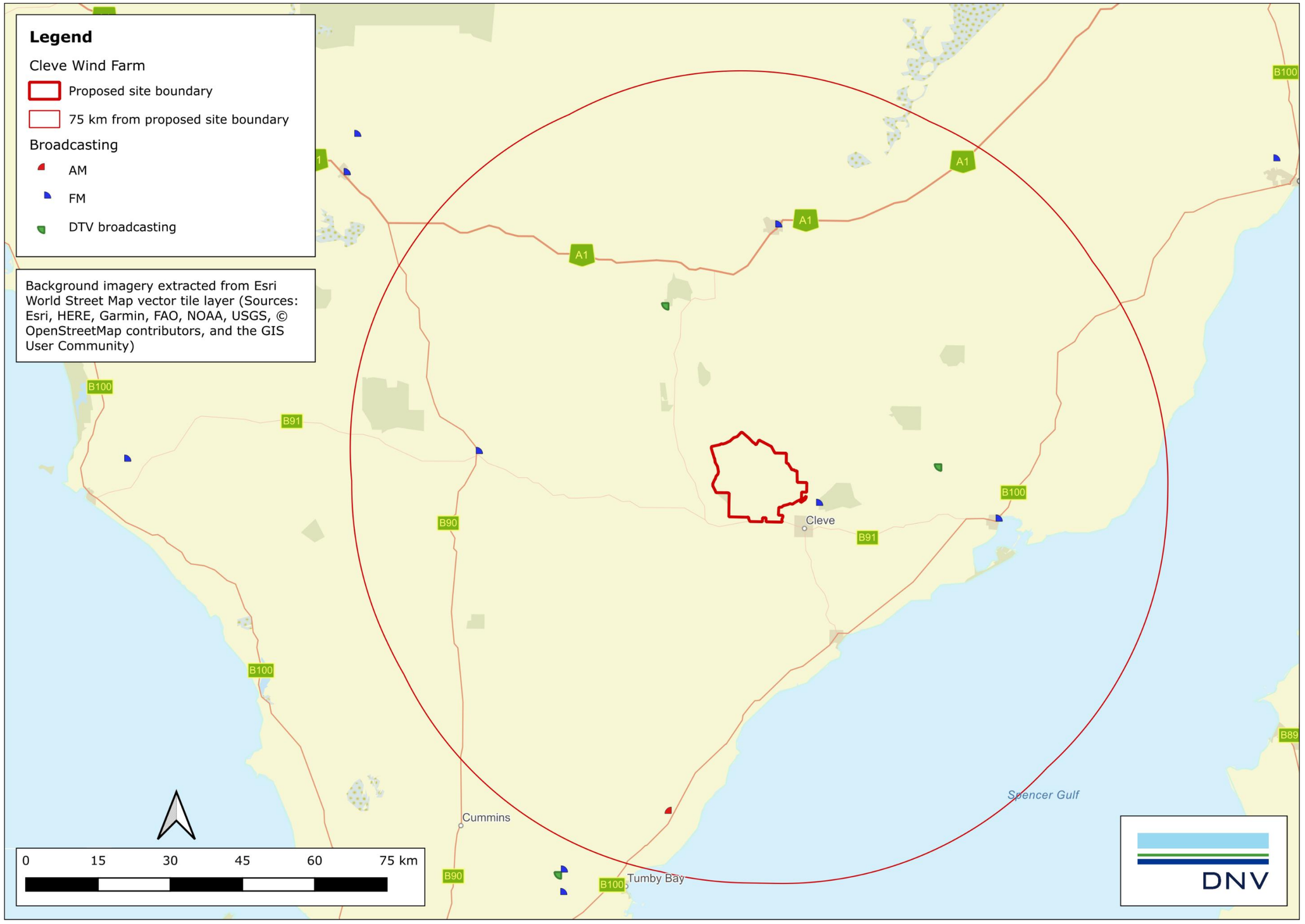

Figure 16 Location of broadcast transmitters in the vicinity of the proposed Project

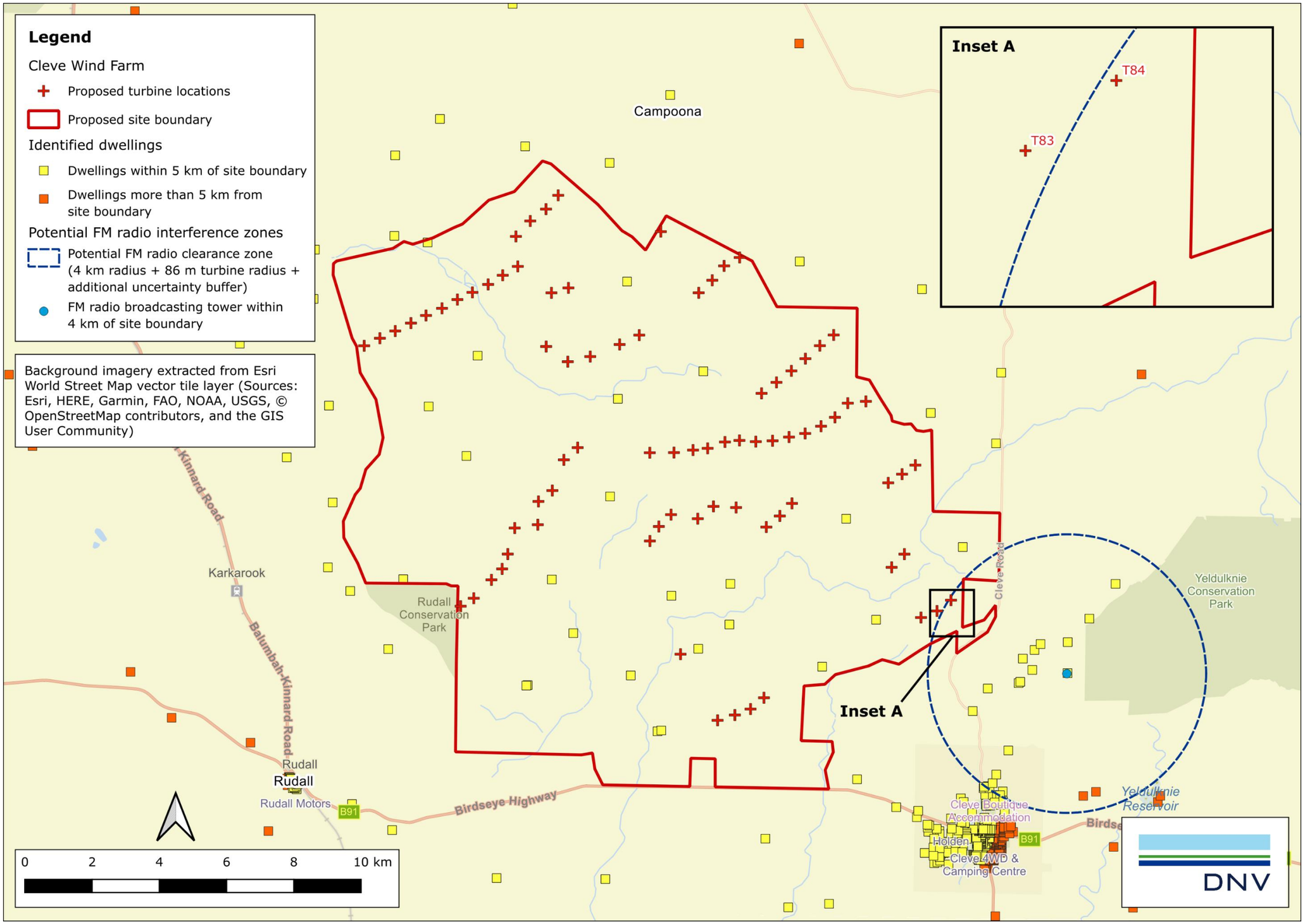

Figure 17 Potential FM radio clearance zone for the proposed Project

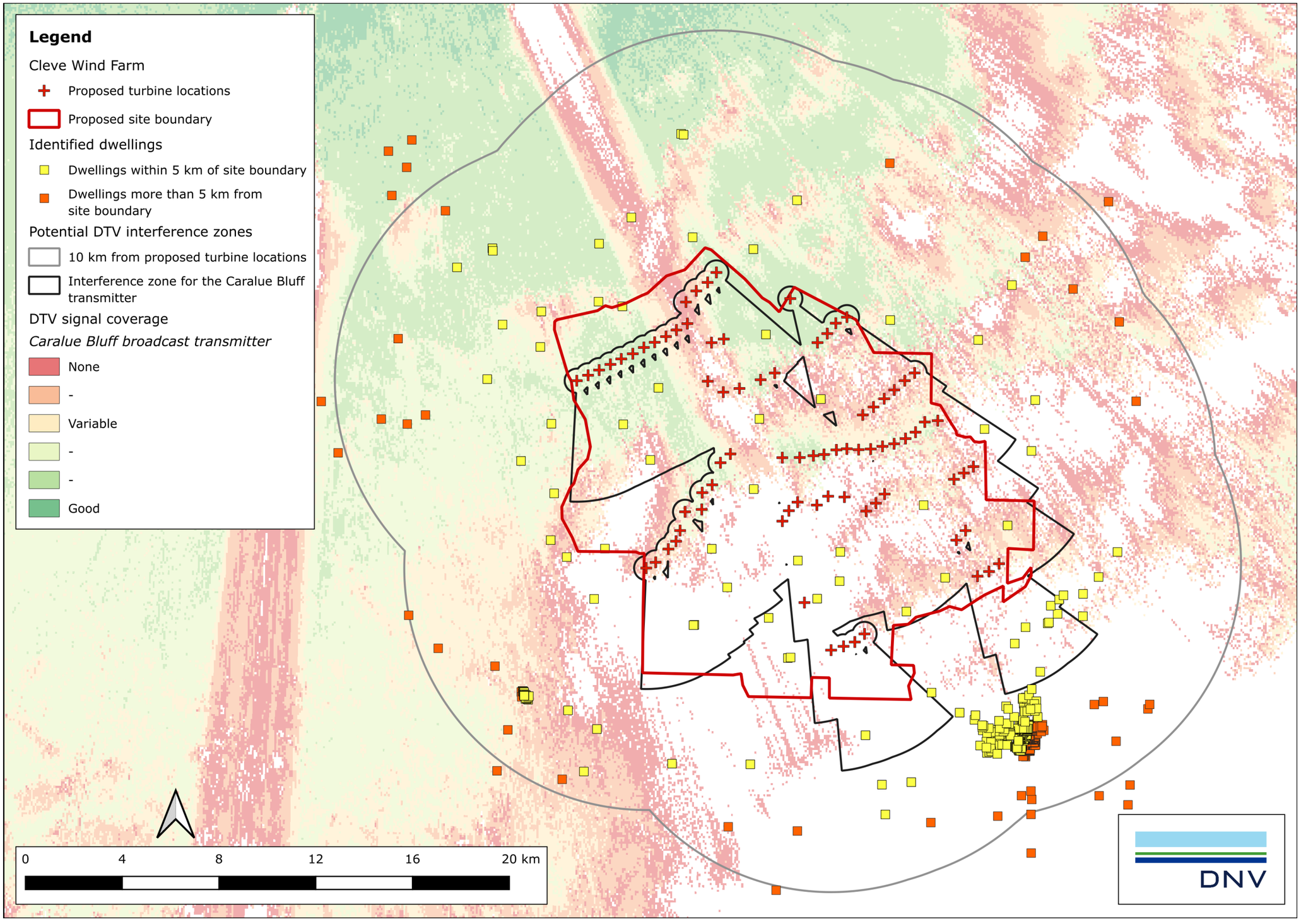

Figure 18 Potential television EMI zones for the Caralue Bluff broadcast transmitter from the proposed Project

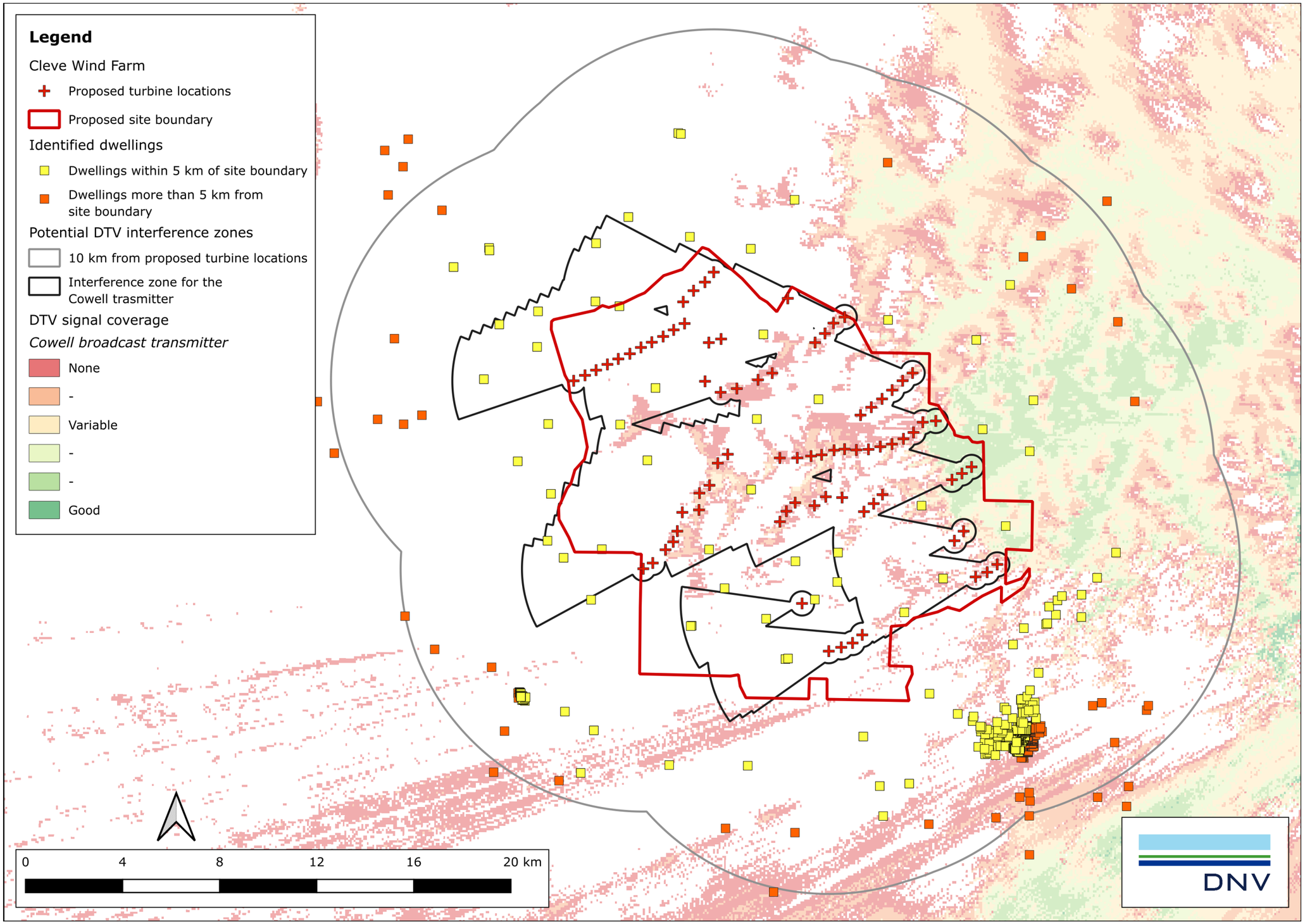

Figure 19 Potential television EMI zones for the Cowell broadcast transmitter from the proposed Project

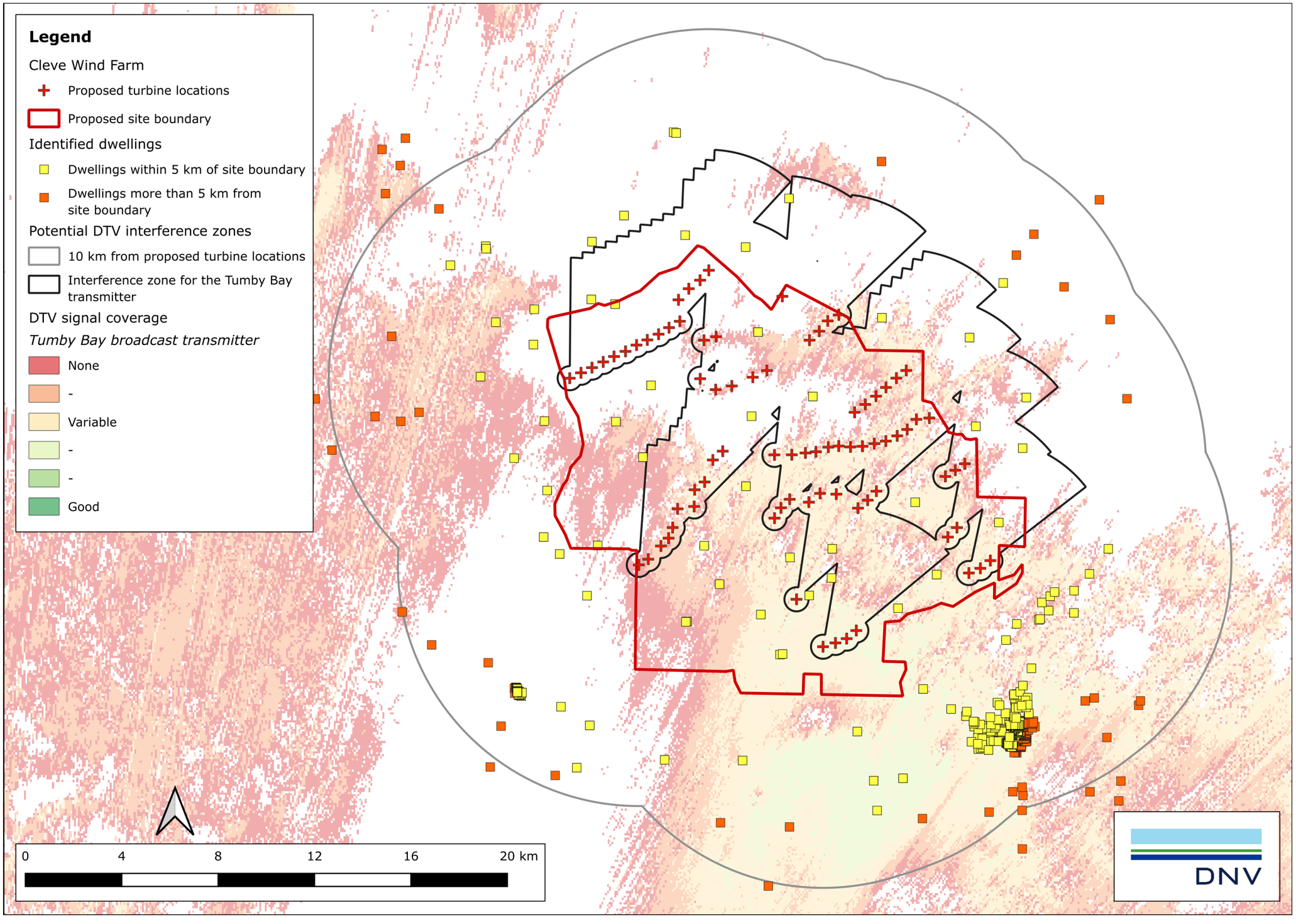

Figure 20 Potential television EMI zones for the Tumby Bay broadcast transmitter from the proposed Project

About DNV

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

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

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