MT FYANS
WIND FARM

APPENDIX O

ELECTROMAGNETIC INTERFERENCE REPORT

DNV GL

AUGUST 2022

MT FYANS WIND FARM

EMI Assessment

Hydro Tasmania

Report No.: 10373388-AUMEL-R-01, Rev. C
Document No.: 10373388-AUMEL-R-01-C
Date: 16 August 2022
Status: FINAL

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Date of issue:	16 August 2022	
Project No.:	10373388	
Organisation unit:	E-KA-D	
Report No.:	10373388-AUMEL-R-01, Rev. C	
Document No.:	10373388-AUMEL-R-01-C	

Applicable contract(s) governing the provision of this Report:

Hydro Tasmania Single Use Consultancy Contract number 3012002498, dated 10 August 2022

Objective: Mt Fyans Wind Farm EMI Assessment

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Document classification:

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Keywords:

Mt Fyans Wind Farm EMI Assessment

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2022-08-10	First issue – PRELIMINARY DRAFT	N Brammer		
B	2022-08-16	Draft	N Brammer	Z Ng, T Gilbert	T Gilbert
C	2022-08-16	FINAL	N Brammer	Z Ng, T Gilbert	T Gilbert

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EXECUTIVE SUMMARY

DNV has been commissioned by Hydro Tasmania acting on behalf of Woolnorth Wind Farm Holding Pty Ltd ("the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Mt Fyans Wind Farm ("the Project") in western Victoria. 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 Victorian Planning Guidelines [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 81 wind turbines with a rotor diameter of 170 m and tip height of 200 m has been considered. These dimensions represent the maximum overall tip height within the maximum rotor and tower hub height dimensions.

There are 212 identified dwellings within 5 km of the Project, 21 of which are involved in the Project.

Outcomes of the assessment

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

The Project has potential to interfere with NBN fixed wireless internet signals received from the Mt Shadwell tower at nearby dwellings, with interference most likely to be experienced at involved dwellings within the Project boundaries. Based on a previous turbine layout and dimensions, NBN Co advised that signals to up to six connected residences could be impacted. DNV is intending to contact NBN Co again to confirm their views on the potential for the Project to interfere with their services, based on the current turbine layout and dimensions. DNV also recommends that the Customer engages with NBN Co prior to the construction of the Project to establish an understanding of how any impacts to their fixed wireless services may be mitigated.

Point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting are generally unlikely to be affected by wind farms. However, interference may be experienced in areas of poor or marginal reception. Specifically, turbines at the Project may interfere with digital television (DTV) broadcast signals received from the Ballarat transmitter at houses surrounding the Project, including parts of Mortlake township. Coverage maps suggest that the Ballarat transmitter is the main source of DTV signals for Mortlake, and so interference to signals from this transmitter may have a significant impact on residents. Turbines at the Project may also interfere with signals received from the Warrnambool DTV transmitter, although the associated coverage map suggests that signals from this transmitter are not available in the affected area. If interference to point-to-area style services is caused by the Project, a range of options are available to rectify difficulties.

Although interference is possible for satellite television and internet signals, the signals that are likely to be intercepted by turbines in the Project are from satellites that do not provide services designed for Australian audiences.

While the Project may cause interference to fixed point-to-multipoint links operated by Wannon Water if the link paths cross the Project near the turbine locations, further information from the operator is required to determine the likely impacts. DNV has previously contacted Wannon Water to seek feedback on whether there is potential for the Project to cause interference to their

operations and services, but no response was received. DNV is intending to contact Wannon Water again to try to confirm the paths for their point-to-multipoint links, and hence the potential for interference. Operators of other point-to-multipoint links in the vicinity of the Project have advised that they do not expect any impacts to their services.

Potential impacts on other services considered in this assessment are either considered unlikely or can be assessed through consultation with the service operators. The operators that have been contacted, and their responses based on a previous turbine layout and dimensions, are summarised in the table on the following page. To date, no concerns have been raised. DNV intends to undertake further consultation with operators who have not previously responded, as well as those operators whose view may be sensitive to the turbine layout or dimensions or may have changed since the previous consultation.

DNV notes that the Project is located in an area of high wind farm development activity, with several approved and operating wind farms located nearby. Cumulative impacts to mobile phone and DTV signals caused by the Project in conjunction with nearby wind farms may be experienced in some areas, particularly where the existing coverage for these services is marginal or where there are multiple turbines between the transmission tower and the user. There may also be potential for increased interference to point-to-multipoint links operated by Wannon Water, if the link paths pass over multiple wind farm sites.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Radio-communication towers	No towers within 2 km of proposed turbine locations	None	None	Consultation not considered necessary	None required
Fixed point-to-point links	10 links crossing Project boundary, operated by: NBN Co Limited (NBN Co) Powercor Australia Ltd (Powercor) Telstra Corporation Limited (Telstra) Vertical Telecoms Pty Limited (VerTel) Diffraction effects: no turbines in exclusion zones established by DNV Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	None	None	No concerns raised by NBN Co, Powercor, Telstra based on previous turbine layout and dimensions Further consultation to be undertaken with all operators	None required
Fixed point-to-multipoint links	58 assignments within 75 km of Project boundary 2 base stations within 20 km of Project boundary, operated by: Powercor Australia Ltd (Powercor) Wannon Region Water Corporation (Wannon Water)	Potential for interference if link paths cross the Project near turbines	Potential for cumulative impact if link paths cross multiple wind farms near turbines	No concerns raised based on previous turbine layout and dimensions Further consultation to be undertaken with Powercor and Wannon Water	If required – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	-	-	-	-
Emergency services	Point-to-point links: no links crossing boundary Mobile telephony systems: unlikely to be affected	Point-to-point links: none Mobile telephony systems: unlikely to cause interference	Point-to-point links: none Mobile telephony systems: very low potential for cumulative impact	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	Point-to-point links: none required Mobile telephony systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

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

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Meteorological radar	Nearest radar: Laverton, 159 km from Project	Potential for interference if turbines at the Project can be detected by radars	Potential for cumulative impact if turbines at multiple wind farms can be detected by radars	No concerns raised based on previous turbine layout and dimensions Further consultation to be undertaken with the Bureau of Meteorology (BoM)	To be determined through consultation with the BoM
Trigonometrical stations	Trigonometrical stations: unlikely to be affected Survey marks: unlikely to be affected	Unlikely to cause interference	Very low potential for cumulative impact	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Very low potential for cumulative impact	Consultation not considered necessary	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	Low potential for cumulative impact where there are multiple turbines between the tower and the user	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	Potential service providers: Aussie Broadband, mobile phone networks, NBN Co NBN: available as a fixed wireless and satellite service, connected dwellings may experience interference to fixed wireless internet signals if turbines intercept signal line of sight	Mobile broadband services: low likelihood of interference NBN: likely to cause interference at some dwellings within Project boundaries, low likelihood of interference at other dwellings	Mobile broadband services: low potential for cumulative impact where there are multiple turbines between the tower and the user NBN: none	No concerns raised by Aussie Broadband, mobile phone networks Potential for interference raised by NBN Co based on previous turbine layout and dimensions Further consultation to be undertaken with NBN Co	Mobile phone networks: as for mobile phones NBN: if required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install new tower

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

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Satellite television and internet	Services intended for Australian audiences: unlikely to be affected Services intended for international audiences: signals from six satellites intercepted at five dwellings	Low likelihood of interference	None	Consultation with operators not considered necessary	If required – redirect satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish
Radio broadcasting	AM and FM signals: may experience interference in close proximity to turbines Digital radio signals: Project is outside the intended coverage area	AM and FM signals: low likelihood of interference Digital radio signals: none	Low potential for cumulative impact where there are multiple turbines between the tower and the user	Consultation not considered necessary	AM and FM signals: if required – install higher-quality antenna at affected location Digital radio signals: none required
Television broadcasting	May experience interference in areas with poor or marginal reception *Ballarat transmitter: 'good' coverage across most areas* 80 dwellings plus additional unidentified dwellings in Mortlake township in potential interference zone	Some likelihood of interference	Potential for cumulative impact at dwellings located to the south and southwest where there are multiple turbines between the transmitter and the user	Consultation yet to commence	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
	Warrnambool transmitter: 'poor' to 'variable' coverage in west and south, limited to no coverage elsewhere 33 dwellings in potential interference zone	Unlikely to cause interference	Low potential for cumulative impact at dwellings located to the northeast		

1 INTRODUCTION

Hydro Tasmania acting on behalf of Woolnorth Wind Farm Holding Pty Ltd ("the Customer") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Mt Fyans Wind Farm ("the Project") in western Victoria. The results of this work are reported here. This document has been prepared in accordance with Hydro Tasmania Single Use Consultancy Contract number 3012002498, dated 10 August 2022, and is subject to the terms and conditions in that agreement.

In accordance with the Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (Victorian Guidelines) prepared by the Department of Environment, Land, Water and Planning (DELWP) in November 2021 [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 Project site is located in western Victoria, approximately 5 km northeast of Mortlake and 70 km southeast of Hamilton. Terrain at the site consists of flat open farmland that is primarily used for sheep grazing, dairy farming, and grain crops.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 81 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 7.

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 considered all identified dwellings within 5 km of the Project boundary. There are 212 identified dwellings located within 5 km of the Project boundary, 21 of which are involved in the Project. The coordinates of these dwellings are presented in Table 8, 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 EMI impacts for wind farms in Victoria.

The Victorian Guidelines [1] state that *"a wind energy facility can affect the amenity of the surrounding area due to … electromagnetic interference"* and that *"[t]he potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting"*.

Although the Victorian Guidelines state that *"potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, [and] turbine design and location"* they do not provide detailed methodologies for these assessments.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [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 Victorian Guidelines. Therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 METHODOLOGY AND RESULTS

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

The Customer has asked DNV to complete this assessment based upon a layout provided for the Project consisting of 81 wind turbines, as outlined in Table 7.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 170 m and a tip height of 200 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 170 m or less
- an upper tip height of 200 m or less.

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

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from a copy of the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 1 August 2022 [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 previously consulted with a number of organisations operating services that may be impacted by the development and operation of the Project, to disseminate basic information on the Project and request responses from the organisations regarding whether they foresee any potential EMI-related impacts on their operations and services. The organisations that have been contacted and all responses received to date are summarised in Table 16.

DNV notes that the proposed turbine rotor diameter at the time of the consultation was 150 m, rather than the 170 m rotor diameter considered in this assessment, and that the consultation was based on a previous iteration of the turbine layout. Additionally, according to the version of the ACMA RRL database used in this assessment, some of the radiocommunication services in the vicinity of the Project have changed since the previous consultation was undertaken. DNV also

understands that some organisations may have revised their position on wind farm developments since the previous consultation, based on more recent experience in operating their services in the presence of wind farms. Therefore, DNV is intending to contact organisations operating services where the potential for impact may be dependent on the turbine layout and dimensions or where DNV is aware that the organisation's views may have changed, as well as organisations that have not previously provided feedback, to seek their feedback regarding the current turbine layout and dimensions.

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

4.1 Radiocommunication towers

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

4.1.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 576 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 no radiocommunication towers located within 2 km of the proposed turbine locations. The nearest radiocommunication tower is located 5.1 km southwest of the nearest wind turbine. Therefore, it is not expected that the Project will cause interference to radiocommunication services associated with nearby towers through near-field effects or reflection or scattering of signals.

4.2 Fixed licences of point-to-point type

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

Wind turbines can potentially cause interference to point-to-point microwave links and, in some cases, point-to-point ultra high frequency (UHF) links through three mechanisms: diffraction of the signal, reflection or scattering of the signal, and near-field effects. It is generally possible to design

around these issues as the link paths and potential interference zones for these signals can be determined.

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

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

Each individual link was given a unique identifier or "Assignment ID" so that it could be readily distinguished. This Assignment ID was taken as either the Device Registration ID (for spectrum licences associated with the use of certain frequency band within a particular geographic area) or the EFL ID (for apparatus licences associated with the use of a particular device).

The links paths associated with the analysed towers are shown in Figure 3. 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 10 point-to-point links recorded in the ACMA RRL database that pass over the proposed Project boundary, operated by NBN Co Limited (NBN Co), Powercor Australia Ltd (Powercor), Telstra Corporation Limited, (Telstra), and Vertical Telecoms Pty Limited (VerTel). The details of the links are provided in Table 9, and the link paths are shown in greater detail in Figure 4.

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

4.2.1.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [2, 6, 7], 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 [6], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [8] (although DNV understands that this zone is under review by the authors of that document). For each of the links crossing the 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 4. Each exclusion zone includes the rotor radius for turbines with a 170 m rotor diameter, and an additional buffer of 25 m on either side to account for potential inaccuracies in the tower locations given in the ACMA RRL database. In reviewing the locations of the radiocommunication towers at the ends of each link using satellite and aerial imagery, DNV has identified large potential inaccuracies in the coordinates given in the ACMA RRL database for the towers associated with links 5 and 6, both operated by Powercor. DNV intends to contact Powercor, as outlined in Section 4.2.2, to confirm the locations of their radiocommunication towers and point-to-point link paths crossing the Project boundary.

The results of this analysis are summarised in Table 1.

There are no turbines located within the diffraction exclusion zones for any of the point-to-point links passing over proposed Project site. Therefore, assuming that the locations of the radiocommunication towers considered in this assessment are accurate, it is not expected that the Project will cause interference to the point-to-point links through diffraction of the signals.

Table 1 Details of turbines located within the diffraction exclusion zones established by DNV for point-to-point links crossing the proposed Project boundary

Link no.	Operator	Turbines within diffraction exclusion zone
1	NBN Co Limited	None
2	NBN Co Limited	None
3	NBN Co Limited	None
4	Powercor Australia Ltd	None
5	Powercor Australia Ltd	None
6	Powercor Australia Ltd	None
7	Telstra Corporation Limited	None
8	Telstra Corporation Limited	None
9	Vertical Telecoms Pty Limited	None
10	Vertical Telecoms Pty Limited	None

4.2.1.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a wind turbine will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [6].

Reference [6] 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.

DNV considers that the transmission towers for all of the point-to-point link crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid reflection or scattering effects. Therefore, it is not expected that the Project will cause interference to the point-to-point links through this mechanism.

4.2.1.3 Interference caused by near-field effects

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

Reference [6] 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.

DNV considers that the transmission towers for all of the point-to-point link crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid near-field effects. Therefore, it is not expected that the Project will cause interference to the point-to-point links through this mechanism.

4.2.2 Stakeholder consultation and responses

DNV has previously contacted NBN Co, Powercor, and Telstra to determine the likelihood that the proposed Project will cause interference to their point-to-point links through diffraction, reflection or scattering, or near-field effects. The responses received from Powercor and Telstra, based on the turbine layout and dimensions considered at the time of the consultation, indicated that they did not expect the Project to interfere with their point-to-point links provided that the clearances determined by DNV were maintained. No response was received from NBN Co in relation to their point-to-point links.

DNV intends to contact NBN Co, Powercor, and Telstra again to seek or confirm their views on the likelihood that the Project will cause interference to their point-to-point links based on the current turbine layout and dimensions. DNV also intends to contact VerTel to determine the likelihood that the proposed Project will cause interference to their point-to-point links through diffraction, reflection or scattering, or near-field effects.

4.2.3 Mitigation options

If interference to point-to-point links is experienced after the Project is operational, mitigation options 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 communications infrastructure.

4.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of the point-to-point type. The difference between them is administrative. A point-to-point licence permits communication

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

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

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

From the ACMA RRL database, DNV has identified 58 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 5. The details of the licence holders as given in the ACMA RRL database are provided in Table 10.

There are 2 point-to-multipoint base stations within 20 km of the Project boundary, operated by Powercor (Site ID 305790) and Wannon Region Water Corporation (Wannon Water, Site ID 300876). 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 4.2.1. However, as it is not possible to know the link paths in a point-to-multipoint network without obtaining further information about the locations of each station in the network, consultation with the relevant operators is needed to determine the potential for interference.

4.3.2 Stakeholder consultation and responses

DNV has previously contacted the operators of potentially affected base stations within 60 km of the Project to determine the likelihood that the proposed Project will cause interference to their services. Responses were received from Powercor, Aussie Broadband, and Central Highlands Water, and no concerns were raised. Specifically, Central Highlands Water have confirmed that they do not have any point-to-multipoint links crossing over the Project site, and Aussie Broadband have advised that they are in the process of shutting down their point-to-multipoint network in the area around the Project. No response was received from Wannon Water.

DNV is intending to contact Powercor and Wannon Water again, to seek or confirm their views on the likelihood that the Project will cause interference to their services based on the current turbine layout and dimensions. Further consultation with Aussie Broadband and Central Highlands Water is not considered necessary.

4.3.3 Mitigation options

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

4.4 Other licence types

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

4.4.1 Locations of other licences and potential for interference

DNV has identified a number of other licences in the ACMA RRL database within 75 km of the proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 6 and Table 11.

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

The potential for interference to emergency services signals and commercial mobile telephony signals is discussed further in Sections 4.5 and 4.10 respectively, while the potential for interference to radio and television broadcasting services is considered in Sections 4.13 and 4.14.

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

4.5 Emergency services

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

4.5.1 Locations of emergency services licences and potential for interference

DNV has reviewed the ACMA RRL database to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 12 along with their contact details. The nearest licence is associated with a tower located approximately 3 km from the Project boundary.

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

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

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

4.5.2 Stakeholder consultation and responses

DNV has previously contacted the operators of potentially affected stations within approximately 60 km of the Project to seek feedback regarding any potential impact that the Project could have on their operations and services. Responses were received from all operators contacted, and no concerns were raised. Nevertheless, the Victorian Emergency Services Telecommunications

Authority (ESTA) has requested that, in the unlikely event that the Project causes interference to the Emergency Alerting System (EAS) owned by ESTA and operated by Visionstream, the wind farm owner or operator work with ESTA to restore the EAS service in the impacted areas at no cost to ESTA or the State of Victoria.

Further consultation with those operators previously contacted is not considered necessary. However, DNV also intends to contact the Department of Sustainability and Environment to seek their feedback regarding any potential impact that the Project could have on their operations and services.

4.5.3 Mitigation options

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

4.6 Aircraft navigation systems and radar

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

4.7 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather radars across Australia consisting of high-resolution Doppler radars and standard weather watch or weather surveillance radars. Operation of the BoM's part-time wind finding radar installations ceased in August 2019 [10].

Standard weather watch radars emit pulsed microwave radiation and use reflections or "echoes" of that radiation from water particles in the atmosphere to detect rain and storm activity. Doppler radar installations operate in the same way but are also able to measure the speed of the moving water particles, and therefore can provide information about wind speed and direction [11, 12].

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

The optimal coverage area for a weather radar generally extends approximately 200 km from the radar installation at a height of around 3000 m [13, 14], and approximately 100 km at a height of 1000 m [14]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high potential for complete or partial

blockage of the radar signal and subsequent loss of weather data [15, 16]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of turbines causing reflection or scattering of the radar signals or interfering with Doppler velocity measurements. At distances of between 20 km and 45 km, the presence of a wind farm may produce radar echoes or signal clutter that can cause loss of data or be mistaken for rain. Significant impacts are generally not expected for wind farms located more than 45 km from a meteorological radar, since in most cases the turbine will below the radar scan line of sight. However, the WMO notes that these guidelines are only applicable to typical radar installations in flat terrain and may need to be modified for higher-powered radars or specific situations.

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

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

4.7.1 Locations of meteorological radars and potential for interference

DNV has identified that the BoM operates 14 weather radars within 250 nautical miles of the proposed Project, with the closest radar located at Laverton approximately 159 km east of the Project. The locations of these radars are shown in Figure 7 and the details of each radar are given in Table 13.

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

4.7.2 Stakeholder consultation and responses

DNV has previously contacted the BoM regarding the Project, as recommended by the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely. The response received from the BoM indicated that they did not expect the Project to cause material interference to their operations and services.

However, DNV understands that the BoM has revised their position on wind farm developments since the previous consultation was undertaken. Therefore, DNV is intending to contact the BoM again to confirm their views on whether interference to their operations and services are likely.

4.7.3 Mitigation options

According to the WMO, there are currently no automated signal processing techniques available that can be used to effectively filter radar data to remove interference caused by wind farms [16], However, if analysis indicates there is a potential for the wind farm to cause reflection or scattering of radar signals, the WMO suggests it may be possible to reduce the potential impact through the relocation of individual turbines prior to construction. In situations where the expected interference is limited to signal clutter, the radar operator may also be able to mask these effects in the data or train the users to take the locations of the wind farms into account.

Previous advice received from the BoM has suggested that, in the event that interference to their radar operations is expected, these impacts may be minimised by shutting the wind farm down during extreme weather conditions and events when the information provided by the radar is most

important. However, DNV notes that any arrangements to shut down the Project during extreme weather events, or any alternative mitigation measures to minimise the potential for the Project to interfere with radar data, would need to be agreed between the BoM and the Customer prior to construction of the Project.

4.8 Trigonometrical stations

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

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

The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 km to 5 km, and could be intercepted or obstructed by the presence of turbines. However, the potential for impact is considered low as it is likely to be possible to relocate the target to obtain an unobstructed view of the trig point. Microwave systems can measure distances up to 150 km, but such systems are not limited by the line of sight or affected by visibility [17].

Global navigation satellite system (GNSS) technology is also commonly used for surveying and distance measurements, as it enables users to accurately determine their geographic location using positioning and timing information received from satellite signals. Geoscience Australia currently operates several GNSS networks across Australia, including the Australian Regional GNSS Network (ARGN) and the AuScope GNSS network [18]. The ARGN is comprised of 20 permanent GNSS Continuously Operating Reference Stations (CORS) which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Eight stations from the ARGN form the Australian Fiducial Network (AFN) [19], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country, and several private and state-based GNSS CORS networks. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, or satellite communications.

4.8.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [20], there are 2 trig points within 20 km of the Project boundary. The details of these trig points are provided in Table 14 and their locations are illustrated in Figure 8. There are also 29 permanent survey marks within the Project boundary [21] as shown in Figure 9. The closest survey mark is located 305 m southwest of the nearest turbine.

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

triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

The closest GNSS station is located approximately 4.8 km southwest of the Project, at Mortlake [20]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network.

4.8.2 Stakeholder consultation and responses

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV has previously contacted Geoscience Australia and the DELWP to inform them of the Project, and seek feedback regarding whether interference to their systems is possible. Responses were received from both Geoscience Australia and the DELWP, and no concerns were raised. Further consultation with Geoscience Australia and the DELWP is not considered necessary.

4.9 Citizen's band radio

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

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

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

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

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

4.9.1 Locations of CB radio devices and potential for interference

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

4.9.2 Mitigation options

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

4.10 Mobile phones

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

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

4.10.1 Availability of mobile phone services and potential for interference

DNV has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 10. The nearest mobile phone tower is located approximately 2.9 km southwest of the Project boundary.

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

Figure 11 and Figure 12 show the Optus Mobile network coverage for the Project area [23]. Outdoor 3G coverage is available across most of the area, although an external antenna is required to receive 3G signals in regions to the immediate northeast and southwest of the Project, with isolated areas of poor or marginal coverage to the north, southwest and southeast. Outdoor 4G coverage is widely available without the need for an external antenna, apart from isolated areas of poor or marginal coverage mainly to the north and southwest of the Project.

Figure 13 and Figure 14 show the Telstra network coverage for the Project area [24]. Both 3G and 4G coverage is available across the Project site and most of the surrounding area, although there are some locations to the northwest and northeast of the Project where coverage is not available.

Figure 15 shows the Vodafone network coverage for the Project area [25]. Coverage generally decreases from south to north across the area around the Project, with outdoor 4G coverage available to the to the immediate south of the Project around Mortlake and across some areas within the Project boundaries near the centre of the site and in the southeast and outdoor 3G coverage available across most of the Project site and in areas to the southwest, north, and east. However, there are some areas within the Project boundaries and to the west and northwest of the Project where coverage is not expected to be available.

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

4.10.2 Stakeholder consultation and responses

DNV has previously contacted Optus, Telstra, and Vodafone to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their mobile phone services. Responses were received from all three operators, and no concerns were raised. Further consultation with these operators regarding impacts to their mobile phone services is not considered necessary.

4.10.3 Mitigation options

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

4.11 Wireless internet

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

4.11.1 Wireless broadband services

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

4.11.1.1 Availability of wireless broadband services and potential for interference

Aussie Broadband Pty Ltd (Aussie Broadband) holds point-to-multipoint licences in the vicinity of the Project, with a base station located 29 km southwest of the Project. As the locations of Aussie Broadband customers are not known, it is not possible to determine whether there is the potential for interference to this service, however it is considered unlikely that a station at this distance will be servicing customers in the vicinity of the proposed Project.

Additionally, residents in the vicinity of the Project may use wireless broadband services provided by Optus, Telstra, and Vodafone. These wireless broadband services use the same networks as

mobile phone services, and therefore the comments made in Section 4.10.1 are applicable here. Specifically, there is a low theoretical potential for interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower.

4.11.1.2 Stakeholder consultation and responses

DNV has previously contacted Aussie Broadband, Optus, Telstra, and Vodafone to seek feedback regarding the potential for interference to their wireless broadband services. Responses were received from all operators, and no concerns were raised. Further consultation with these operators regarding impacts to their wireless broadband services is not considered necessary.

4.11.1.3 Mitigation options

As noted above, interference with wireless broadband services is considered unlikely. If interference to the wireless broadband services provided by mobile phone networks occurs, the mitigation options given in Section 4.10.3 may be applicable. Specifically, localised interference can often be rectified by the user moving a short distance or using an external antenna to improve signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower on the opposite side of the Project.

4.11.2 National Broadband Network

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

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

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a maximum range of 14 km [26]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [27].

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

4.11.2.1 Availability of NBN services and potential for interference

The NBN website [28] indicates that the network is currently available as a 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 10, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 16.

The NBN fixed wireless tower servicing the Project area is located at Mt Shadwell in Mortlake, approximately 3 km from the Project boundaries. Based on the relative positions of the Mt Shadwell NBN tower and nearby dwellings, and the fixed wireless coverage areas shown in Figure 16, there is potential for turbines at the Project to intercept the line of sight between the Mt Shadwell tower and several involved dwellings within the Project boundaries. While interference to NBN fixed wireless signals is also possible at neighbouring dwellings, those dwellings that have potential to be affected are located at the edges of the coverage area and may not currently be

able to access the service. Further investigation would be required to determine which dwellings are likely to be receiving NBN fixed wireless signals from the Mt Shadwell tower, and whether the lines of sight from the tower to those dwellings have potential to be intercepted by turbines at the Project.

DNV understands that NBN Co is planning to extend the fixed wireless coverage range for some towers from 14 km to 29 km [29]. In addition to the NBN fixed wireless internet tower at Mt Shadwell, there are other NBN fixed wireless internet towers located within 29 km of the proposed turbine locations, at Caramut, Derrinallum, Lake Bolac, Noorat, and Terang. If the coverage from these towers 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 neighbouring dwellings outside the Project boundaries. However, the assessment presented here is based on the current network availability, as shown in Figure 16, which suggests that interference to NBN fixed wireless internet services is likely to be confined to involved dwellings within the Project boundaries.

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

4.11.2.2 Stakeholder consultation and responses

DNV has previously contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps. The response received from NBN Co, based on the turbine layout and dimensions considered at the time of the consultation, indicated that wireless internet signals from the Mt Shadwell NBN tower at Mortlake to up to six connected residences could be intercepted by turbines at the Project. Five of the potentially impacted residences identified by NBN Co, based on the previous turbine layout and dimensions, are located within the Project boundaries near the centre of the site, with one additional residence located immediately to the north of the Project.

DNV is intending to contact NBN Co again to confirm their views on the potential for the Project to cause interference to their services, based on the current turbine layout and dimensions. It is also recommended that the Customer engages with NBN Co to establish an understanding of how any impact to their services may be mitigated, if interference to NBN fixed wireless internet signals are expected.

4.11.2.3 Mitigation options

As noted above, interference with NBN fixed wireless internet services is possible. If interference to NBN fixed wireless signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available to improve the signal reception. NBN Co has previously advised that in most instances where the signal line of sight from a given tower is obstructed an alternative tower can be used to service the affected dwelling. If an alternative tower is not available, interference can usually be rectified by moving the outdoor antenna at the affected dwelling a short distance from the building, to a location where the signal is not impacted by the turbines, and connecting that antenna to the dwelling via a cable (described by NBN Co as a "non-standard install process" [30]). It may also be possible to avoid impact by micro-siting the turbines in some cases, or by installing a new NBN tower to service the affected dwellings. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN

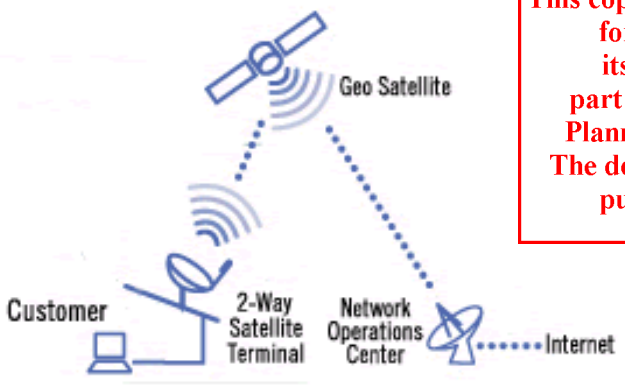
Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

4.12 Satellite television and internet

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

Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. Satellite television signals are typically transmitted to the user's antenna in one of two frequency bands: the C-band between 4 GHz and 8 GHz, or the Ku-band between 12 GHz and 18 GHz. Signals in the C-band are susceptible to interference due to radio relay links, radar systems, and other devices operating at a similar frequency. Signals in the Ku-band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. The main satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [31, 32].

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



Two-way connection to the internet via satellite [33]

4.12.1 Locations of satellite vectors and potential for interference

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

A number of satellites transmit television and internet signals that can be received in Australia. Although only a small number of satellites are likely to be providing services specifically intended

for Australian audiences, DNV has considered the line of sight to dwellings in the vicinity of the Project from all theoretically viewable satellites.

The results of the analysis are shown in Table 2. Based on these results, turbines at the Project may intercept signals from six satellites at five nearby dwellings, two of which are involved dwellings.

DNV understands that all the potentially affected satellites shown in Table 2 provide television signals intended for international audiences, and consequently it is unlikely that residents in the vicinity of the Project will currently be receiving signals from these satellites. Many of the satellites have a low angle of elevation above the horizon at the wind farm site location, and so degradation caused by atmospheric effects or interference from terrain or other obstacles may already prevent the signals from being received at the affected dwellings. For some of these satellites, the programs transmitted on the beam footprints that cover Australia may also be available through other satellite services which have a higher angle of elevation above the horizon and are not expected to be intercepted by turbines at the Project. If residents are not currently receiving signals from the satellites identified in Table 2, either by choice or because those signals are not available due to existing degradation or interference, there will be no potential for the Project to impact on those services.

Table 2 Satellite vectors with potential to be intercepted by the proposed Project

Intercepted satellite	Services provided [34]	Affected dwellings[1]
Eutelsat 70B (E70B, W5A, Eutelsat W5A)	Programs intended for international audiences	*i15*, u163, u38
Intelsat 22 (IS-22)	Programs intended for international audiences	*i15*, *i16*
G-Sat 11, G-Sat 14, G-Sat 18, G-Sat 7 (Insat 4F, Rukmini)	Programs intended for international audiences	*i15*, *i16*, u58

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

4.12.2 Stakeholder consultation

As discussed in Section 4.12.1, it is unlikely that nearby residents are currently receiving signals from satellites that may be affected by interference from turbines at the Project. If desired by the Customer, the potential for impact could be confirmed by engaging with the residents of the dwellings identified in Table 2 prior to construction of the Project to determine if any are currently receiving signals from the potentially affected satellites and to establish an understanding of how any impact to these services may be mitigated.

4.12.3 Mitigation options

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

4.13 Radio broadcasting

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

4.13.1 AM radio

AM radio signals are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also reflected or refracted by the ionosphere at night. This means that AM radio waves are able to travel significant distances under the right conditions. Due to their long wavelength, they can readily propagate around physical obstructions on the surface of the earth (such as 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 [35].

4.13.1.1 Locations of AM transmitters and potential for interference

The locations of AM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [36], and are shown in Figure 17.

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

4.13.1.2 Mitigation options

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

4.13.2 FM radio

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

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

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the signal strength at a receiver or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [37]. 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 [35, 38].

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 [37]. 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 [39].

4.13.2.1 Locations of FM transmitters and potential for interference

The locations of FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [36], and are shown in Figure 17.

The closest FM broadcast transmitter is located approximately 21 km from the proposed Project boundary. Therefore, it is considered unlikely that the Project will cause interference to the FM radio signals from this transmitter.

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

4.13.2.2 Mitigation options

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

4.13.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne, and Sydney [40]. 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 [37] states that *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*. DNV has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

4.13.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [41], the Project is outside the intended service area for digital radio broadcasts. Since it is therefore unlikely that residents in the vicinity of the Project are currently receiving digital radio signals, it is not expected that the Project will cause interference to these services.

4.14 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in Australia are now digital broadcasts [42]. 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.

4.14.1 Availability of DTV broadcasting and potential for interference

The locations of DTV broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [42], and are shown in Figure 17. The main DTV transmitter used by residents in the vicinity of the Project is the Ballarat transmitter at Lookout Hill. However, according to the Australian Government mySwitch website [43], it is also possible that residents to the south and west of the Project are able to receive DTV signals from the Warrnambool transmitter at Tower Hill. Coverage maps for these broadcast transmitters are reproduced in Figure 18 to Figure 19.

Figure 18 shows that coverage from the Ballarat transmitter is generally good across the Project site, with some notable areas of variable coverage to the west and the south around Mortlake. Conversely, Figure 19 shows that coverage from the Warrnambool transmitter is only available to the west and south of the Project, and is generally poor to variable in those areas.

4.14.1.1 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 [7].

The closest DTV transmitter to the Project is the Terang relay transmitter at Mount Noorat, which is approximately 15 km away. Therefore, it is considered that the Project will not cause large scale interference to signals from this transmitter.

4.14.1.2 Interference caused by reflection or scattering

Although DTV signals are generally unlikely to be susceptible to interference from 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 15 and Figure 18 to Figure 19. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 3. Dwellings located just outside the potential interference zones shown in Figure 18 to Figure 19 have not been included in Table 3 and Table 15, but may also be susceptible to interference.

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 and Figure 19 also show the area within 10 km of the proposed turbine locations, although a more detailed assessment would be required to determine whether there is any potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

Based on the analysis presented here, there is increased potential for turbines at the Project to cause interference to signals received from the Ballarat broadcast tower at dwellings to the south and southeast of the Project, including parts of Mortlake township, and close to the Project site boundaries in the northeast. The coverage maps in Figure 18 and Figure 19 suggest that the Ballarat transmitter is the main source of DTV signals for Mortlake, and so interference to signals from this transmitter may have a significant impact on local residents. Additionally, as noted above, there is potential for impacts on DTV signals to extend beyond the interference zones shown in Figure 18, which could result in interference being experienced in areas around the Project where the signal coverage from the Ballarat transmitter is already marginal. Although several dwellings have been identified within the potential interference zones for the Warrnambool transmitter, the coverage map in Figure 19 suggests that there is no signal coverage from this transmitter in the potentially affected area.

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
Ballarat (Lookout Hill)	80 identified dwellings (11 involved dwellings) plus additional unidentified dwellings in Mortlake township	Generally good, with some areas of variable coverage around Mortlake and to the southwest
Warrnambool (Tower Hill)	33 identified dwellings (12 involved dwellings)	Limited to none – dwellings in the potential interference zone are unlikely to be receiving signals from this tower

The method used here to assess the potential interference to television signals from the Project represents a simplified approach which is expected to capture locations where interference is most likely to occur. This simplified analysis is deemed appropriate in most cases as the implications of potential television interference are typically low. If reception difficulties are encountered, there are a number of mitigation options available as discussed in further detail in Section 4.14.3.

4.14.2 Stakeholder consultation and responses

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

4.14.3 Mitigation options

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

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

In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. However, the effectiveness of this mitigation may be reduced if there is no clear line of sight from the antenna to the transmitter. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue, however, as noted in [44], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [45] 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 [46].

In addition to the mitigation options outlined above, the Victorian Guidelines [1] include example permit conditions stating that, prior to commencing development, a survey must be undertaken to determine the average television and radio reception strength within 5 km of the wind farm site. If a complaint is later received regarding the effect of the wind farm on television or radio reception at a pre-existing dwelling within 5 km of the site, the operator must investigate that complaint. If the investigation finds that the wind farm has had a detrimental impact on the quality of television or radio reception, the operator must then restore reception at the affected dwelling to at least the quality determined in the pre-development survey to the satisfaction of the responsible authority.

4.15 Cumulative impacts

DNV notes that the Project is located in an area of high wind farm development activity. Consequently, it is possible that some radiocommunication services could experience cumulative impacts from the proposed Project.

4.15.1 Locations of nearby wind farms and potential for cumulative impacts

The nearest wind farm developments are the Dundonnell Wind Farm, Salt Creek Wind Farm, and Mortlake South Wind Farm, all of which are located within 10 km of the Project site. Details of these wind farms are summarised in Table 4 and their locations relative to the Project are shown in Figure 20, based on information obtained from publicly available sources. Other wind farms located within approximately 50 km of the Project include the operating Morton's Lane Wind Farm, the approved Berrybank, Hawkesdale, Ryan Corner, and Woolsthorpe Wind Farms, and the proposed Mumblin Wind Farm [47].

Table 4 Neighbouring wind farm developments located within 10 km of the Project [47]

Wind farm	Status	Number of turbines	Location relative to the Project	Source of mapping data
Dundonnell Wind Farm	Constructed	80	3 km northeast	[48]
Salt Creek Wind Farm	Operating	15	3 km north	[49]
Mortlake South Wind Farm	Operating	35	7 km south	[50]

Table 5 summarises the anticipated EMI-related impact of the Project in isolation, as discussed in Sections 4.1 to 4.14 and the potential for cumulative impacts from the Project in conjunction with the nearby Dundonnell, Salt Creek, and Mortlake South Wind Farms. Given that the other identified wind farms are all located at least 30 km from the Project, it is considered unlikely that these developments will contribute to any cumulative impact from the Project. For services where impact from the Project itself is considered either unlikely or non-existent, it is generally expected that there will be no cumulative impact.

Table 5 Potential for cumulative EMI-related impacts from the Project and neighbouring wind farms

Licence or service type	Anticipated impact from the Project in isolation	Potential for cumulative impact from the Project and neighbouring wind farms
Radiocommunication towers	No impact expected (see Section 4.1)	No cumulative impact
Fixed point-to-point links	No impact expected (see Section 4.2)	No cumulative impact, as the link paths do not cross multiple wind farms
Fixed point-to-multipoint links	Potential for interference if link paths cross the wind farm site near turbines (see Section 4.3)	Potential for cumulative impact if link paths cross multiple wind farms near turbines
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	
Emergency services	No impact expected for point-to-point links (see Section 4.2) Unlikely to cause interference to mobile telephony systems (see Section 4.5)	No cumulative impact to point-to-point links Very low potential for cumulative impact to mobile telephony systems
Meteorological radar	Potential for interference if turbines at the Project can be detected by radars (see Section 4.7)	Potential for cumulative impact if turbines at multiple wind farms can be detected by radars
Trigonometrical stations	Unlikely to cause interference (see Section 4.8)	Very low potential for cumulative impact
Citizens band radio	Unlikely to cause interference (see Section 4.9)	Very low potential for cumulative impact
Mobile phones	Low likelihood of interference in areas with marginal coverage (see Section 4.10)	Low potential for cumulative impact where there are multiple turbines between the tower and the user
Wireless internet	Low likelihood of interference to wireless broadband services (see Section 4.11.1) Likely to cause interference to NBN fixed wireless internet signals at dwellings located within the Project boundaries, low likelihood of interference at other dwellings (see Section 4.11.2)	Low potential for cumulative impact to wireless broadband services provided by mobile phone networks where there are multiple turbines between the tower and the user No cumulative impact to NBN fixed wireless signals, as the signal lines of sight do not cross multiple wind farms
Satellite television and internet	Low likelihood of interference to services intended for international audiences only (see Section 4.12)	No cumulative impact
Radio broadcasting	Low likelihood of interference to AM and FM signals received in close proximity to turbines (see Section 4.13)	Low potential for cumulative impact where there are multiple turbines between the tower and the user
Television broadcasting	Some likelihood of interference to signals from the Ballarat transmitter at dwellings located to the south of turbines including parts of Mortlake township, unlikely to cause interference to signals from the Warrnambool tower (see Section 4.14)	Potential for cumulative impact at dwellings located to the south and southwest of the Project, where there are multiple turbines between the transmitter and the user Low potential for cumulative impact at dwellings located to the northeast of the Project

There is some potential for increased interference to point-to-area style services such as mobile phone and radio broadcasting signals in areas with marginal coverage, or where there may be multiple wind turbines between the user and the transmission tower. Based on the coverage maps shown in Figure 11 to Figure 15, and the relative locations of the mobile phone towers shown in Figure 10, cumulative impacts are considered unlikely for the Optus and Telstra mobile phone networks. Vodafone mobile phone signals may be more susceptible to cumulative impacts than the Optus and Telstra networks, due to the small number of towers servicing the area and existing poor coverage in areas to the north of the Project, although it is also less likely that residents will be using this service.

Similarly, there is some potential for increased interference to DTV broadcasting signals in areas where the signal passes through multiple wind farms and there are multiple wind turbines between the user and the transmission tower. Based on the relative locations of the wind farm sites and the nearby DTV transmitters, this is more likely to be an issue for signals from the Ballarat DTV transmitter received at dwellings located to the south and southwest of the Project and to the south of the Mortlake South Wind Farm. Given that the proposed turbine locations for the Project are within 10 km of the Dundonnell Wind Farm, as shown in Figure 21, signals passing through the Project from the Ballarat transmitter may already be degraded by interference from the Dundonnell Wind Farm. These signals, which would be received by dwellings to the south and southwest of the Project, may therefore be more susceptible to interference from the Project. In the same way, DTV signals from the Ballarat transmitter received at dwellings to the south of the Mortlake South Wind Farm may be degraded by interference from turbines at the Project before reaching the Mortlake South Wind Farm, and therefore may be more susceptible to cumulative impacts. However, DNV notes that this assessment is based on an assumed potential interference distance of 10 km, as suggested by BAI Communications, and does not include detailed analysis of the existing DTV signal coverage in the area around the Project. Consultation with BAI Communications, as described in Section 4.15.2, may help to determine the likelihood of such cumulative impacts.

There is also potential for dwellings located to the southeast of the Project, between the Project and the Mortlake South Wind Farm to experience impacts to DTV reception caused by interference to signals from both the Ballarat and Warrnambool DTV transmitters. Based on the relative locations of the wind farm sites and the transmitters, dwellings in this area may experience interference to signals from the Ballarat transmitter caused by the Project, as indicated by the interference zone shown in Figure 21, as well as interference to signals from the Warrnambool transmitter caused by the Mortlake South Wind Farm. However, DNV notes that there are relatively few dwellings in this region that would be expected to fall within the DTV interference zones for both wind farms. Additionally, the coverage map shown in Figure 19 suggests that dwellings in this area are unlikely to be receiving signals from the Warrnambool transmitter. Therefore, the potential for cumulative impacts to DTV signals at these dwellings arising from impacts to signals from both the Ballarat and Warrnambool transmitters is considered low.

The potential for increased interference to DTV signals received from the Ballarat transmitter at dwellings located to the northeast of the Project has also been considered. Dwellings in this area could experience interference to signals from the Ballarat transmitter caused by both the Project and the approved Dundonnell Wind Farm. Although all of the dwellings that may have an increased susceptibility to interference to signals from the Ballarat transmitter caused by the Project, based on the potential interference zone shown in Figure 21, are located more than 5 km from the Dundonnell Wind Farm site boundary, several such dwellings are within 10 km of the Dundonnell

Wind Farm. Since interference to DTV signals may extend up to 10 km from the turbine locations, there is potential for cumulative impacts from the Project and the Dundonnell Wind Farm to be experienced at these dwellings. However, DNV notes that the signal coverage from the Ballarat transmitter in this region is generally good, which may reduce the likelihood that cumulative impacts will be experienced.

Based on the relative locations of the Project and the Salt Creek Wind Farm, and the DTV coverage maps for the Ballarat and Warrnambool transmitters shown in Figure 18 and Figure 19, cumulative impacts on DTV signals at dwellings to the northwest of the Project are not generally expected.

There may be potential for cumulative impacts to point-to-multipoint links if the link paths pass over the Project and a neighbouring wind farm in the vicinity of the turbines at both sites. However, as discussed in Section 4.2, previous consultation with the operators of nearby point-to-multipoint licences suggests that the associated links for most operators do not pass over the Project site. Further feedback is required from Wannon Water to confirm the paths for their point-to-multipoint links and hence determine whether there is any potential for cumulative impact to those links. Similarly, further feedback from the BoM is needed to determine whether there is potential for their meteorological radars to detect turbines at both the Project and the neighbouring wind farm.

Cumulative impacts to point-to-point links crossing the proposed Project are not expected, as none of these links pass over the neighbouring wind farms. Similarly, the locations of the NBN fixed wireless internet towers and the fixed wireless coverage areas in the vicinity of the Project, as shown in Figure 10 and Figure 16 respectively, suggest that the signal lines of sight from those towers to nearby dwellings will not pass over multiple wind farm sites. Therefore, cumulative impacts to the NBN fixed wireless internet service are also not expected.

4.15.2 Stakeholder consultation and responses

As discussed in Section 4.3.2, DNV is intending to contact Powercor and Wannon Water to confirm the link paths associated with their point-to-multipoint licences and hence determine the potential for cumulative impact to those links. Responses received from the operators of other nearby point-to-multipoint licences have indicated that they do not expect the Project to cause interference to their services and so further consultation to assess the potential for cumulative impact is not considered necessary.

DNV also intends to contact the BoM to seek further feedback on whether interference to their operations and services and services is likely, as discussed in Section 4.7.2, which may help to determine the potential for cumulative impact on meteorological radar operations. Similarly, consultation with the operators of DTV broadcasting services, as outlined in Section 4.14.2, may help to confirm whether there is any likelihood of cumulative EMI-related impacts to these services.

Responses received from the operators of other services have indicated that they do not expect the Project in isolation to impact on their services, and therefore it can be assumed that the potential for cumulative impact is also low.

4.15.3 Mitigation options

For most radiocommunication services, cumulative impacts from the Project in conjunction with other nearby wind farms are either not expected or are expected to be minimal. In the event that interference to mobile phone signals, radio broadcasting, or DTV broadcasting is experienced as a result of cumulative impacts after construction of the Project, the mitigation options given in

Sections 4.10.3, 4.13.2, and 4.14.3 may be applicable. Mitigation options to resolve cumulative impacts for other services, such as point-to-multipoint links or meteorological radar, may include the options outlined in the previous sections or can be developed through consultation with the relevant operator if required.

5 CONCLUSIONS

Radiocommunication 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 81 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 170 m or less and an upper tip height of 200 m or less.

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

Turbines at the Project may interfere with fixed wireless internet signals received from the Mt Shadwell NBN tower at nearby dwellings, with interference most likely to be experienced at involved dwellings within the Project boundaries. Based on a previous turbine layout and dimensions, NBN Co advised that signals to up to six connected residences, comprising five residences within the Project boundaries and one resident immediately to the north of the Project, could be impacted. DNV is intending to contact NBN Co again to confirm their views on the potential for the Project to interfere with their services, based on the current turbine layout and dimensions. If interference is expected, DNV also recommends that the Customer engages with NBN Co to establish an understanding of how any impacts to their fixed wireless services may be mitigated.

The Project also has potential to cause interference to DTV signals received from the Ballarat transmitter at dwellings in the vicinity of the Project, including parts of Mortlake township. Coverage maps suggest that the Ballarat transmitter is the main source of DTV signals for Mortlake, and so interference to signals from this transmitter may have a significant impact on residents. Although dwellings have been identified within the potential interference zone for the Warrnambool transmitter, the associated coverage map suggests that signals from this transmitter are not available in the affected area. If interference to DTV signals is experienced, a range of options are available to rectify difficulties.

While the Project may cause interference to fixed point-to-multipoint links operated by Wannon Water if the link paths cross the Project near the turbine locations, further information from the operator is required to determine the likely impacts. Although previous attempts at consultation have been unsuccessful, DNV is intending to contact Wannon Water again to seek feedback on the potential for the Project to cause interference to their operations and services. Operators of other point-to-multipoint links in the vicinity of the Project have advised that they do not expect any impacts to their services.

Potential EMI impacts on other services considered in this assessment are either considered unlikely or can be assessed through consultation with the service operators. Based on a previous turbine layout and dimensions, no concerns have been raised to date. DNV intends to undertake further consultation with operators who have not previously responded, as well as those operators whose view may be sensitive to the turbine layout or dimensions or may have changed since the previous consultation.

The expected cumulative impact of the Project in conjunction with nearby wind farms has also been considered. There is potential for increased interference to mobile phone signals where coverage is marginal and there are multiple turbines between the mobile phone tower and the user, and to DTV signals received at dwellings in areas where the signals pass through multiple wind farm sites.

There may also be potential for cumulative impacts to point-to-multipoint links operated by Wannon Water, if the link paths pass over multiple wind farm sites.

Table 6 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Radio-communication towers	No towers within 2 km of proposed turbine locations Nearest tower: 5.1 km from turbines	None	None	Consultation not considered necessary	None required
Fixed point-to-point links	10 links crossing Project boundary, operated by NBN Co, Powercor, Telstra, VerTel Diffraction effects: no turbines in exclusion zones established by DNV Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	None	None	No concerns raised by NBN Co, Powercor, Telstra based on previous turbine layout and dimensions Further consultation to be undertaken with all operators	None required
Fixed point-to-multipoint links	58 assignments within 75 km of Project boundary 2 base stations within 20 km of Project boundary, operated by Powercor, Wannon Water	Potential for interference to links operated by Powercor and Wannon Water if link paths cross the Project near turbines.	Potential for cumulative impact if link paths cross multiple wind farms near turbines	No concerns raised based on previous turbine layout and dimensions Further consultation to be undertaken with Powercor and Wannon Water	If required – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-	-	-	-
Emergency services	Point-to-point links: no links crossing boundary Mobile telephony systems: unlikely to be affected	Point-to-point links: none Mobile telephony systems: unlikely to cause interference	Point-to-point links: none Mobile telephony systems: very low potential for cumulative impact	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	Point-to-point links: none required Mobile radio systems: if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

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

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Meteorological radar	Nearest radar: Laverton, 159 km from Project	Potential for interference if turbines at the Project can be detected by radars	Potential for cumulative impact if turbines at multiple wind farms can be detected by radars	No concerns raised based on previous turbine layout and dimensions Further consultation to be undertaken with the BoM	To be determined through consultation with the BoM
Trigonometrical stations	2 stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Survey marks: unlikely to be affected Sight lines to other stations: may be blocked by turbines	Unlikely to cause interference	Very low potential for cumulative impact	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Very low potential for cumulative impact	Consultation not considered necessary	None required
Mobile phones	Optus and Telstra: fair to good coverage across Project Vodafone: good coverage in south, poor coverage in north Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low likelihood of interference	Low potential for cumulative impact where there are multiple turbines between the tower and the user	No concerns raised based on previous turbine layout and dimensions Further consultation not considered necessary	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	Potential service providers: Aussie Broadband, mobile phone networks, NBN Co NBN: available as a fixed wireless and satellite service in areas surrounding the Project, connected dwellings may experience interference to fixed wireless internet signals if turbines intercept signal line of sight	Mobile broadband services: low likelihood of interference NBN: likely to cause interference at some dwellings within Project boundaries, low likelihood of interference at other dwellings	Mobile broadband services: low potential for cumulative impact where there are multiple turbines between the tower and the user NBN: none	No concerns raised by Aussie Broadband, mobile phone networks Potential for interference raised by NBN Co based on previous turbine layout and dimensions Further consultation to be undertaken with NBN Co	Mobile phone networks: as for mobile phones NBN: if required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install new tower

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

Licence or service type	Assessment findings	Expected impact	Potential for cumulative impact	Stakeholder feedback (to date)	Potential mitigation options
Satellite television and internet	Services intended for Australian audiences: unlikely to be affected Services intended for international audiences: signals from 6 satellites intercepted at 5 dwellings	Unlikely to cause interference	None	Consultation with operators not considered necessary	If required – redirect satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish
Radio broadcasting	AM and FM signals: may experience interference in close proximity to turbines Digital radio signals: Project is outside the intended coverage area	AM and FM signals: low likelihood of interference Digital radio signals: none	Low potential for cumulative impact where there are multiple turbines between the tower and the user	Consultation not considered necessary	AM and FM signals: if required – install higher-quality antenna at affected location Digital radio signals: none required
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception *Ballarat transmitter: 'good' coverage across most areas* 80 dwellings (11 involved dwellings) plus additional unidentified dwellings in Mortlake township in potential interference zone *Warrnambool transmitter: 'poor' to 'variable' coverage in west and south, limited to no coverage elsewhere* 33 dwellings (12 involved dwellings) in potential interference zone	Some likelihood of interference Unlikely to cause interference	Potential for cumulative impact at dwellings located to the south and southwest where there are multiple turbines between the transmitter and the user Low potential for cumulative impact at dwellings located to the northeast	Consultation yet to commence	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 [37] 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 [44]. Both of these effects can potentially degrade the DTV signal quality.

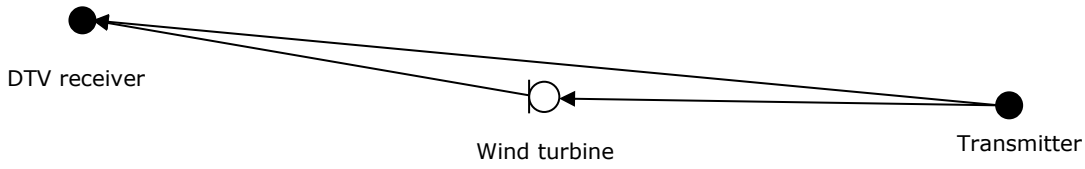

Figure A.1 Forward scatter signal path for DTV signals

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).

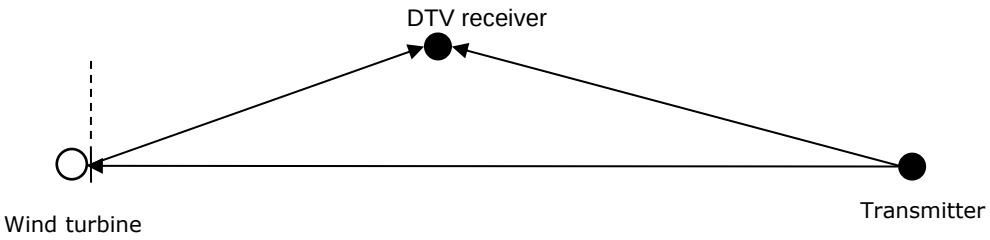

Figure A.2 Back scatter signal path for DTV signals

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 [44].

According to Ofcom [37], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [7, 51]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the turbines [37]. 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 [7, 37], 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.

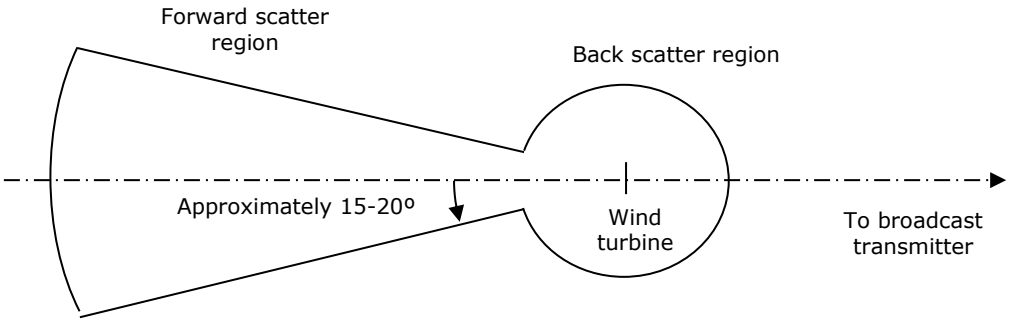

Figure A.3 Potential television interference zones around a wind turbine

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 [52] 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 [45] 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 [45].

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 [53]. 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 [52], 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 [37]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

LIST OF TABLES

Table 7 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]
A01	654220	5792117	138	B43	663705	5789380	151
A02	655861	5791796	148	B44	664980	5788114	151
A03	655207	5790907	143	B45	665362	5788397	148
A04	655298	5791536	147	B46	664817	5789436	151
A05	655923	5790627	142	B47	665389	5789213	151
A06	654999	5792071	147	B48	666037	5789323	148
A07	654672	5792711	144	B49	666743	5789328	153
A08	654722	5793338	144	B50	667081	5789708	152
A09	656408	5791021	140	B51	667693	5789246	154
A10	656721	5791922	144	B52	667649	5789905	153
A11	655929	5792960	149	B53	666950	5790403	150
A12	654975	5794218	151	B54	665296	5790313	153
A13	655277	5794701	154	B55	665818	5790610	156
A14	655964	5794091	155	B56	666288	5790894	152
A15	655879	5794930	155	B58	666493	5791631	155
A16	656397	5795472	159	B59	667200	5791992	159
A17	656877	5793409	144	B60	667663	5792443	159
A18	657025	5794171	153	B61	666686	5792435	156
A19	657354	5792501	145	B62	666299	5793024	162
A20	657799	5793896	150	B63	667150	5793248	162
A21	657850	5793230	148	B64	667763	5793196	159
A22	658458	5793144	150	B65	665830	5793760	158
A23	658313	5792228	148	B66	666569	5793792	165
A24	658830	5792616	149	B67	666642	5794385	157
A25	659632	5792797	144	B68	665929	5794501	156
A26	659595	5791846	147	B69	666098	5795080	162
A27	659978	5792247	146	B70	666336	5795566	159
B28	660477	5791459	149	B71	667192	5795441	161
B30	661391	5791230	149	B72	667282	5794782	160
B31	661826	5790575	155	B73	667977	5793926	163
B32	662242	5790139	154	B74	668304	5794530	162
B33	661877	5789367	151	C77	669731	5796626	171
B34	662582	5789614	152	C78	670284	5796768	172
B35	661713	5788497	148	C79	669449	5796956	167
B36	662357	5788194	148	C80	669578	5797459	173
B37	662896	5788444	153	C81	670041	5797581	174
B38	662679	5787695	153	C82	669606	5798065	172
B39	663397	5787946	150	C83	668786	5798385	171
B40	663166	5787306	152	C84	668180	5799072	173
B41	663175	5789275	149	C85	668677	5799296	173
B42	664701	5788792	151				

1. Coordinate system: MGA zone 54, GDA94 datum.
2. Base elevations have been determined by DNV based on publicly available SRTM1 data.

Table 8 Dwellings in the vicinity of the proposed Project [4]

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
i1	668431	5795940	Involved	1.3
i2	672104	5801865	Involved	4.3
i3	672364	5801189	Involved	4.1
i4	673030	5801785	Involved	5.0
i7	667848	5796262	Involved	1.1
i8	666446	5788270	Involved	1.1
i9	659907	5788137	Involved	1.8
i10	659646	5788438	Involved	2.1
i11	668152	5790956	Involved	1.2
i12	661427	5792502	Involved	1.3
i14	665790	5787346	Involved	1.1
i15	664251	5787101	Involved	1.1
i16	657659	5795094	Involved	1.1
i17	658010	5795224	Involved	1.3
i18	659127	5794699	Involved	1.6
i19	654065	5790672	Involved	1.2
i20	670099	5794975	Involved	1.7
i21	659314	5787808	Involved	2.5
i22	652028	5792668	Involved	2.3
i23	650832	5792931	Involved	3.5
i24	669336	5798650	Involved	0.6
u9	674263	5799631	Not involved	4.7
u10	673085	5798418	Not involved	3.2
u11	672521	5795682	Not involved	2.5
u12	672876	5793966	Not involved	3.8
u13	672870	5793589	Not involved	4.1
u14	671946	5794550	Not involved	2.8
u15	671014	5794636	Not involved	2.3
u17	665046	5792260	Not involved	1.5
u18	664166	5794029	Not involved	1.7
u19	664130	5793868	Not involved	1.7
u20	667260	5796702	Not involved	1.3
u21	665548	5798638	Not involved	2.7
u22	667381	5796888	Not involved	1.5
u23	664833	5799387	Not involved	3.4
u24	666344	5803239	Not involved	4.6
u25	667868	5802257	Not involved	3.1
u26	663809	5800561	Not involved	4.6
u27	664011	5800525	Not involved	4.4
u28	664306	5797104	Not involved	2.5
u29	659147	5798651	Not involved	4.2
u30	659430	5798900	Not involved	4.6
u31	659260	5794768	Not involved	1.7
u34	663373	5800537	Not involved	5.0
u36	664772	5796988	Not involved	2.1
u37	662531	5797677	Not involved	4.4
u38	668783	5789961	Not involved	1.1
u40	669830	5788036	Not involved	2.5
u41	667704	5787156	Not involved	2.1
u42	667817	5786972	Not involved	2.3
u43	668600	5787345	Not involved	2.1
u44	669142	5787606	Not involved	2.2

Table 8 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
u45	671101	5788627	Not involved	3.5
u47	663503	5790960	Not involved	1.5
u49	660754	5794401	Not involved	2.0
u50	662782	5794252	Not involved	3.1
u51	661796	5786881	Not involved	1.2
u52	664138	5784064	Not involved	3.4
u53	663788	5785568	Not involved	1.8
u57	662385	5785372	Not involved	2.1
u58	668523	5791583	Not involved	1.2
u59	655494	5787092	Not involved	3.6
u60	656198	5786692	Not involved	3.9
u61	656528	5787050	Not involved	3.6
u62	652144	5792555	Not involved	2.1
u63	652162	5792645	Not involved	2.1
u64	652426	5793899	Not involved	2.4
u65	652458	5794210	Not involved	2.4
u66	653439	5795130	Not involved	1.8
u70	657944	5788331	Not involved	3.1
u71	657398	5788156	Not involved	2.9
u72	666626	5781838	Not involved	6.5
u80	671139	5787862	Not involved	3.7
u81	671310	5788388	Not involved	3.7
u84	653017	5798226	Not involved	4.2
u89	667122	5804584	Not involved	5.5
u90	659813	5787900	Not involved	2.0
u91	659845	5787783	Not involved	2.0
u96	643083	5786979	Not involved	12.3
u97	643253	5787016	Not involved	12.1
u98	643372	5786990	Not involved	12.0
u99	644127	5787639	Not involved	11.0
u100	644023	5787379	Not involved	11.2
u101	644066	5789690	Not involved	10.4
u117	646742	5791254	Not involved	7.5
u119	648459	5792895	Not involved	5.8
u120	648271	5793164	Not involved	6.0
u121	649340	5790910	Not involved	5.0
u122	649447	5791092	Not involved	4.9
u123	648928	5790619	Not involved	5.5
u136	642087	5784523	Not involved	14.3
u137	650540	5791154	Not involved	3.8
u139	651436	5789175	Not involved	4.1
u140	651404	5787974	Not involved	4.8
u141	649470	5788156	Not involved	6.2
u157	655082	5788280	Not involved	2.5
u158	654199	5788968	Not involved	2.2
u159	653399	5789715	Not involved	2.2
u160	670215	5795187	Not involved	1.5
u161	661264	5794527	Not involved	2.4
u162	660778	5794657	Not involved	2.2
u163	657783	5790185	Not involved	1.6
u164	657720	5790068	Not involved	1.6
u165	650865	5785793	Not involved	6.7

Table 8 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
u166	651619	5785367	Not involved	6.6
u167	648393	5785313	Not involved	8.8
u168	649125	5783601	Not involved	9.5
u169	659602	5786467	Not involved	2.9
u170	659659	5786983	Not involved	2.6
u171	659549	5785999	Not involved	3.3
u172	658973	5785621	Not involved	4.0
u173	659481	5785393	Not involved	3.8
u174	675335	5797038	Not involved	5.1
u179	676038	5797457	Not involved	5.8
u202	662729	5782706	Not involved	4.6
u203	663160	5782590	Not involved	4.7
u204	663921	5782999	Not involved	4.4
u205	664203	5782960	Not involved	4.5
u206	660860	5782704	Not involved	5.1
u207	660830	5782712	Not involved	5.2
u208	660475	5784418	Not involved	3.9
u209	661838	5781198	Not involved	6.3
u216	652872	5795783	Not involved	2.6
u219	650261	5795396	Not involved	4.9
u220	649034	5793228	Not involved	5.3
u221	660056	5784496	Not involved	4.1
u222	660058	5784375	Not involved	4.2
u223	660130	5784269	Not involved	4.3
u224	660276	5783900	Not involved	4.5
u225	659962	5783817	Not involved	4.7
u226	659880	5783881	Not involved	4.7
u227	659129	5784638	Not involved	4.6
u228	659153	5784383	Not involved	4.8
u229	659866	5784173	Not involved	4.5
u230	659650	5784266	Not involved	4.6
u231	659716	5784304	Not involved	4.5
u232	659756	5784315	Not involved	4.5
u233	659460	5784041	Not involved	4.9
u234	659454	5784095	Not involved	4.8
u235	659493	5784174	Not involved	4.7
u236	659501	5784297	Not involved	4.7
u237	659477	5784284	Not involved	4.7
u238	659146	5784364	Not involved	4.9
u239	659154	5784315	Not involved	4.9
u240	659131	5784326	Not involved	4.9
u241	659314	5784252	Not involved	4.8
u242	659373	5784215	Not involved	4.8
u243	659322	5784063	Not involved	4.9
u244	659307	5784056	Not involved	5.0
u245	659339	5784191	Not involved	4.8
u246	659322	5784181	Not involved	4.9
u247	659273	5784170	Not involved	4.9
u248	659360	5784081	Not involved	4.9
u249	659217	5783995	Not involved	5.1
u250	659118	5784258	Not involved	4.9
u251	659109	5784205	Not involved	5.0

Table 8 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
u252	659101	5784142	Not involved	5.0
u253	659110	5784120	Not involved	5.1
u254	659217	5783954	Not involved	5.1
u255	659149	5783956	Not involved	5.1
u256	659176	5783976	Not involved	5.1
u257	659180	5784130	Not involved	5.0
u258	659198	5784096	Not involved	5.0
u259	659104	5784167	Not involved	5.0
u260	659216	5784110	Not involved	5.0
u261	659240	5784120	Not involved	5.0
u262	659093	5784085	Not involved	5.1
u263	659091	5784064	Not involved	5.1
u264	659089	5784038	Not involved	5.1
u265	659076	5784023	Not involved	5.1
u266	660297	5783712	Not involved	4.6
u267	659836	5783558	Not involved	5.0
u268	659445	5783573	Not involved	5.2
u269	659278	5783603	Not involved	5.3
u270	659278	5783603	Not involved	5.3
u271	659267	5784089	Not involved	5.0
u272	659267	5784089	Not involved	5.0
u273	659336	5784081	Not involved	4.9
u274	658946	5784362	Not involved	5.0
u275	659002	5784412	Not involved	4.9
u276	659020	5784348	Not involved	4.9
u277	658973	5784283	Not involved	5.0
u278	659061	5784252	Not involved	5.0
u279	659042	5784175	Not involved	5.1
u280	659033	5784154	Not involved	5.1
u281	659034	5784138	Not involved	5.1
u282	658969	5784132	Not involved	5.1
u283	658961	5784077	Not involved	5.2
u284	658976	5784167	Not involved	5.1
u285	658979	5784190	Not involved	5.1
u286	659024	5784095	Not involved	5.1
u287	659022	5784078	Not involved	5.1
u288	659001	5784033	Not involved	5.2
u289	658986	5784021	Not involved	5.2
u290	659018	5783986	Not involved	5.2
u291	659039	5784000	Not involved	5.2
u292	659062	5784015	Not involved	5.2
u293	658946	5784280	Not involved	5.0
u294	658939	5784136	Not involved	5.2
u295	666011	5798323	Not involved	2.3
u296	664337	5800236	Not involved	4.0
u297	670640	5786688	Not involved	3.9
u298	666293	5786618	Not involved	2.0
u299	659026	5785354	Not involved	4.1
u300	658912	5785399	Not involved	4.2
u301	658711	5785371	Not involved	4.3
u302	660766	5784099	Not involved	4.0
u303	662498	5781385	Not involved	6.0

Table 8 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
u304	663912	5781508	Not involved	5.8
u306	659268	5784009	Not involved	5.0
u307	659355	5784204	Not involved	4.8
u308	652195	5796002	Not involved	3.3

1. Involved dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 54, GDA94 datum.

Table 9 Details of point-to-point links crossing the proposed Project

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
1	10728607/1	5530234	11245000000	NBN Co Limited Level 13 100 Arthur Street NORTH SYDNEY NSW 2060
		5530235	10755000000	
		5530236	10755000000	
		5530237	11245000000	
2	11478011/1	8690509	6212065000	
		8690510	6212065000	
		8690511	5960025000	
		8690512	5960025000	
3	11480283/1	8692979	6271365000	
		8692980	6271365000	
		8692981	6019325000	
		8692982	6019325000	
4	1149179/2	1382076	1523000000	Powercor Australia Ltd Locked Bag 14090 Manager Communications Network Provisioning MELBOURNE VIC 8001
		1382077	1523000000	
		1382078	1430500000	
		1382079	1430500000	
5	1327287/1	794070	1499000000	
		794071	1499000000	
		794072	1438500000	
		794073	1438500000	
6	1923617/1	893468	1503000000	
		893469	1503000000	
		893470	1442500000	
		893471	1442500000	
7	9848595/1	1316920	7662500000	Telstra Corporation Limited Attn: Stewart Beveridge Level 2 Bld M5 30 Henderson Rd CLAYTON VIC 3168
		1316921	7662500000	
		1316922	7501500000	
		1316923	7501500000	
8	1912959/1	876346	13031000000	
		876347	13031000000	
		876348	12765000000	
		876349	12765000000	
9	1316585/1	787573	8118320000	Vertical Telecoms Pty Limited PO Box 126 ROSEBERY NSW 2018
		787574	8118320000	
		787575	7807000000	
		787576	7807000000	
10	1931701/1	904629	8088670000	
		904630	8088670000	
		904631	7777350000	
		904632	7777350000	

Table 10 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
753454	133844	1182426/1	-38.2402	142.4202	29	Aussie Broadband Pty Ltd PO Box 3351 GIPPSLAND MC VIC 3841
753449	133844	1182426/1	-38.2402	142.4202	29	
753445	133844	1182425/1	-38.2402	142.4202	29	
1174798	133844	1920117/1	-38.2402	142.4202	29	
1174795	133844	1920117/1	-38.2402	142.4202	29	
753448	133844	1182425/1	-38.2402	142.4202	29	
2505416	41974	10214884/1	-38.3913	143.5946	71	Barwon Region Water Corporation Barwon Water PO Box 659 (Matthew Grills) GEELONG VIC 3220
857506	41974	1804457/1	-38.3913	143.5946	71	
857503	41974	1804457/1	-38.3913	143.5946	71	
2505417	41974	10214884/1	-38.3913	143.5946	71	
947505	41974	1959247/1	-38.3913	143.5946	71	
947508	41974	1959247/1	-38.3913	143.5946	71	
832971	9004396	1566084/1	-37.6733	143.3544	47	Central Highlands Region Water Corporation Central Highlands Water PO Box 152 BALLARAT VIC 3353
832968	9004396	1566084/1	-37.6733	143.3544	47	
833016	204824	1566090/1	-37.6894	143.5237	58	
833019	204824	1566090/1	-37.6894	143.5237	58	
750917	9001492	1149775/1	-37.4245	143.3813	69	
750920	9001492	1149775/1	-37.4245	143.3813	69	
762792	45665	1192847/1	-37.8560	143.7566	72	
762795	45665	1192847/1	-37.8560	143.7566	72	
832759	9004355	1565856/1	-37.6393	143.7048	75	
945466	9004355	1958169/1	-37.6393	143.7048	75	
832756	9004355	1565856/1	-37.6393	143.7048	75	
945463	9004355	1958169/1	-37.6393	143.7048	75	
2208175	302343	10143098/1	-38.5729	143.0409	59	Iona Operations Pty Ltd Iona Gas Plant 285 Waarre Road PORT CAMPBELL VIC 3269
2208178	302343	10143098/1	-38.5729	143.0409	59	
923787	305790	1945114/1	-38.0560	142.8116	3	Powercor Australia Ltd Locked Bag 14090 Manager Communications Network Provisioning MELBOURNE VIC 8001
923790	305790	1945114/1	-38.0560	142.8116	3	
3515620	305783	10404937/1	-38.3130	142.3781	37	
3515617	305783	10404937/1	-38.3130	142.3781	37	
3799567	11728	10457448/1	-37.2651	142.8902	74	
3799566	11728	10457447/1	-37.2651	142.8902	74	
3799563	11728	10457447/1	-37.2651	142.8902	74	
3799570	11728	10457448/1	-37.2651	142.8902	74	

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

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
793650	300876	1326839/1	-38.0642	142.8085	4	Wannon Region Water Corporation PO Box 1158 WARRNAMBOOL VIC 3280
793653	300876	1326839/1	-38.0642	142.8085	4	
793630	42618	1326836/1	-38.2378	143.1220	28	
793633	42618	1326836/1	-38.2378	143.1220	28	
793645	305626	1326838/1	-38.3081	142.3743	37	
793642	305626	1326838/1	-38.3081	142.3743	37	
924158	41654	1945301/1	-37.8825	142.3006	37	
924155	41654	1945301/1	-37.8825	142.3006	37	
3711287	40981	10435722/1	-38.3768	142.4883	38	
3711290	40981	10435722/1	-38.3768	142.4883	38	
793638	40981	1326837/1	-38.3768	142.4883	38	
793641	40981	1326837/1	-38.3768	142.4883	38	
793625	46455	1326835/1	-38.4925	142.9805	49	
793622	46455	1326835/1	-38.4925	142.9805	49	
872281	302384	1909709/1	-38.3865	142.2144	53	
872278	302384	1909709/1	-38.3865	142.2144	53	
744711	302384	1143861/1	-38.3865	142.2144	53	
744716	302384	1143861/1	-38.3865	142.2144	53	
5832505	10017714	10757780/1	-38.6206	143.0052	64	
5832502	10017714	10757780/1	-38.6206	143.0052	64	
761724	11703	1191982/1	-37.6834	142.0198	70	
761721	11703	1191982/1	-37.6834	142.0198	70	
755292	136307	1185110/1	-38.3878	142.4592	40	Warrnambool Golf Club Inc Younger St WARRNAMBOOL VIC 3280
755289	136307	1185110/1	-38.3878	142.4592	40	

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

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	406
2 GHz Band	Spectrum	345
2.3 GHz Band	Spectrum	9382
2.5 GHz Band	Spectrum	278
3.4 GHz Band	Spectrum	4968
700 MHz Band	Spectrum	804
800 MHz Band	Spectrum	433
Aeronautical Assigned System	Aeronautical	25
Amateur Beacon	Amateur	8
Amateur Repeater	Amateur	19
Ambulatory System	Land Mobile	78
AWL - FSS Only	Spectrum	105
AWL - Standard	Spectrum	2
CBRS Repeater	Land Mobile	8
Commercial Radio	Broadcasting	8
Commercial Television	Broadcasting	12
Community Broadcasting	Broadcasting	3
Land Mobile System - > 30MHz	Land Mobile	1230
Land Mobile System 0-30MHz	Land Mobile	176
Narrowband Area Service station(s)	Broadcasting	3
Narrowcasting Service (Fixed Tax)	Broadcasting	4
Narrowcasting Service (LPON)	Broadcasting	29
National Broadcasting	Broadcasting	14
Paging System - Exterior	Land Mobile	28
Paging System - Interior	Land Mobile	4
PMTS Class B	PTS	274
PMTS Class B (935-960 MHz)	PTS 900 MHz	122
Radiodetermination	Radiodetermination	1
Retransmission	Broadcasting	10
Scientific Assigned	Scientific	2

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

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Ambulance Victoria	Ambulance Victoria Attn: Tim McCallum 303 Gillies Street North WENDOUREE VIC 3355	26
Ararat Fire Brigade	Ararat Fire Brigade PO Box 501 ARARAT VIC 3377	74
Country Fire Authority	Country Fire Authority PO Box 701 MOUNT WAVERLEY VIC 3149	5
Department of Justice and Community Safety – Regional Mobile Radio	Department of Justice and Community Safety RMR Regional Mobile Radio C/- Level 2 Bld M5 30 Henderson Rd CLAYTON VIC 3168	3
Department of Justice and Community Safety – Visionstream Australia	Department of Justice and Community Safety Visionstream Australia Locked Bag 4001 Attn: Phillip Minopoulos Heatherton VIC 3202	3
Department of Sustainability and Environment	Department of Environment Land Water and Planning Department of Sustainability and Environment Attn Paul Rofe DELWP Accounts Payable Locked Bag 32017 Collins Street East VIC 8003	58
St John Ambulance	St. John Ambulance Australia Incorporated Technical Services 170 Forster Road MOUNT WAVERLEY VIC 3149	26
The Australian Volunteer Coast Guard Association	The Australian Volunteer Coast Guard Association Inc PO Box 64 SANDRINGHAM VIC 3191	41
Victoria State Emergency Service	Victoria State Emergency Service 168 Sturt St SOUTHBANK VIC 3006	21

Table 13 BoM radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
49834	Met Bureau Radar Site RAAF Base LAVERTON	-37.8552	144.7552	159
23944	Meteorology Radar Site Airport MOUNT GAMBIER	-37.7478	140.7746	170
302559	Met Rd MELBOURNE AIRPORT	-37.6735	144.8433	170
49723	Met Bureau Glenlitta Ave BROADMEADOWS	-37.6902	144.9435	178
49837	Met Bureau BMTC Annex Glenlitta Ave BROADMEADOWS	-37.6905	144.9470	178
134173	Met Bureau S1 Doppler Radar Training Facility Glenlitta Avenue BROADMEADWS	-37.6911	144.9480	179
10012512	Wimmera Radar Pullut West Road PULLUT	-35.9977	142.0134	229
304566	Met Bureau Site YARRAWONGA AIRPORT	-36.0297	146.0227	347
136780	Wind Profiler Radar Site RAAF Base EAST SALE	-38.1156	147.1329	368
136953	Weather Radar site Bairnsdale Aerodrome Aerodrome Road BAIRNSDALE	-37.8875	147.5755	407
700224	Weather Radar Site WEST TAKONE	-41.1791	145.5797	416
141677	Meteorological Office Mildura Airport MILDURA	-34.2353	142.0873	417
502339	Bureau of Meteorology site MILDURA AIRPORT	-34.2352	142.0861	417
10019217	Mildura Radar off Sturt Highway CULLULLERAINE	-34.2871	141.6077	421

Table 14 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94	Distance to Project [km]
Noorat	AGD66	142.9365	-38.1774	14
Shadwell	AGD66, AGD84, GDA94	142.8120	-38.0560	3

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

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone	
			Ballarat	Warrnambool
i1	668431	5795940	X	X
i2	672104	5801865		X
i3	672364	5801189		X
i7	667848	5796262	X	X
i8	666446	5788270	X	X
i9	659907	5788137	X	
i10	659646	5788438	X	
i11	668152	5790956	X	X
i12	661427	5792502		X
i14	665790	5787346	X	
i15	664251	5787101	X	
i16	657659	5795094		X
i17	658010	5795224		X
i18	659127	5794699		X
i19	654065	5790672	X	
i20	670099	5794975	X	X
i21	659314	5787808	X	
i24	669336	5798650		X
u9	674263	5799631		X
u10	673085	5798418		X
u11	672521	5795682		X
u14	671946	5794550		X
u15	671014	5794636		X
u17	665046	5792260	X	X
u18	664166	5794029		X
u19	664130	5793868		X
u20	667260	5796702	X	X
u22	667381	5796888	X	X
u29	659147	5798651		X
u30	659430	5798900		X
u31	659260	5794768		X
u38	668783	5789961		X
u47	663503	5790960	X	X
u49	660754	5794401		X
u50	662782	5794252		X
u51	661796	5786881	X	
u52	664138	5784064	X	
u53	663788	5785568	X	
u57	662385	5785372	X	
u58	668523	5791583		X
u59	655494	5787092	X	
u70	657944	5788331	X	
u71	657398	5788156	X	
u90	659813	5787900	X	
u91	659845	5787783	X	
u139	651436	5789175	X	

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

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone	
			Ballarat	Warrnambool
u157	655082	5788280	X	
u158	654199	5788968	X	
u159	653399	5789715	X	
u160	670215	5795187	X	X
u161	661264	5794527		X
u162	660778	5794657		X
u163	657783	5790185	X	
u164	657720	5790068	X	
u169	659602	5786467	X	
u170	659659	5786983	X	
u171	659549	5785999	X	
u172	658973	5785621	X	
u173	659481	5785393	X	
u202	662729	5782706	X	
u208	660475	5784418	X	
u221	660056	5784496	X	
u222	660058	5784375	X	
u223	660130	5784269	X	
u224	660276	5783900	X	
u225	659962	5783817	X	
u226	659880	5783881	X	
u227	659129	5784638	X	
u228	659153	5784383	X	
u229	659866	5784173	X	
u230	659650	5784266	X	
u231	659716	5784304	X	
u232	659756	5784315	X	
u233	659460	5784041	X	
u234	659454	5784095	X	
u235	659493	5784174	X	
u236	659501	5784297	X	
u237	659477	5784284	X	
u238	659146	5784364	X	
u239	659154	5784315	X	
u240	659131	5784326	X	
u241	659314	5784252	X	
u242	659373	5784215	X	
u243	659322	5784063	X	
u244	659307	5784056	X	
u245	659339	5784191	X	
u246	659322	5784181	X	
u247	659273	5784170	X	
u248	659360	5784081	X	
u250	659118	5784258	X	
u266	660297	5783712	X	
u271	659267	5784089	X	
u272	659267	5784089	X	
u273	659336	5784081	X	
u274	658946	5784362	X	
u275	659002	5784412	X	
u276	659020	5784348	X	
u298	666293	5786618	X	
u299	659026	5785354	X	

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

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone	
			Ballarat	Warrnambool
u300	658912	5785399	X	
u301	658711	5785371	X	
u302	660766	5784099	X	
u307	659355	5784204	X	

1. Involved dwellings are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 54, GDA94 datum.

Table 16 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, no turbines in diffraction exclusion zones established by DNV Spectrum (wireless internet): 3 km from Project boundary	NBN Co Limited (NBN Co) PP197158-AUME-L-02	Response received by email on 19 October 2018, based on previous turbine layout and dimensions: *"Since the turbines are densely populated we can assume that NBN RF coverage will be hindered for all the NTPs (NBN fixed wireless covered premise) located within and across the Wind Farm boundary area… Total of 6 NTPs are potentially impacted."* File containing coordinates of potentially affected dwellings provided by NBN Co. **Additional consultation yet to commence**
2	Fixed point-to-point: 3 links crossing the Project site, no turbines in diffraction exclusion zones established by DNV Fixed point-to-multipoint: 3 km from Project boundary	Powercor Australia Ltd (Powercor) PP197158-AUME-L-03	Response received by email on 4 May 2018, based on previous turbine layout and dimensions: *"There are three Powercor fixed point-to-point microwave radio links (1.5GHz) intersecting the Mt. Fryans [sic] Wind farm turbine field…* *The five point-to-multipoint licences within 75Km of proposed windfarm are not impacted by the Mt. Fryans [sic] windfarm… – these sites are clear of the Mt. Fryans [sic] windfarm foot print…* *The clearance to be allowed on either side of radio line of sight = Second Fresnel Zone Radius (1.5 GHz) + 75Mts."* The additional 75 m buffer requested by Powercor is equal to one rotor radius for a 150 m rotor diameter turbine, as proposed at the time of consultation. The current layout maintains a clearance of the second Fresnel zone plus an 85 m buffer, for a 170 m rotor diameter turbine. Follow-up response received by email on 9 May 2018, based on previous turbine layout and dimensions: *"I have had a look at the calculated clearance zone corridors as marked in the attached png maps– it all looks good. The line of sight to Linton Radio Site had quite a few turbines bordering the clearance zone – but the calculations show there is no infringement of turbines into the clearance zone. If the developer can strictly observe the clearance zones all will be well."* **Additional consultation yet to commence**

Table 16 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
3	Fixed point-to-point: 2 links crossing the Project site, no turbines in diffraction exclusion zones established by DNV PMTS/spectrum (mobile phone): 3 km from Project boundary	Telstra Corporation Limited (Telstra) PP197158-AUME-L-04	Response received by email on 4 May 2018, based on previous turbine layout and dimensions: *"The Telstra m/w radio link identified by DNV GL-Energy is the only link that crosses the proposed Wind Farm area. This is a 7.5GHz SMR radio link from Mt Shadwell to Lake Bolac CMTS.* *It is noted that the Lake Bolac ACMA coordinates… are incorrect… However when using the correct cords this provides more clearance from the nearest turbines…"* The coordinates recorded in the ACMA RRL database have since been corrected, and are now consistent with the coordinates provided by Telstra. Follow-up response received by email on 14 May 2018, based on previous turbine layout and dimensions: *"Previous advice on other wind farms is that they do not interfere with the mobile phone signals. In this case there are no Telstra mobile base stations within the windfarm boundary either so there would be no risk of interference."* **Additional consultation yet to commence**
4	Fixed point-to-point: 2 links crossing the Project site, no turbines in diffraction exclusion zone established by DNV	Vertical Telecoms Pty Limited (VerTel)	**Consultation yet to commence**
5	Fixed point-to-multipoint: 29 km from Project boundary	Aussie Broadband Pty Ltd (Aussie Broadband) PP197158-AUME-L-01	Response received by email on 3 May 2018, based on previous turbine layout and dimensions: *"We don't have any objections to the proposed wind farm…"* Follow-up response received by email on 9 May 2018, based on previous turbine layout and dimensions: *"We are in the process of shutting down a lot of our point to multipoint network so by the time this windfarm is built, we will have surrendered the frequency licences."* **Further consultation not considered necessary**

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

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
6	Fixed point-to-multipoint: 47 km from Project boundary	Central Highlands Region Water Corporation (Central Highlands Water) PP197158-AUME-L-05	Response received by email on 18 July 2018, based on previous turbine layout and dimensions: *"…we can confirm that we do not have any links crossing over the wind farm site and therefore can only assume there will be not any [sic] impact."* **Further consultation not considered necessary**
7	Fixed point-to-multipoint: 4 km from Project boundary	Wannon Region Water Corporation (Wannon Water) PP197158-AUME-L-07	**No response received to date**
8	Emergency service communications: 26 km from Project boundary	Ambulance Victoria PP197158-AUME-L-08	Response received by email on 15 May 2018, based on previous turbine layout and dimensions: *"Ambulance Victoria communications facilities located at Hamilton and Warrnambool are designed to provide local portable (population centre) communications by means of gateways connected to a third party carrier network (Telstra RAVnet)* *Notwithstanding EMI potentially introduced into the Telstra network, it is unlikely your proposed development will impact the Ambulance Victoria local communications at Hamilton and Warrnambool."* **Further consultation not considered necessary**
9	Emergency service communications: 5 km from Project boundary	Country Fire Authority PP197158-AUME-L-09	Response received by email on 15 May 2018, based on previous turbine layout and dimensions: *"I confirm that the CFA radio services (fixed radio links and land mobile services) are not affected by the proposed wind turbines at Mt Fyans Wind Farm wind farm (based on the wind farm boundary details supplied by DNV GL - Energy)."* **Further consultation not considered necessary**

Table 16 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
10	Emergency service communications: 3 km from Project boundary	Department of Justice and Community Safety – Regional Mobile Radio PP197158-AUME-L-11	Response received by email on 28 May 2018, based on previous turbine layout and dimensions: *"From the data you have supplied, and our investigations so far, we don't foresee any issues."* **Further consultation not considered necessary**
11	Emergency service communications: 3 km from Project boundary	Department of Justice and Community Safety – Visionstream Australia PP197158-AUME-L-12	Response received by email on 8 June 2018, based on previous turbine layout and dimensions: *"We have reviewed the documents supplied and can advise the following in response to your request for feedback items…:* *• ESTA does not envisage any interference issues with the proposed wind farm…* *• The proposed wind farm is noted to be approximately 2km away from our site at Mt Shadwell, and ESTA believes this is sufficient clearance. Otherwise, a clearance of 1km would be a minimum preferred clearance.* *• If the wind farm is found to impact the EAS service coverage (once built and commissioned) by introducing EMI, then ESTA will require the wind farm operator or owner to work with ESTA to restore the EAS service in the impacted area/s at no cost to ESTA or the State of Victoria…* *With regards to the final dot point above, we don't envisage any significant impact to the EAS service coverage for the area defined but must ensure the State of Victoria and the ESO's are not impacted operationally as the EAS is a mission critical service and operates to provide Public Safety."* **Further consultation not considered necessary**
12	Emergency service communications: 58 km from Project boundary	Department of Environment, Land, Water and Planning (Department of Sustainability and Environment)	**Consultation yet to commence**

Table 16 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	Emergency service communications: 26 km from Project boundary	St John Ambulance Australia Incorporated (St John Ambulance) PP197158-AUME-L-10	Response received by email on 29 May 2018, based on previous turbine layout and dimensions: *"St John Ambulance has a number of licenced radio services in the area but none of the St John installations have links with paths that are impacted by the proposed wind farm.* *St John cannot foresee any interference to our assets or services from your proposed wind farm installation."* **Further consultation not considered necessary**
14	Emergency service communications: 21 km from Project boundary	Victoria State Emergency Service PP197158-AUME-L-13	Response received by email on 30 May 2018, based on previous turbine layout and dimensions: *"No issues thanks."* **Further consultation not considered necessary**
15	Meteorological radar: 159 km from Project boundary	Bureau of Meteorology (BoM) PP197158-AUME-L-14	Response received by email on 15 May 2018, based on previous turbine layout and dimensions: *"No Bureau radar is within 20 to 30 km of the proposed Mt Fyans… wind farm.* *The closest Bureau radar to the proposed wind farm is approximately 180km away at Laverton (S-band) and 200km from Mount Gambier (C-band), greater than the range at which the WMO suggests an impact study is required."* **Additional consultation yet to commence**
16	Trigonometrical station: 3 km from Project boundary GNSS station: 5 km from Project boundary	Geoscience Australia PP197158-AUME-L-15	Response received by email on 15 May 2018, based on previous turbine layout and dimensions: *"Geoscience Australia do not foresee any impact to our trigonometrical stations, Global Navigation Satellite System stations, equipment or facilities or services associated with the proposed Mt Fyans Wind Farm."* **Further consultation not considered necessary**

Table 16 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
17	Trigonometrical station: 3 km from Project boundary Permanent survey mark: 305 m from nearest turbine	Department of Environment, Land, Water and Planning (DELWP) PP197158-AUME-L-16	Response received by email on 11 June 2018, based on previous turbine layout and dimensions: *"Given the location of the proposed Mt Fyans Wind Farm, the proposal does not present any concerns or negative implications to the operation of Victoria's GNSS CORS network."* **Further consultation not considered necessary**
18	PMTS/spectrum (mobile phone): 3 km from Project boundary	Optus Mobile PP197158-AUME-L-17	Response received by email on 17 May 2018, based on previous turbine layout and dimensions: *"The initial analysis indicates that there is no impact on the existing microwave radio transmission links in the area."* Follow-up response received by email on 5 June 2018, based on previous turbine layout and dimensions: *"There is no impact on the planned sites."* **Further consultation not considered necessary**
19	PMTS/spectrum (mobile phone): 15 km from Project boundary	Vodafone PP197158-AUME-L-18	Response received by email on 15 May 2018, based on previous turbine layout and dimensions: *"Our local RF engineers have reviewed the location in relation to the nearest Vodafone facility. At more than 14km away from our closest base station Vodafone do not consider the proposed Mt Fyans Wind Farm, located near Mortlake in western Victoria, likely to impact service to Vodafone customers."* **Further consultation not considered necessary**
20	DTV broadcasting: 15 km from Project boundary	BAI Communications	**Consultation yet to commence**

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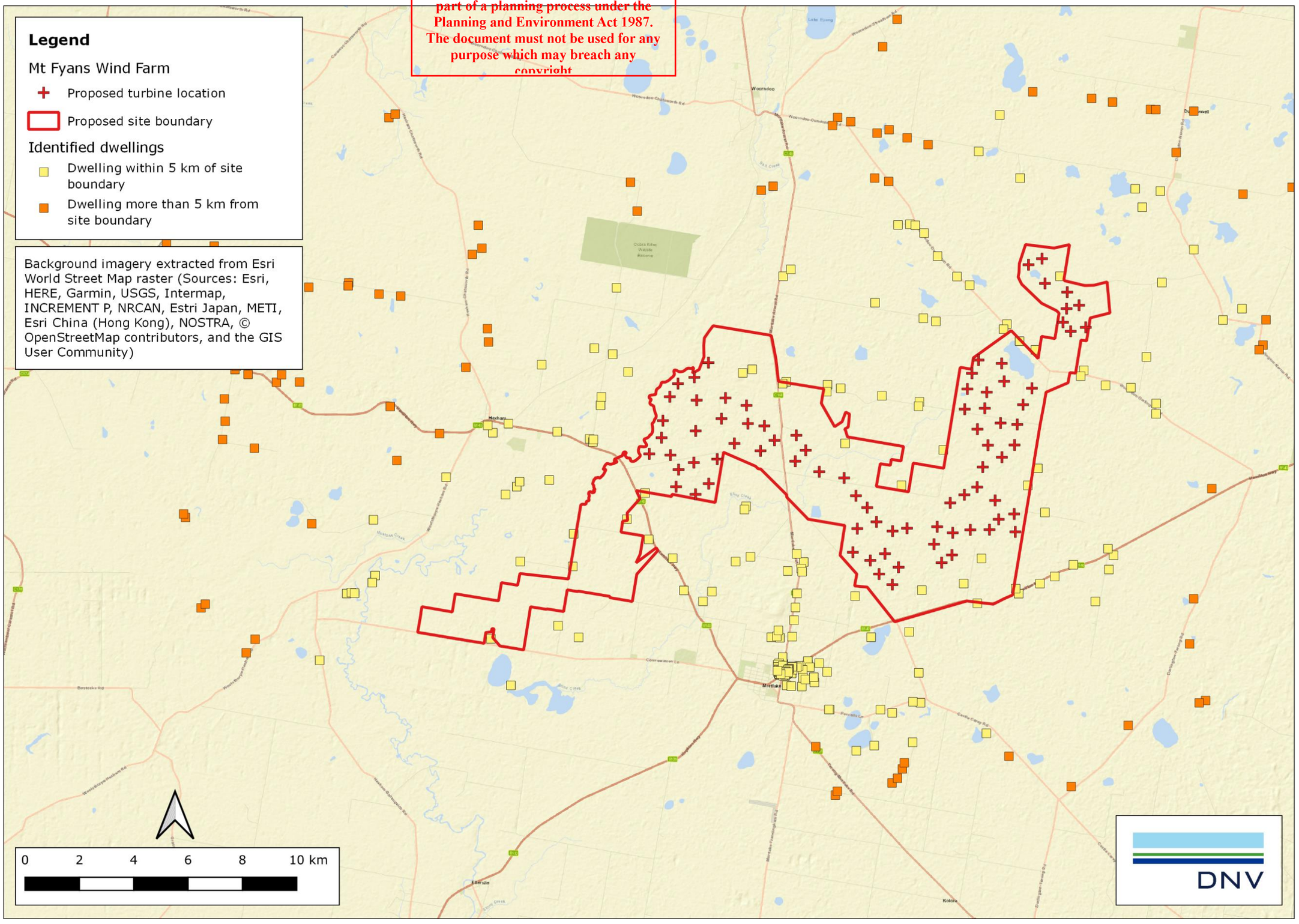

Figure 1 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby dwellings

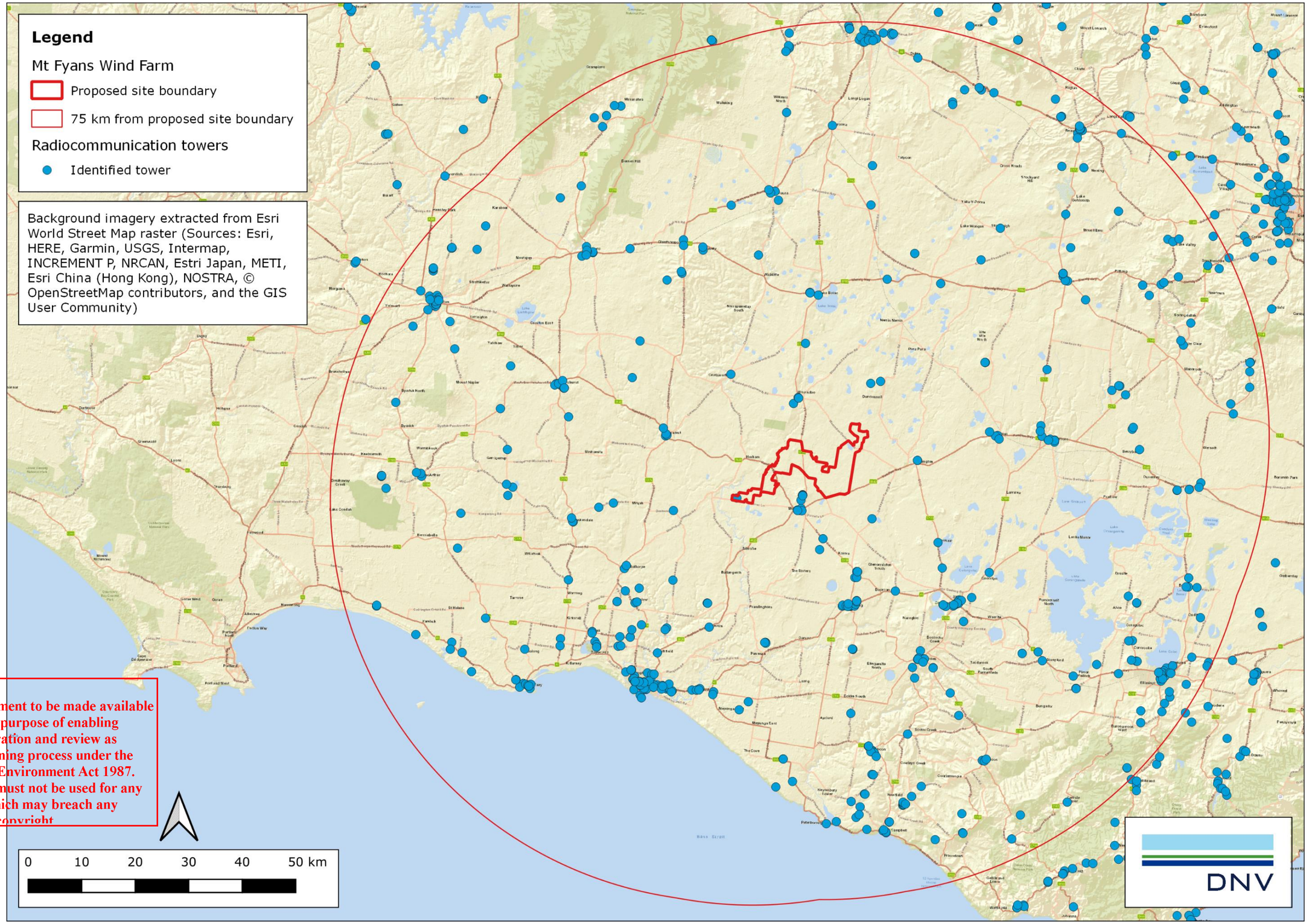

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

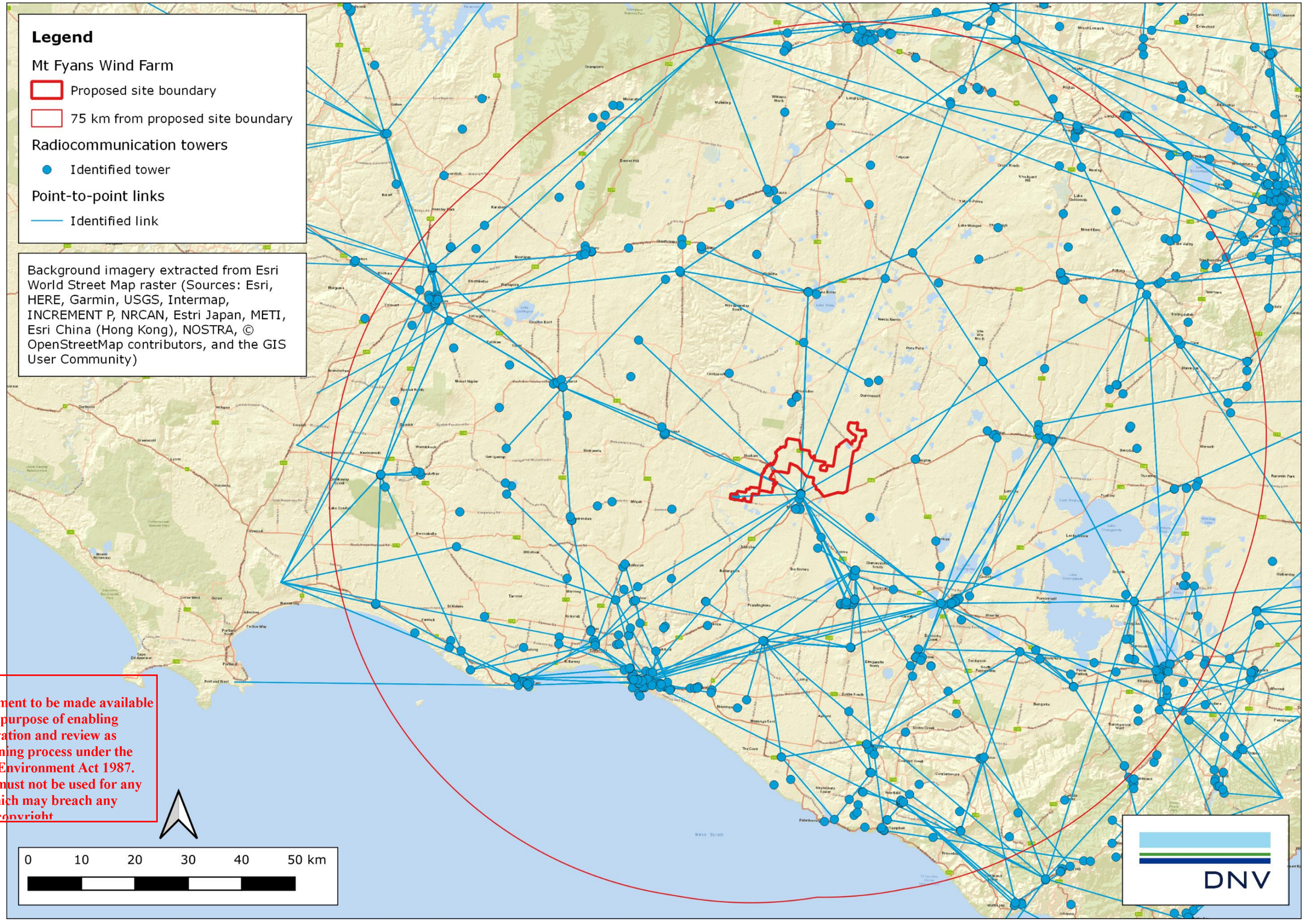

Figure 3 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

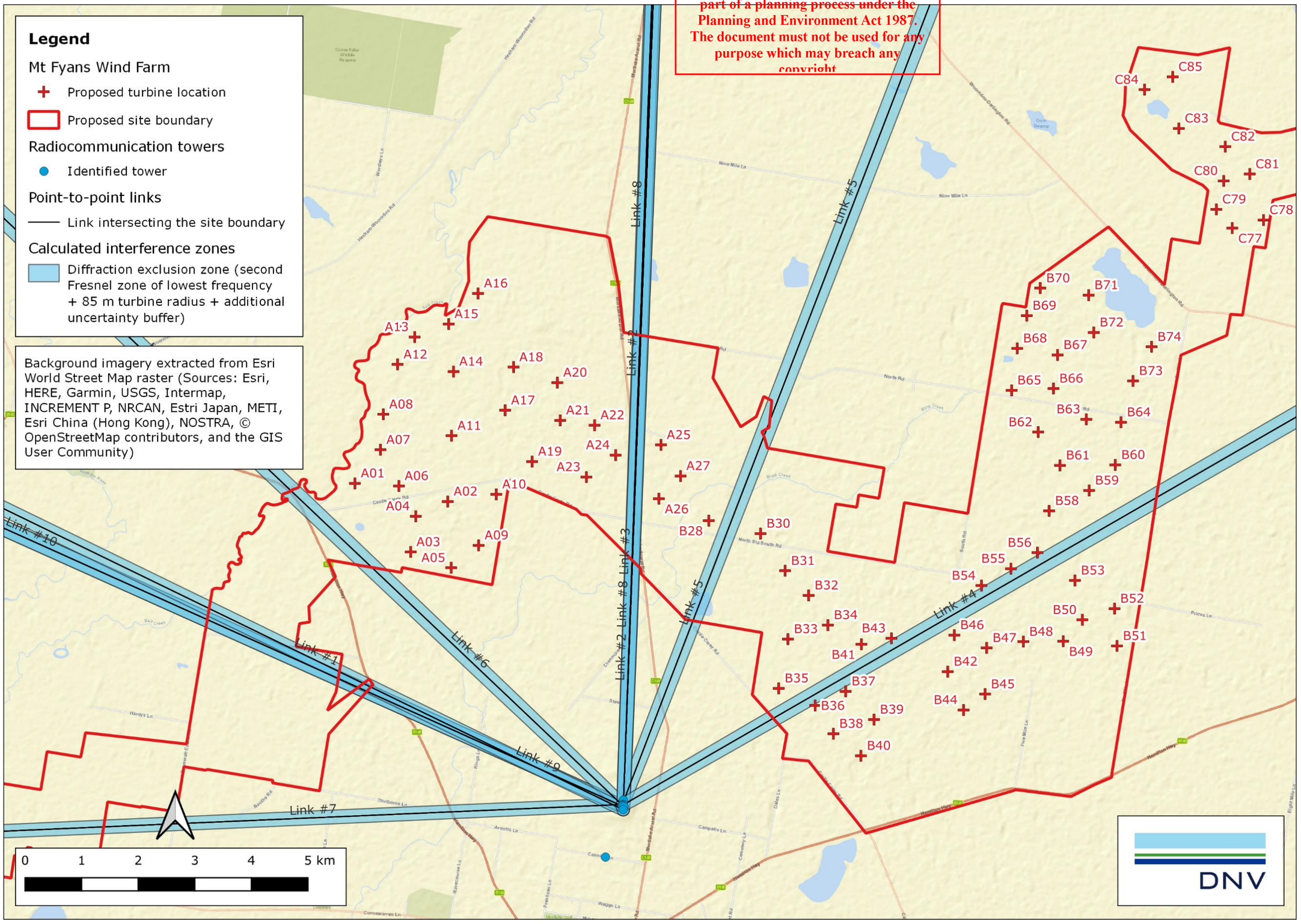

Figure 4 Identified point-to-point radiocommunication vectors crossing the proposed Project and calculated interference zones

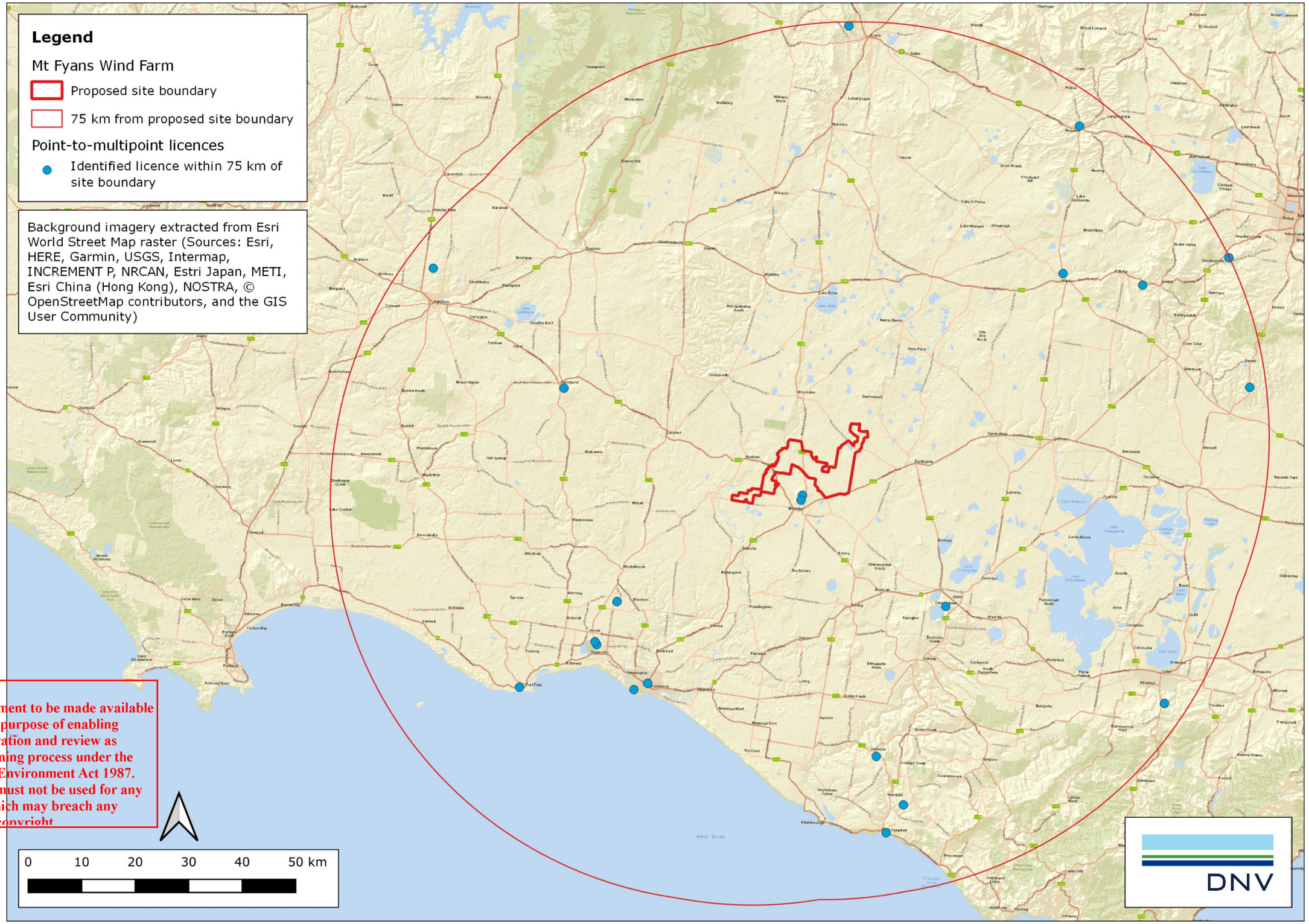

Figure 5 Location of point-to-multipoint licences in the vicinity of the proposed Project

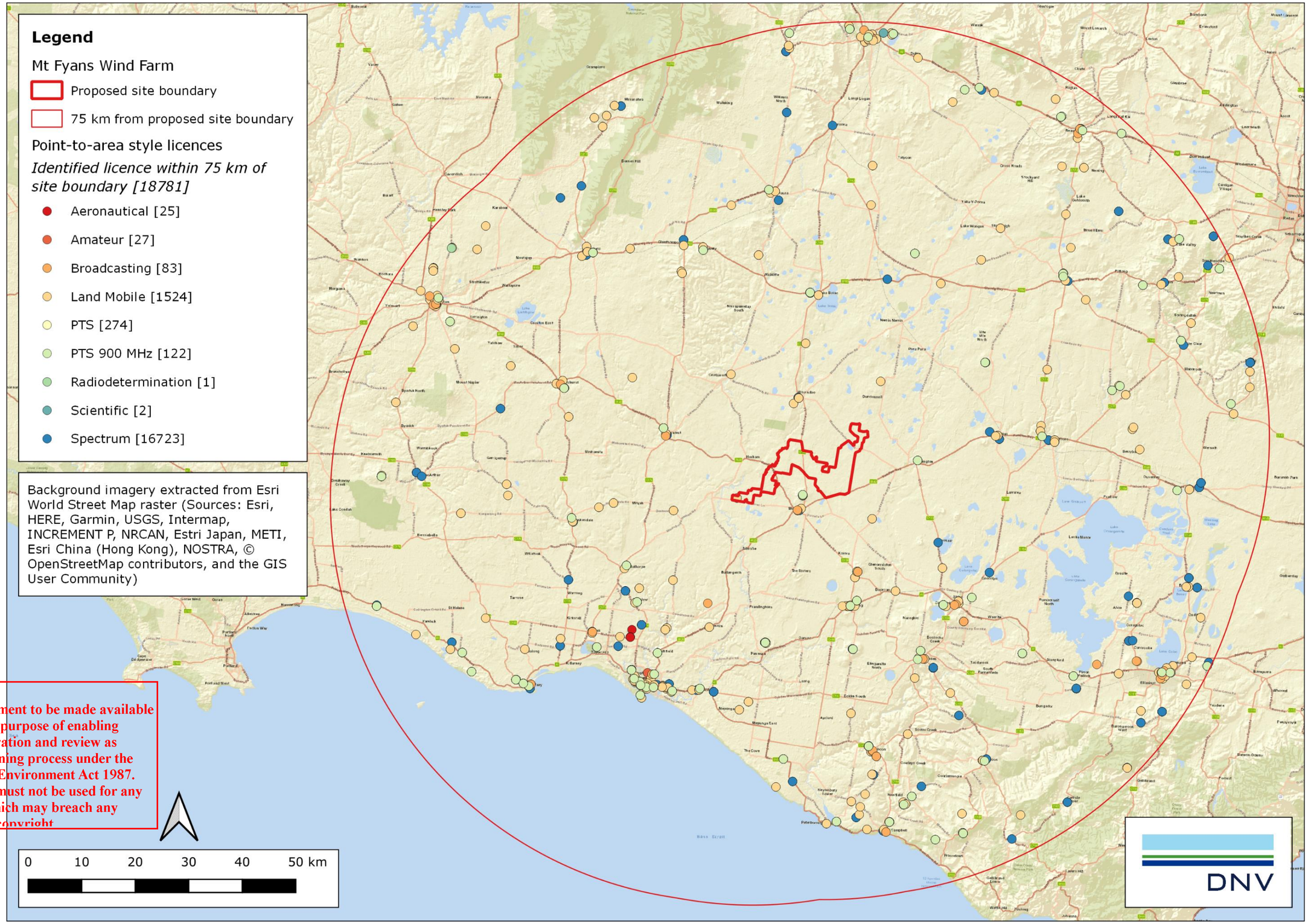

Figure 6 Location of general point-to-area style licences within 75km of the proposed Project

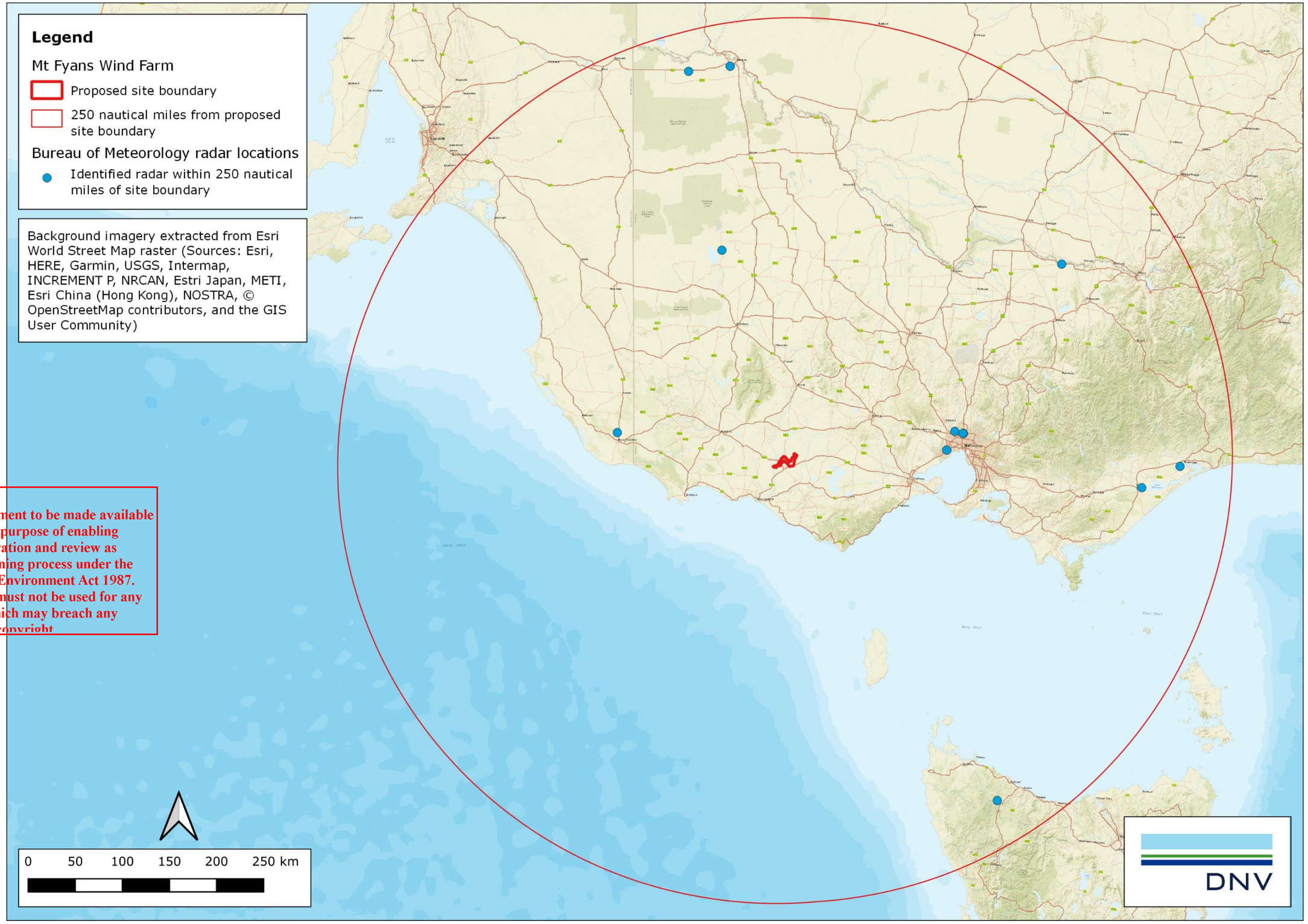

Figure 7 Location of meteorological radar sites within 250 nautical miles of the proposed Project

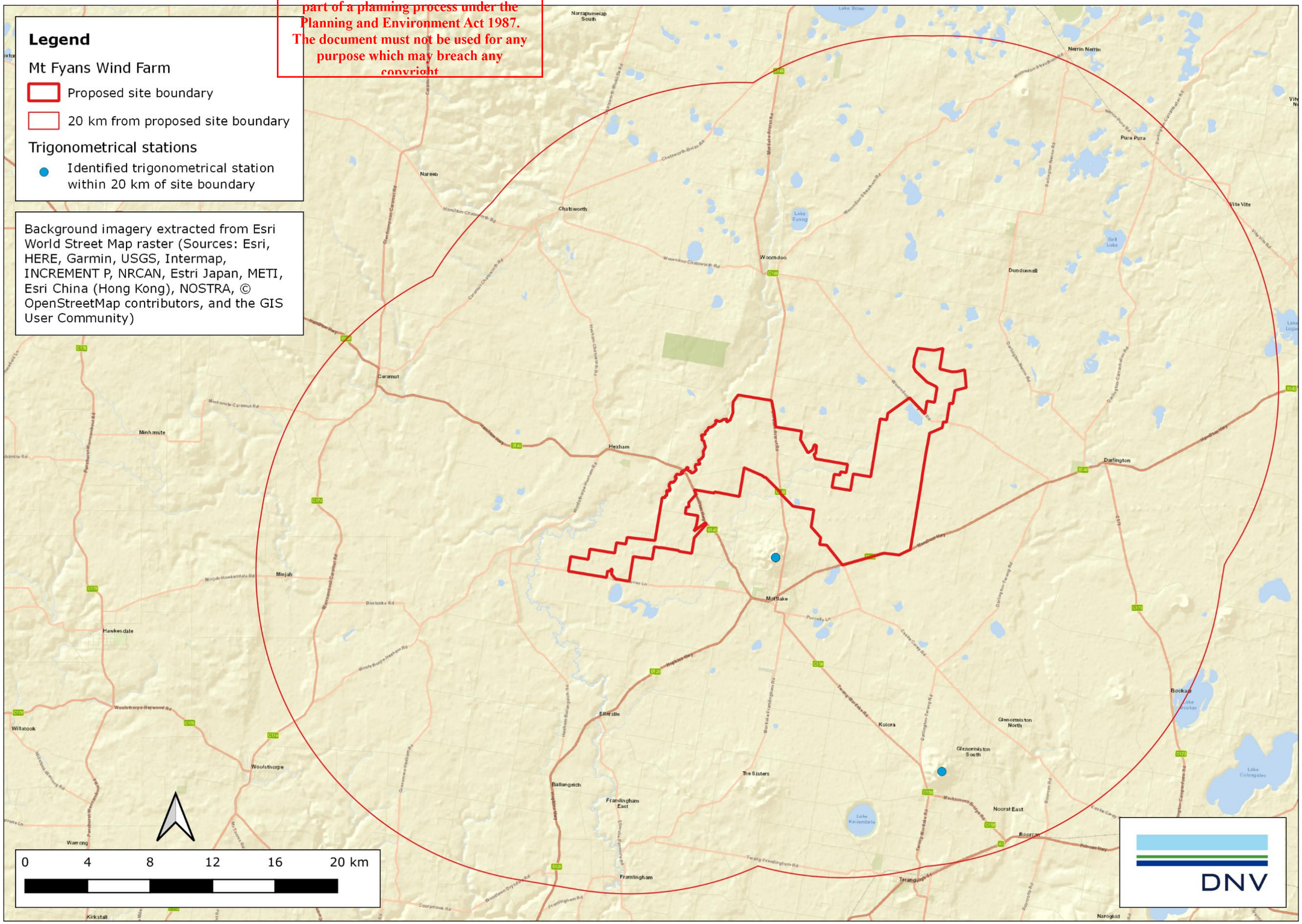

Figure 8 Location of trigonometrical stations within 20 km of the proposed Project

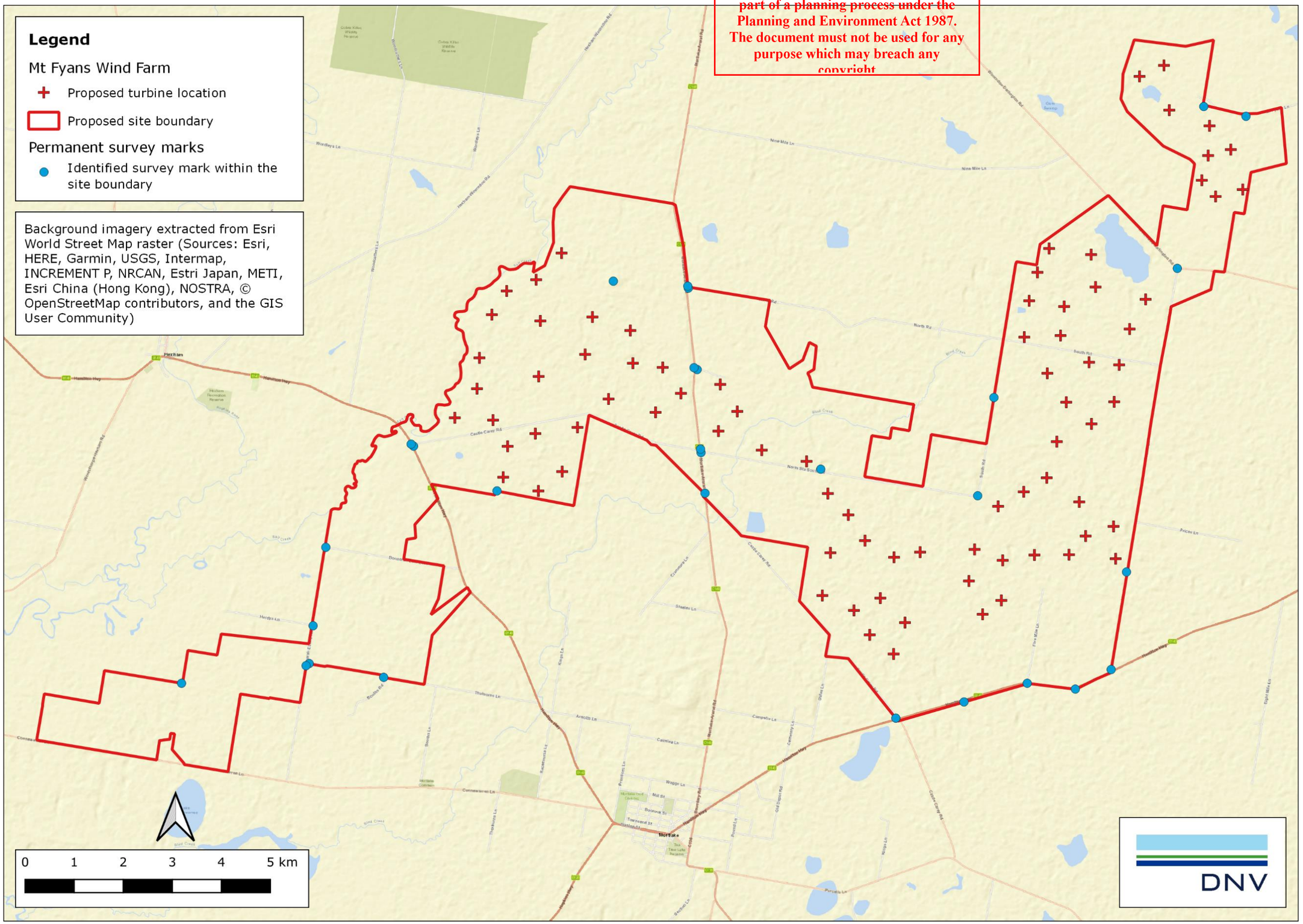

Figure 9 Location of permanent survey marks within the proposed Project boundary

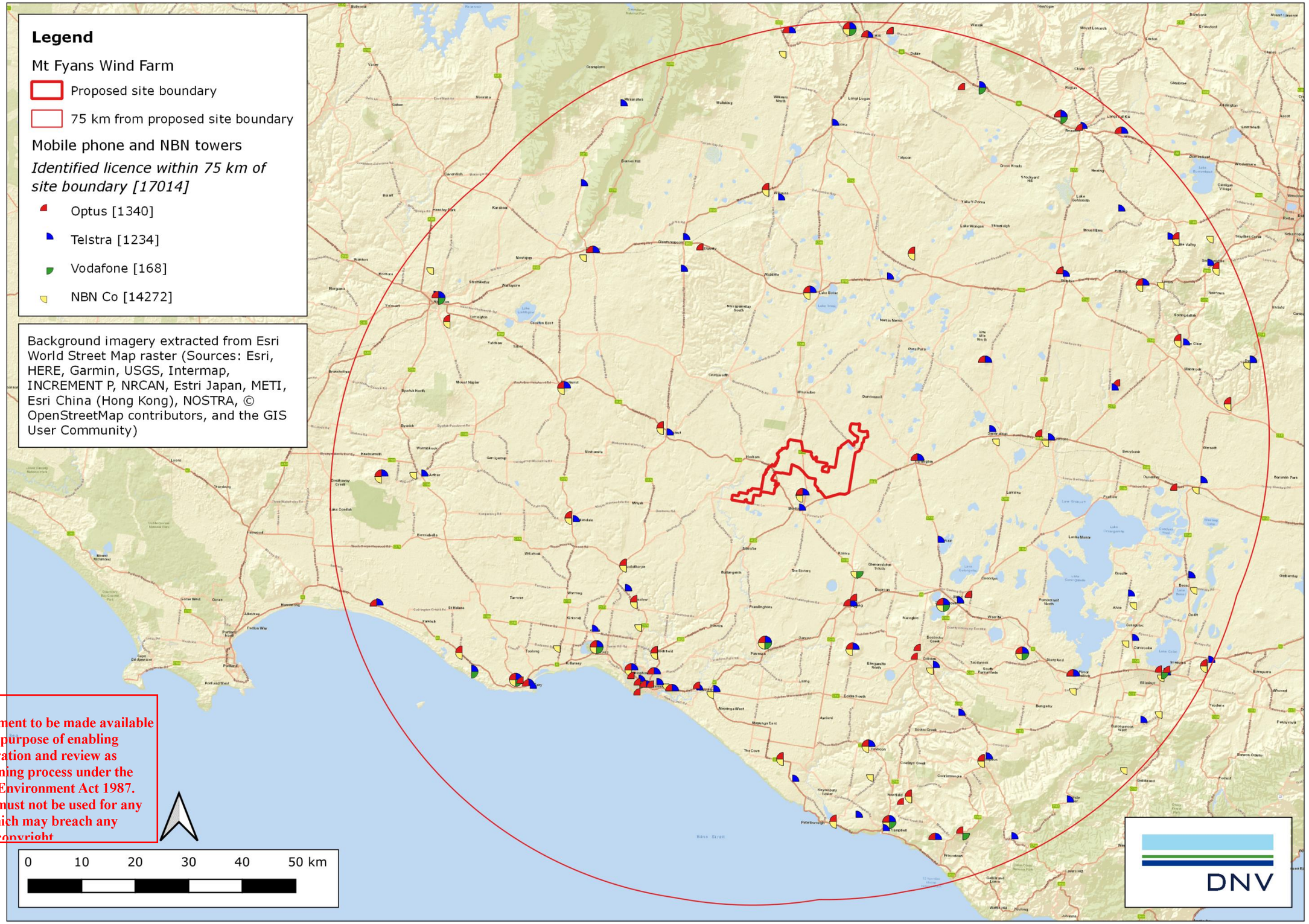

Figure 10 Location of mobile phone and NBN towers within 75 km of the proposed Project

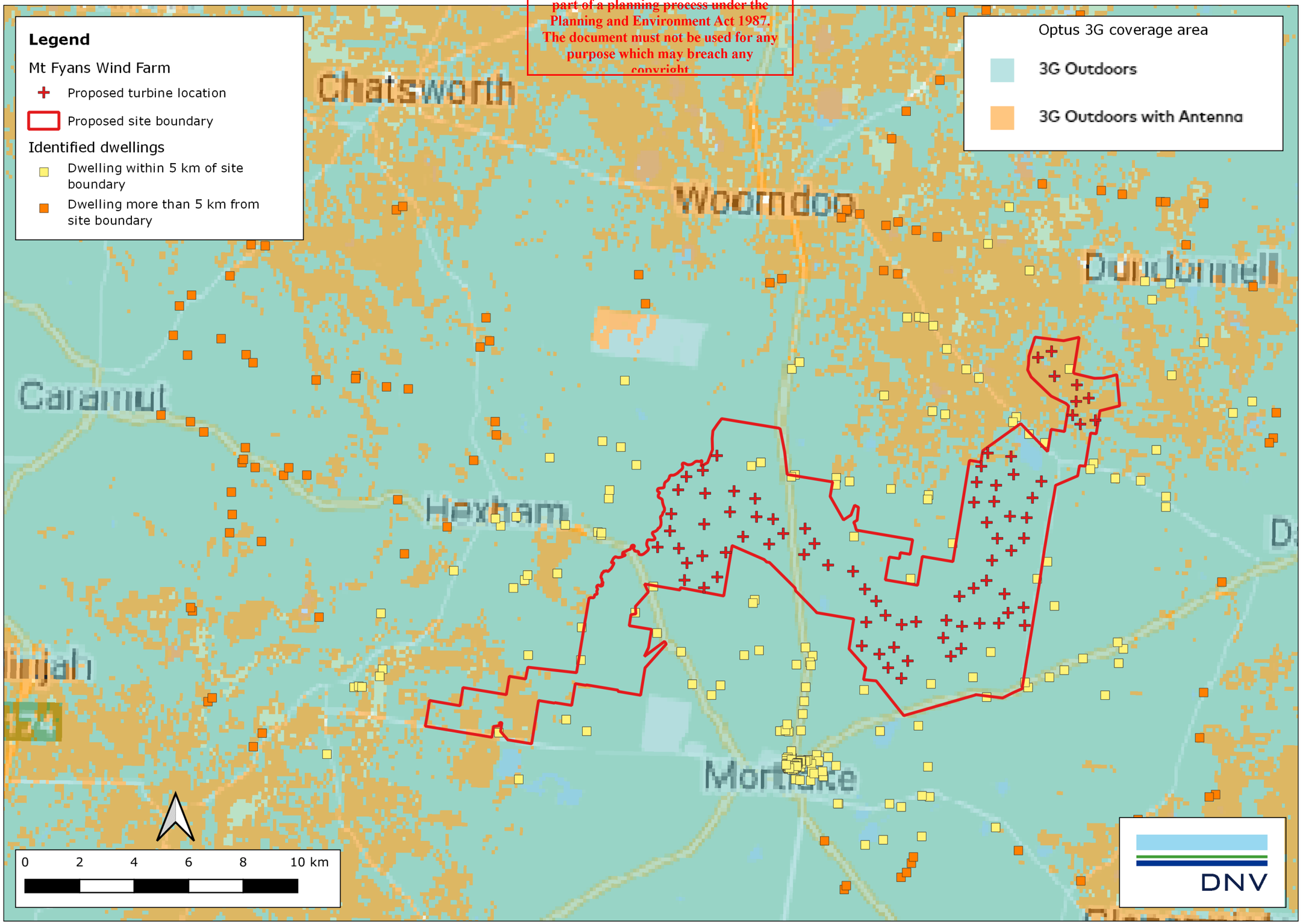

Figure 11 Optus Mobile 3G network coverage for the proposed Project

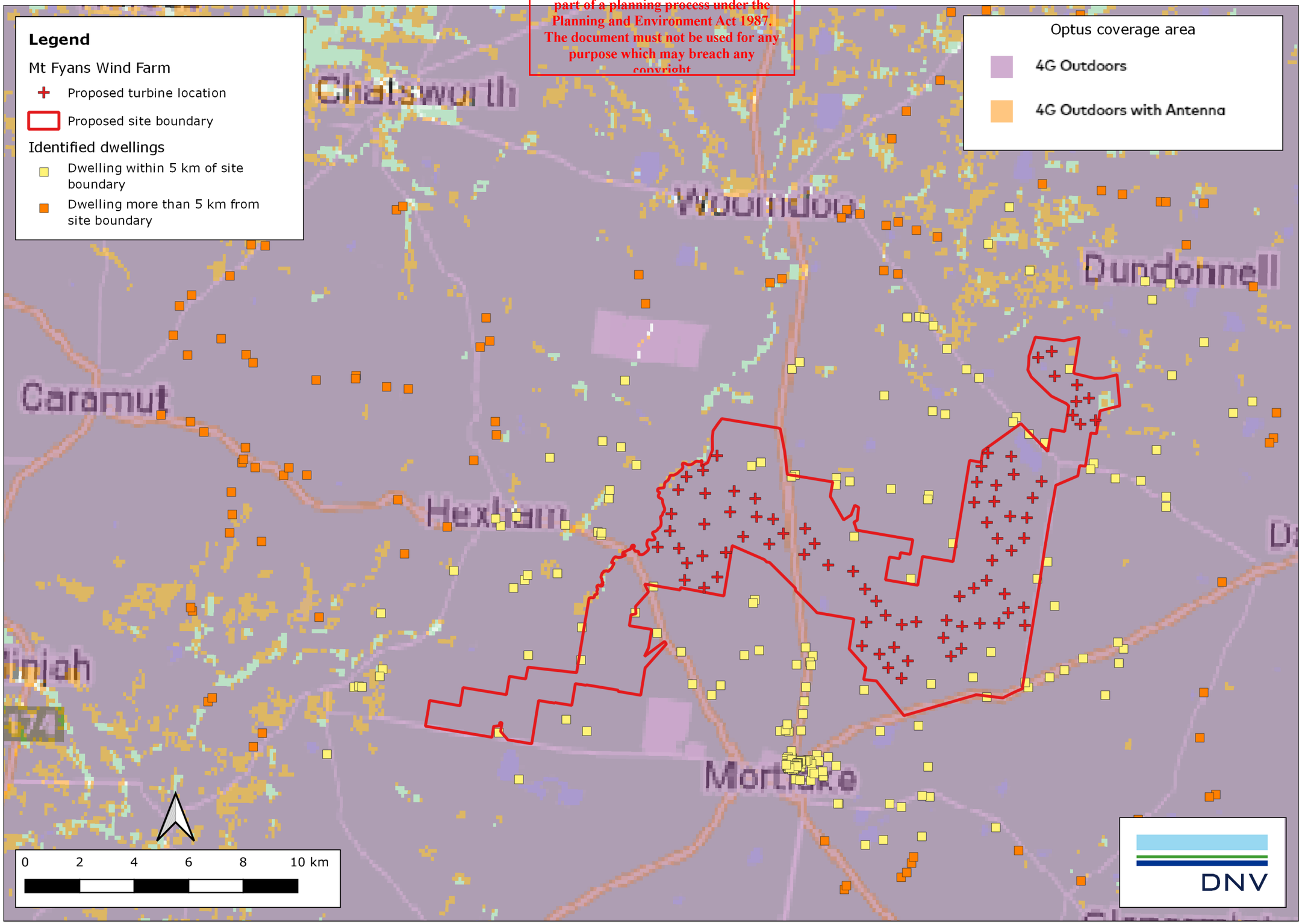

Figure 12 Optus Mobile 4G network coverage for the proposed Project

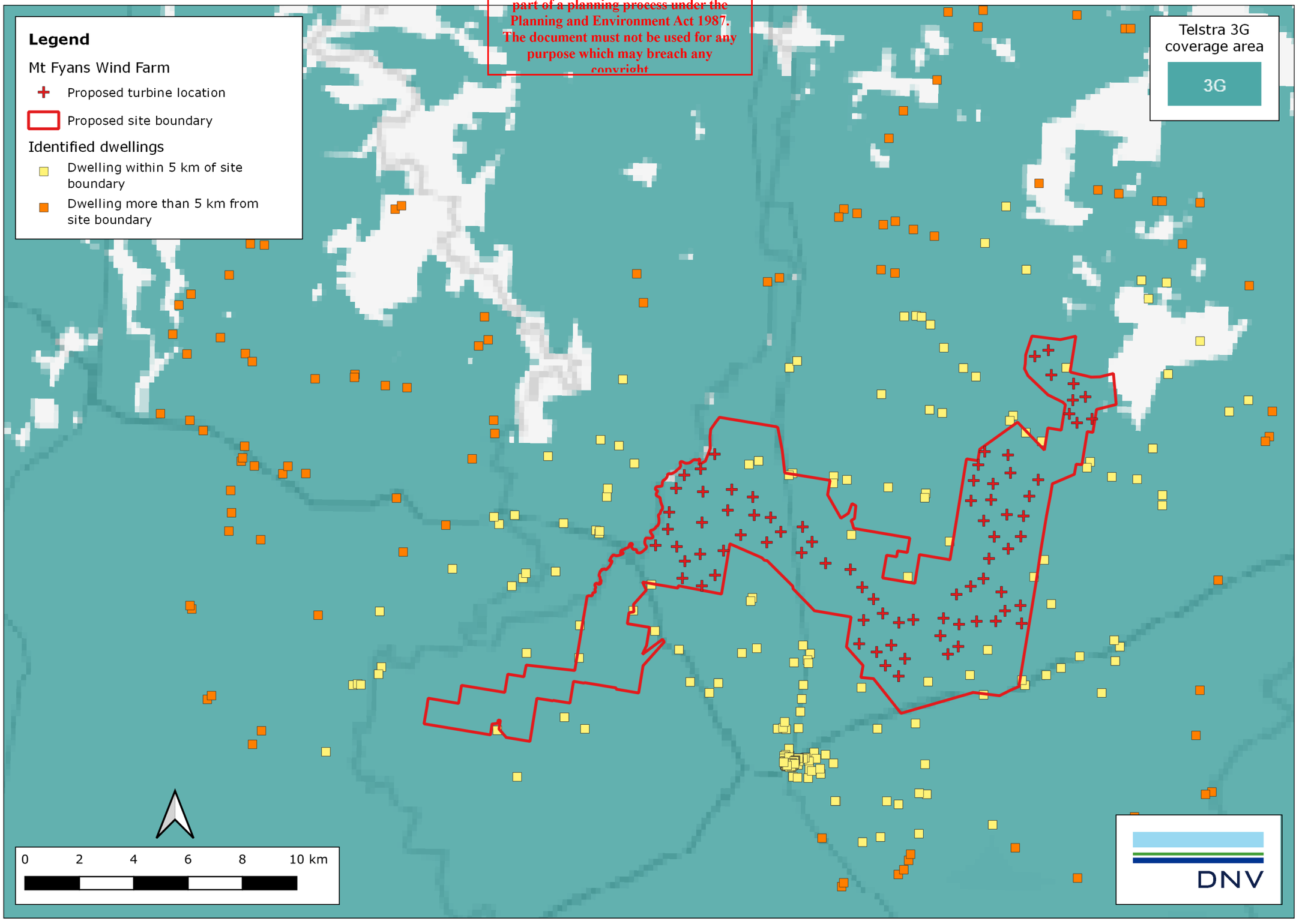

Figure 13 Telstra 3G network coverage for the proposed Project

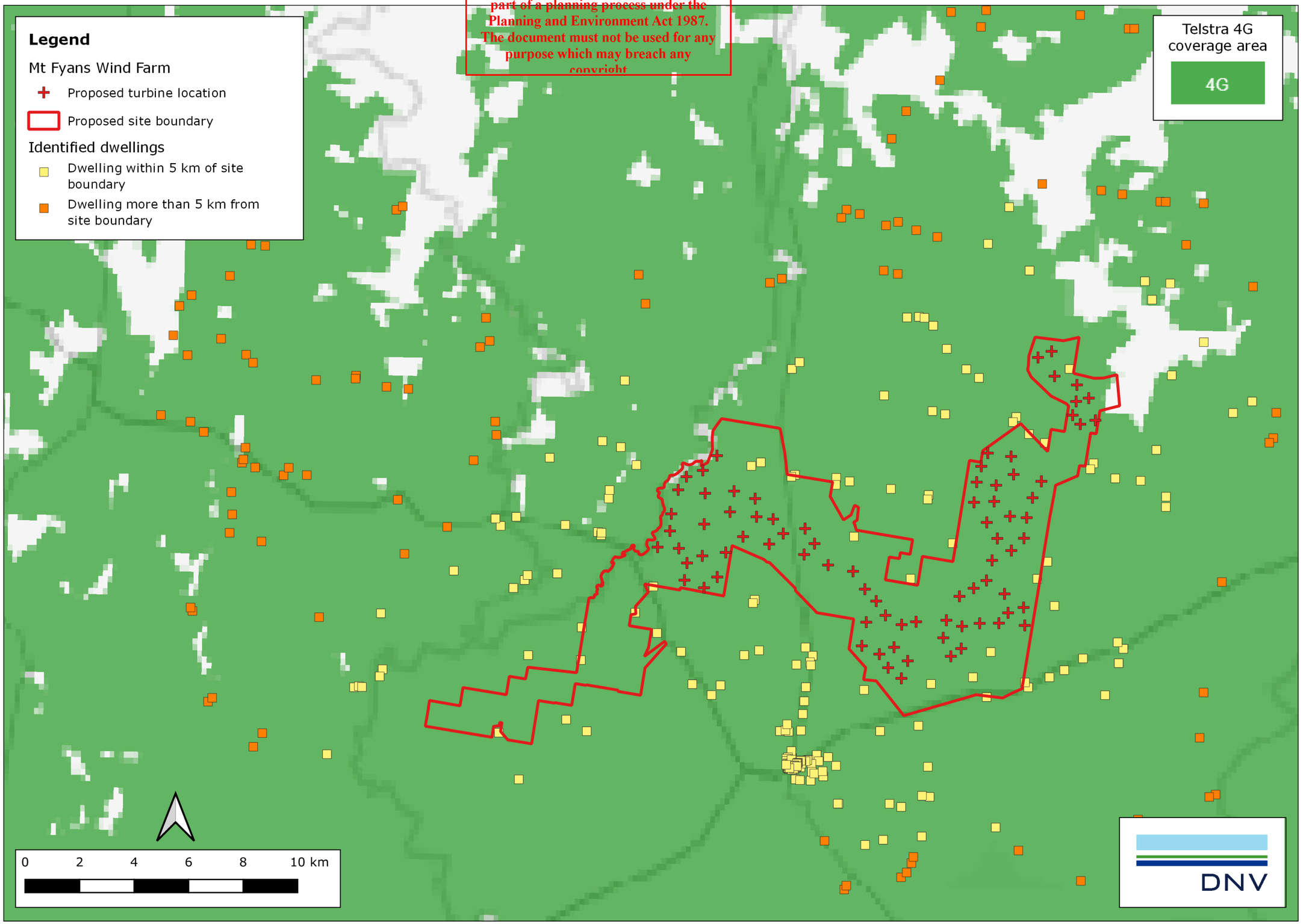

Figure 14 Telstra 4G network coverage for the proposed Project

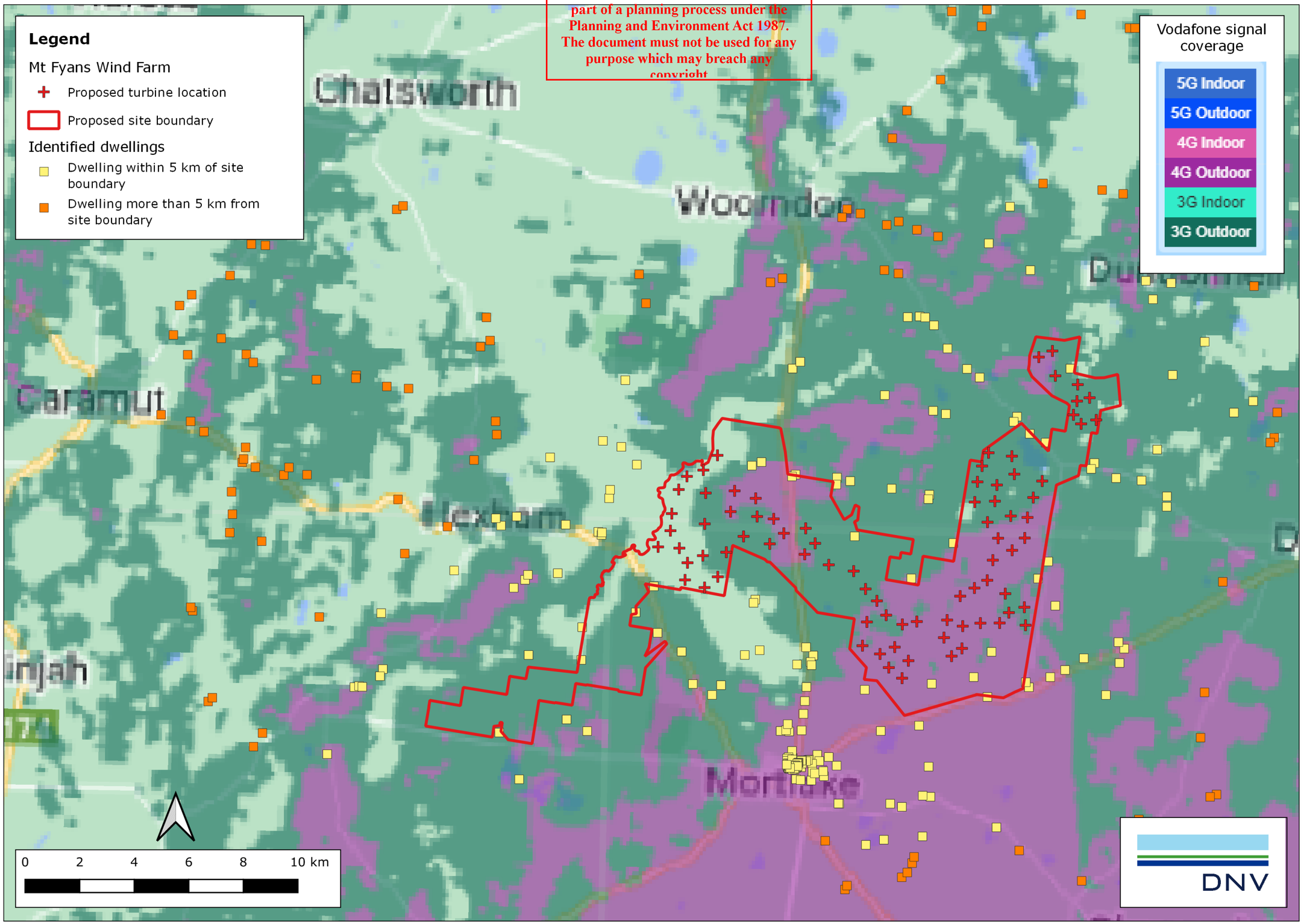

Figure 15 Vodafone network coverage (Apple iPhone 13 handset) for the proposed Project

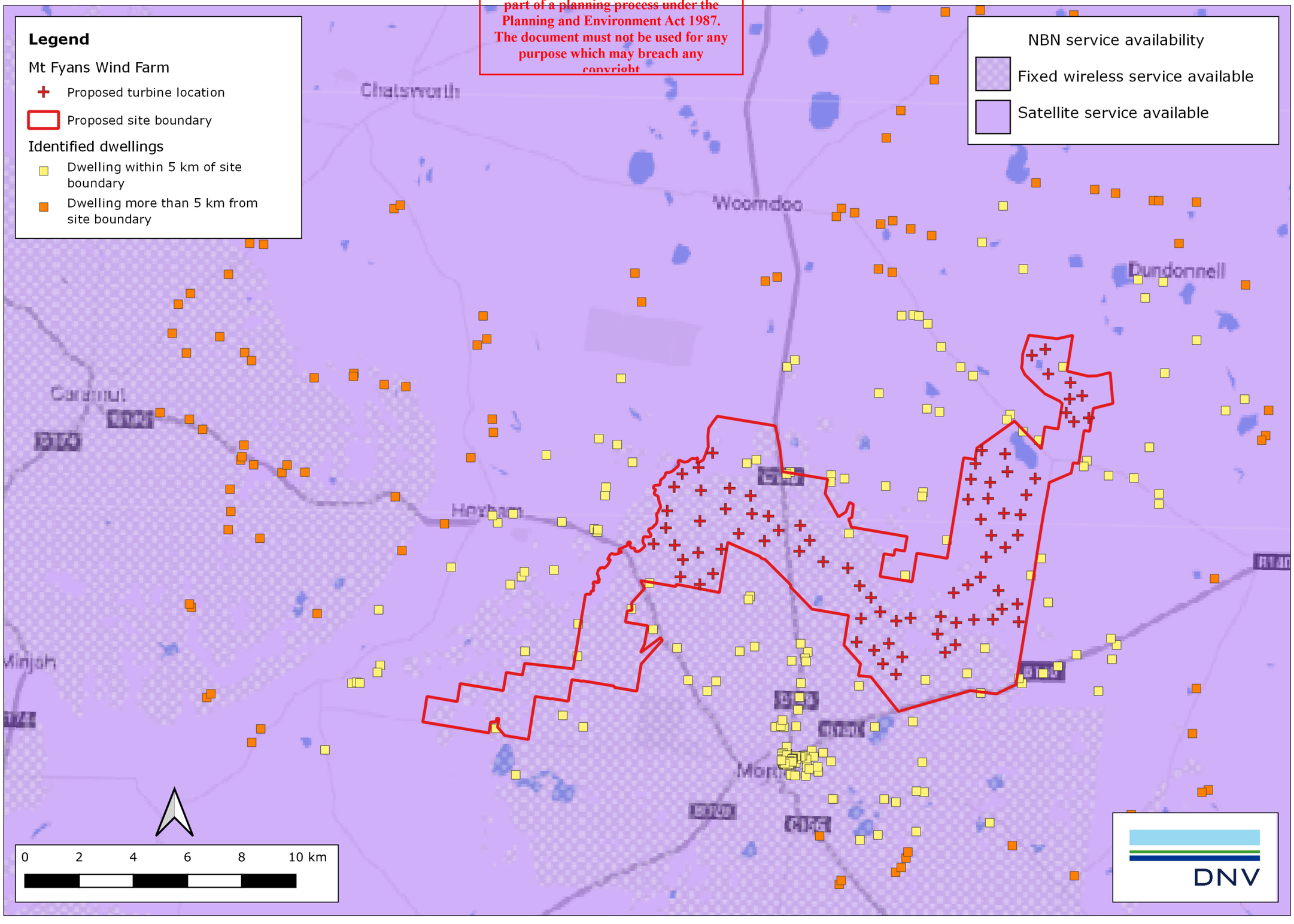

Figure 16 NBN internet coverage in the vicinity of the proposed Project

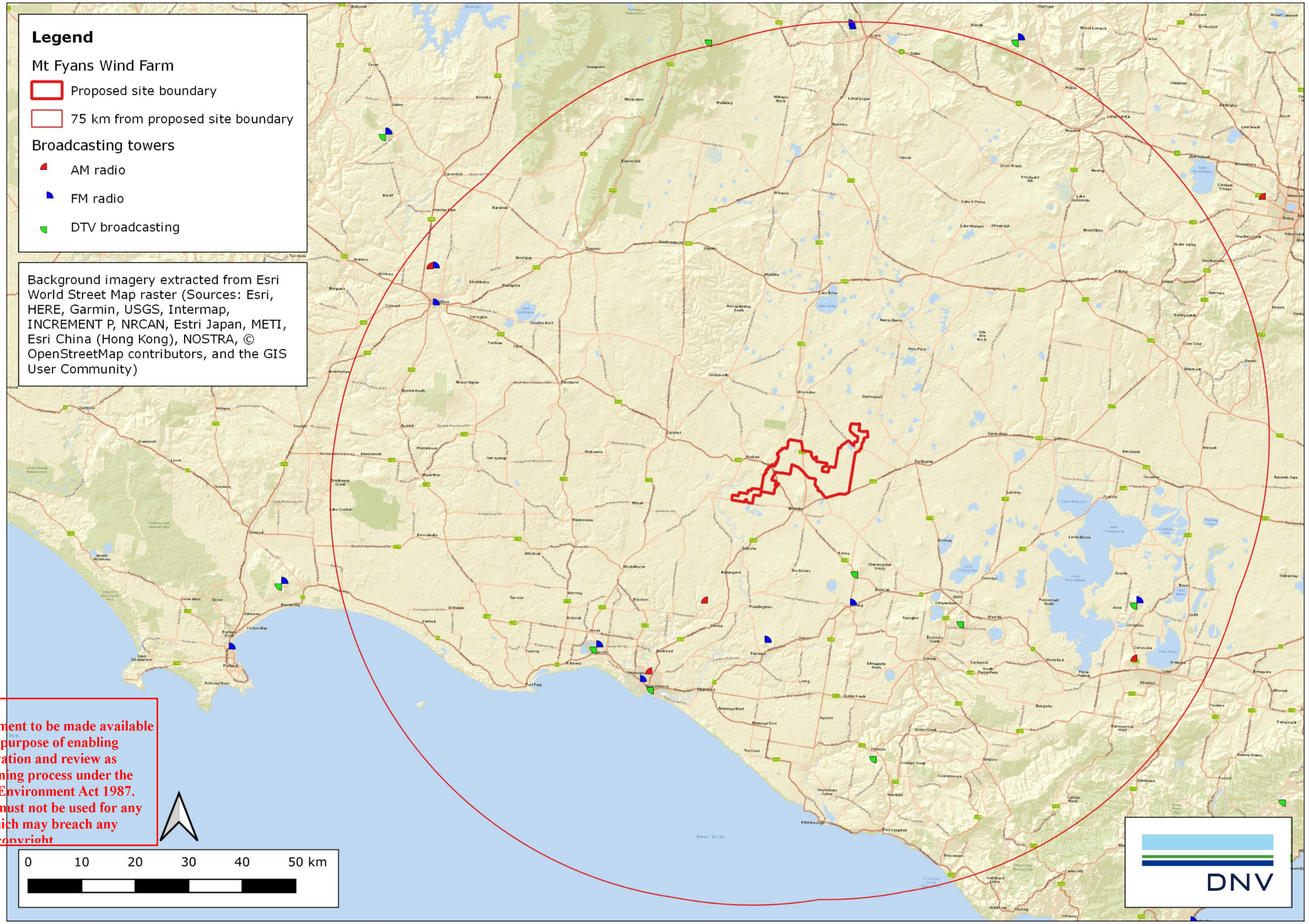

Figure 17 Location of broadcast transmitters in the vicinity of the proposed Project

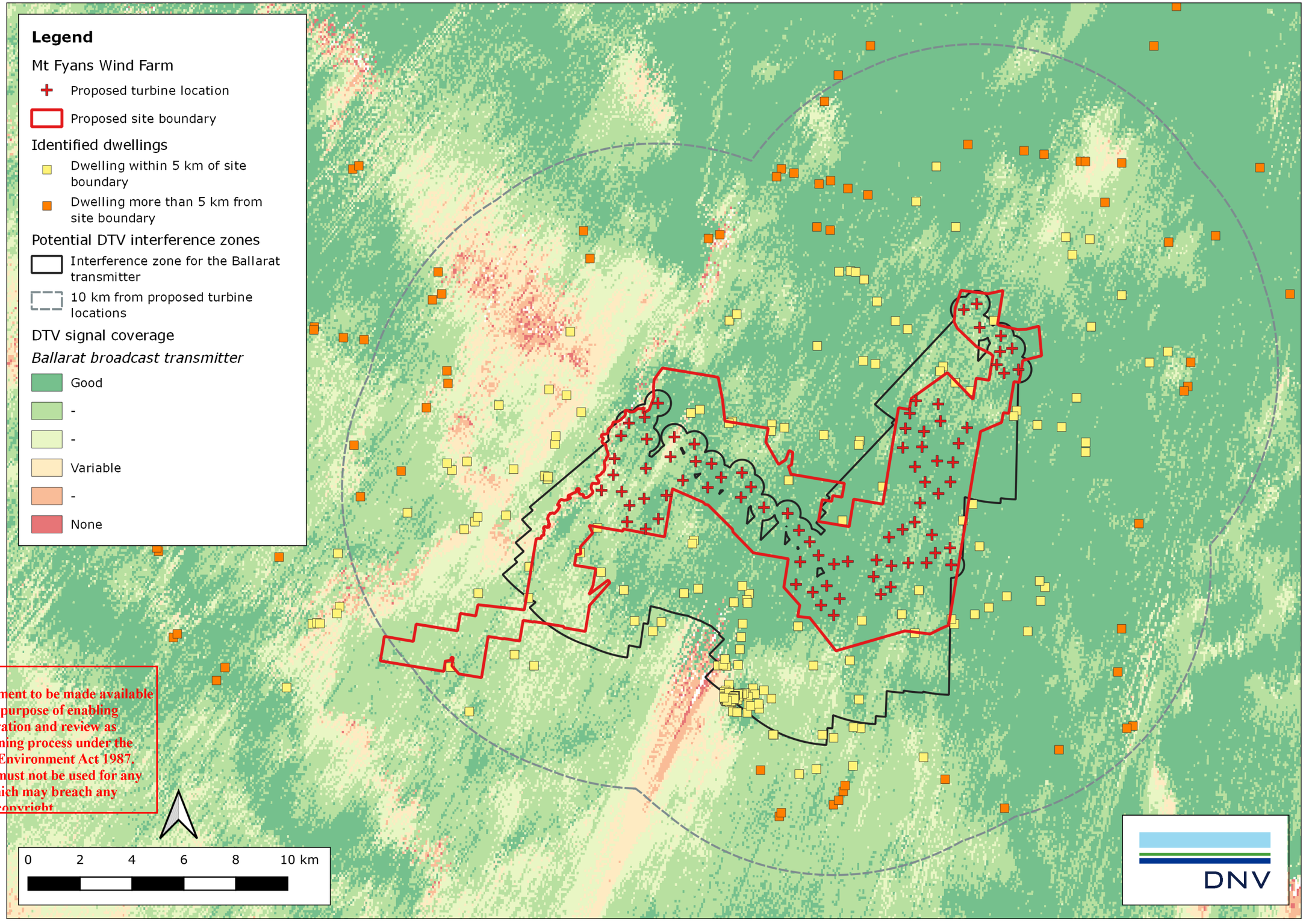

Figure 18 Potential television EMI zones for the Ballarat broadcast transmitter from the proposed Project

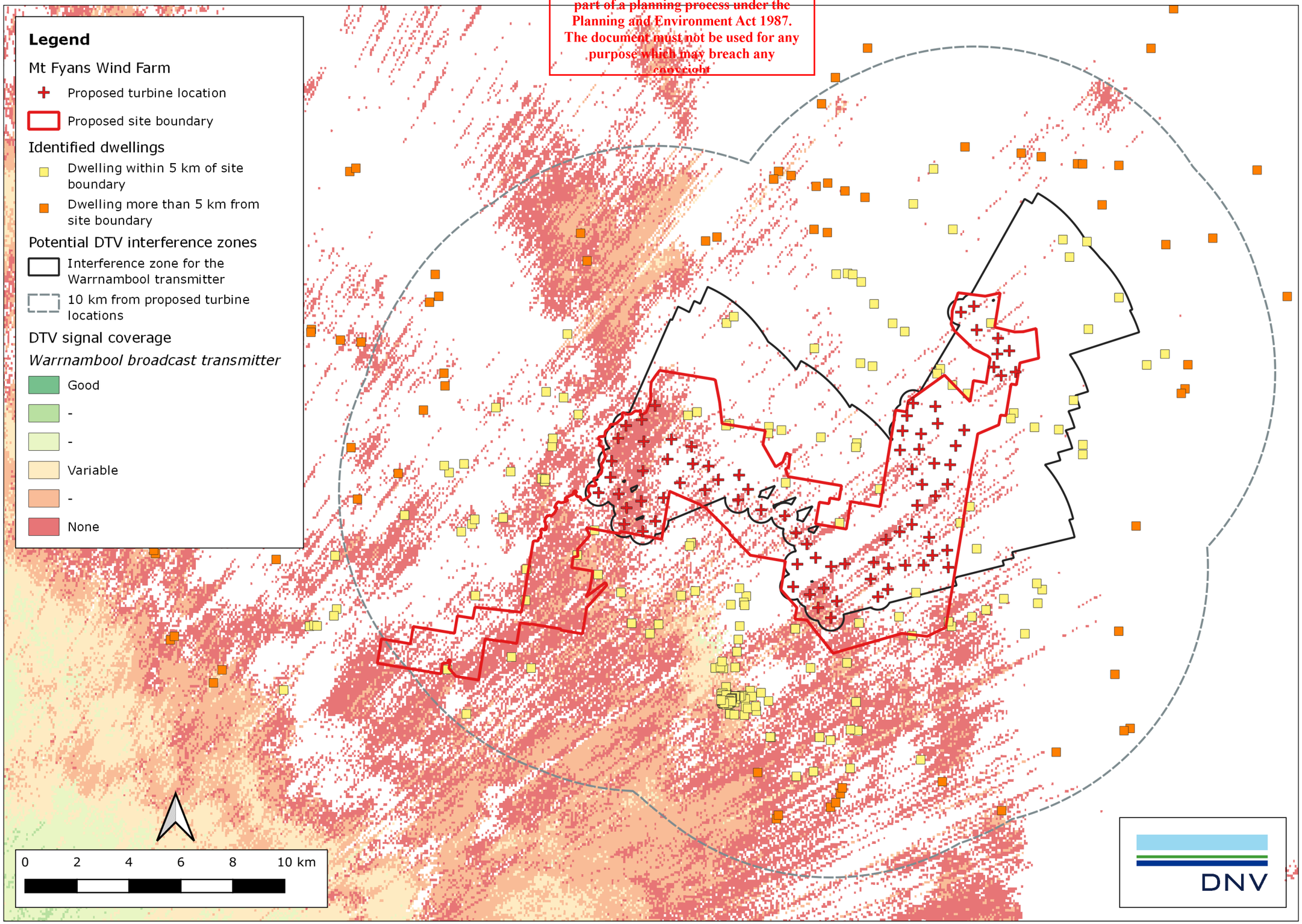

Figure 19 Potential television EMI zones for the Warrnambool broadcast transmitter from the proposed Project

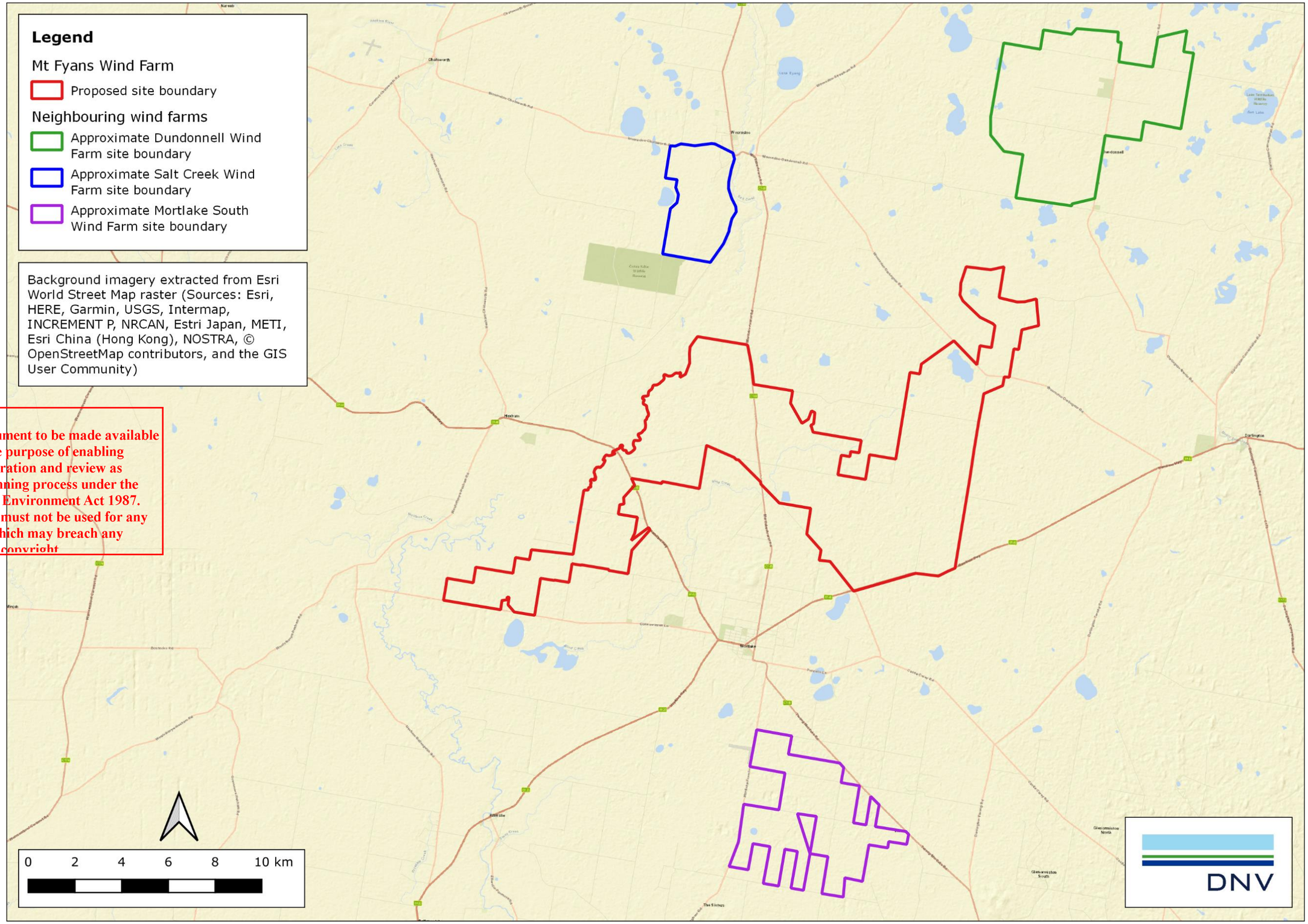

Figure 20 Location of nearby wind farm developments in relation to the proposed Project

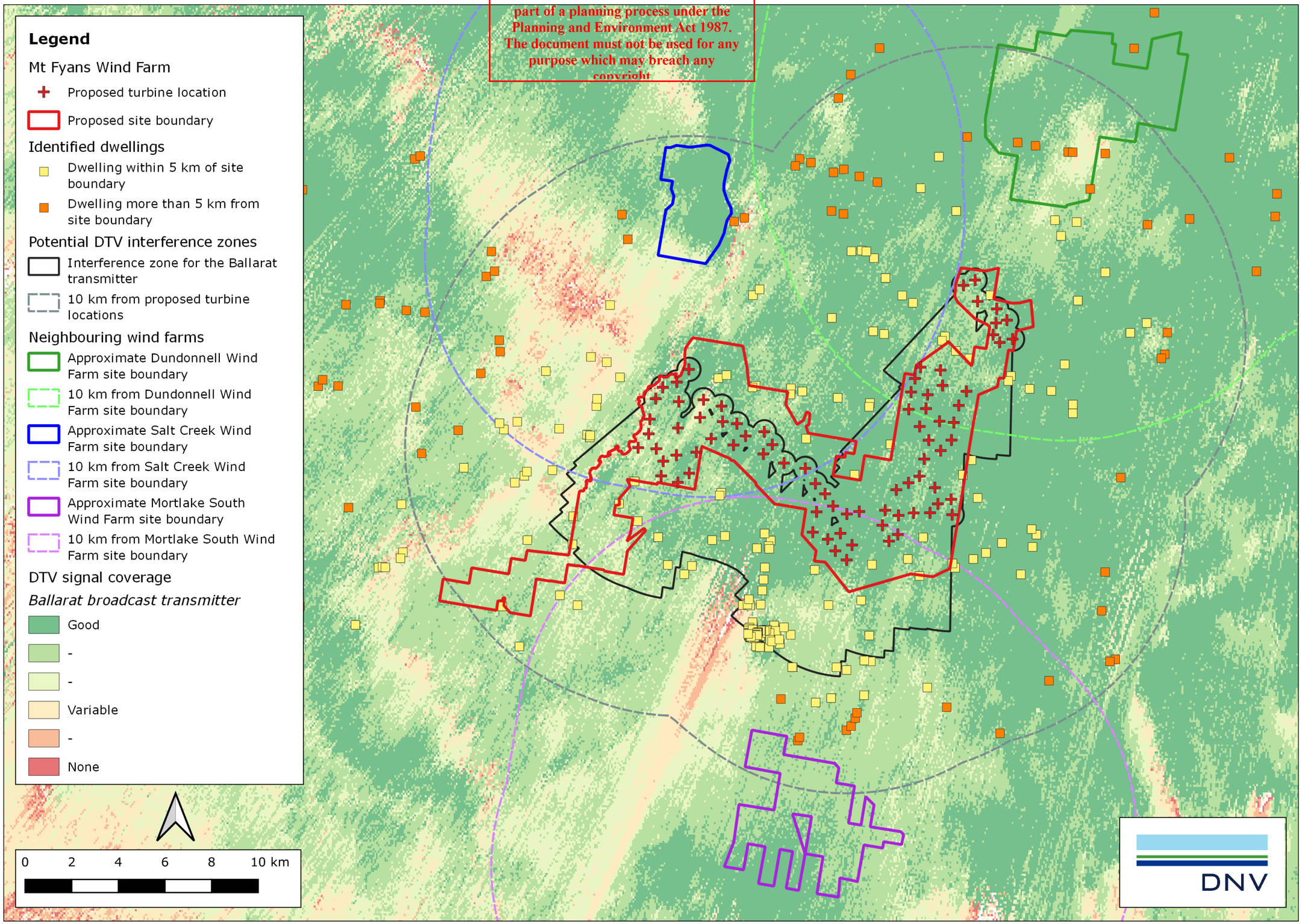

Figure 21 Location of nearby wind farm developments, showing locations of nearby dwellings and potential television EMI zones for the Ballarat broadcast transmitter from the proposed Project

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.