GL Garrad Hassan

ASSESSMENT OF ELECTROMAGNETIC INTERFERENCE ISSUES FOR THE COOPERS GAP WIND FARM

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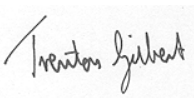

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CONTENTS

EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd (GH) has been commissioned by AECOM Australia Pty Ltd (AECOM) to independently assess the electromagnetic interference issues associated with the proposed Coopers Gap wind farm. This report summarises the results of an EMI assessment conducted at the site. Up to date information relating to nearby telecommunication licences has been obtained from the Australian Communications and Media Authority (ACMA) [1].

This document assesses the potential risks regarding interference with radiocommunications services operating in the vicinity of the wind farm, and makes the findings and recommendations discussed below.

Radiocommunications is used as a broad term in this report to encompass all services that rely on electromagnetic or radio waves to transfer information. There are many methods of transmitting information via radiocommunication. Radiocommunications services operating in the vicinity of the proposed Coopers Gap wind farm, and their susceptibility to interference from the wind farm, are discussed in this document.

If not properly designed, wind farms have the potential to cause interference to analogue television broadcast signals and microwave signals. Analogue broadcast signals are still commonly used to transmit domestic television, while microwave signals 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.

For analogue television broadcast signals (point-to-area) large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. A clearance of at least 1 km is recommended. No analogue television broadcast tower has been identified within 1 km of the Coopers Gap wind farm site boundary, with the nearest broadcast tower being at least 18 km from the site, at Mt Mowbullan, Darling Downs. It is still possible however for interference to analogue television to occur at residences in and around a wind farm site, and the potential for this interference has been assessed here. However by the second half of 2011 analogue television is scheduled to be replaced by digital television in the Coopers Gap area, which is less susceptible to interference from wind turbines. Digital television signals from Darling Downs also services the area around the Coopers Gap wind farm.

Wind turbines can potentially cause interference to point-to-point microwave signals through diffraction, scattering or near-field effects. However it is possible to design around this issue, as the path and interference zone of point-to-point signals is generally well known. The nearest transmission tower with fixed licences of point-to-point type is at least 1.3 km from the proposed Coopers Gap site boundary. It has been found that no fixed point-to-point links cross the site and therefore, interference to the identified links from the wind farm is unlikely. The closest communication tower is located at 1.8 km from the proposed site and is operated by Telstra Corporation. As per the EPHC guidelines, the operators of all communication towers within 2 km of the site should consulted to assess the likely impact of the wind farm on their services. Telstra Corporation Ltd has been contacted to determine the likely impact of Coopers Gap wind farm on their services, and provided a response stating that they do not foresee any impact to their services from the proposed development.

Wind turbines can also cause interference with point-to-multipoint microwave signals; however it is not possible to identify the locations of paths for point-to-multipoint links as only the base-station is licensed and contained in the ACMA Radiocommunications Database [1]. The closest point-to-multipoint base station has been identified at approximately 17.5 km east-southeast of the Coopers Gap wind farm boundary. A consultation process with operators of telecommunication assets located within 75 km of the wind farm has been conducted, seeking feedback in regards to the potential impact of Coopers Gap wind farm on their operating services. Responses have been obtained from the majority of the license owners, and to date none have indicated that their services are likely to be impacted.

In general, Very High Frequency (VHF) and Ultra High Frequency (UHF) band radio signals, and digital voice based technologies such as cellular phones (often called Global System for Mobile Communications, or GSM phones), and third generation phones (often called 3G or Next G mobiles) are essentially unaffected by wind farm development. This includes land mobile repeaters, radio, the audio component of analogue television, and mobile phones.

Emergency services operating radiocommunications assets in the vicinity of the proposed Coopers Gap wind farm have been identified and contacted to determine if their services are likely to be affected by the wind farm. To date, none have indicated that their services are likely to be impacted, however the Queensland Police Service raised a question regarding impact to UHF mobile communications. Interference to these services is deemed to be unlikely, and is addressed within this report.

It is possible that wind turbines could cause interference to satellite television or internet if a wind turbine intercepts the signal between a satellite and ground based receiver. For the Coopers Gap wind farm, interference is not likely to occur to satellite television or internet, and this has been confirmed through consultation with a number of organisations providing satellite based internet services in the vicinity of the wind farm. One operator of a satellite based internet service specified that their customers should be located at least 1 km from a wind turbine, however from a review of turbines, house and satellite locations, GH believes this estimate to be overly conservative.

Broadcast radio signals do not generally suffer from interference from wind turbines. AM radio signals are very unlikely to be affected by wind farms. FM radio signals may experience interference in the form of low level hiss or distortion, but generally only in close proximity to the wind turbines. Any reception difficulties are likely to be easily rectified through the installation of a high quality antenna.

GH has not specifically considered impact to aircraft navigation systems, as it is understood that impact to these services will be considered as part of the aviation impact study being conducted by Hart Aviation. It is also noted that consultation with organisations responsible for aircraft navigation in Australia is within the scope of the aviation impact study.

Wind turbines have the potential to interfere with meteorological and aviation radars. Reflection off turbine blades may give false readings or create a radar “shadow” behind the turbines Due to the distance from meteorological radar assets, and the high probability that the turbines will lie below the

radar line-of-sight, it is unlikely that the proposed Coopers Gap wind farm will cause any significant interference to meteorological radar. As per the recommendations of EPHC guidelines, the Bureau of Meteorology (BoM) has been contacted to determine the likely impact of the wind farm on their radar operations. At present, no formal response has been received from the BoM.

A review of trigonometrical stations in proximity to the wind farm has been conducted and it is unlikely that these stations will be subject to intereference from the wind farm. Geoscience Australia (GA) and the Queensland Department of Environment and Resource Management (DERM) have been contacted to provide feedback on the potential for interference from the Coopers Gap wind farm. Both GA and DERM have indicated that they do not forsee any significant impacts to trigonometrical stations in the vicinity of the wind farm.

A company that develops systems for livestock tracking based on RFID technology operates approximately 2 km from the proposed Coopers Gap wind farm. It is not expected that RFID systems will experience interference at this distance from the wind farm.

At present, there are no wind farms currently being developed in the vicinity of the proposed Coopers Gap wind farm. The closest wind farm is the Crows Nest wind farm, approximately 80 km away from Coopers Gap. Due to the significant distance between the two proposed sites, an assessment of the cumulative EMI impacts from the two projects was deemed unnecessary.

Conclusions and recommendations from this analysis have been made in Section 5 of this report.

1 INTRODUCTION

AGL is developing the Coopers Gap Wind Farm in Queensland, Australia. AECOM is undertaking the environmental planning and assessment on behalf of AGL and has instructed Garrad Hassan Pacific Pty Ltd (GH) to carry out an independent analysis of the potential electromagnetic interference issues associated with the proposed wind farm. The results of the work are reported here. This document has been prepared pursuant to the GH proposal P1034/PP/01 Issue B dated 02 Dec 2010, and is subject to the terms and conditions contained therein.

In order to conduct the EMI assessment, up to date information regarding radiocommunication licences in the vicinity of the wind farm have been obtained from the Australian Communication and Media Authority (ACMA) database [1].

This assessment investigates the impact of the proposed wind farm on:

- Fixed point-to-point links,
- Fixed point-to-multipoint links,
- Radiocommunications assets belonging to emergency services,
- Aircraft navigation systems,
- Aviation and meteorological radar,
- Trigonometrical stations,
- RFID tags,
- Citizens Band (CB) radio and mobile phones,
- Wireless internet
- Broadcast radio,
- Satellite television and internet,
- Broadcast television.

The prospective turbine considered in this analysis is detailed in Table 1.

For services where it has not been possible to assess potential impacts from the wind farm, GH has undertaken a process of consultation with organisations operating services that may be impacted by the wind farm. This has involved dissemination of basic information on the wind farm, and a request for the organisation to respond regarding whether they forsee any potential impacts. The results of this consultation process are also reported here.

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The Project

The Coopers Gap Wind Farm Project is being developed by AGL Energy Ltd (AGL) and AECOM is undertaking the environmental planning and assessment on behalf of AGL in order to obtain planning approval through the Community Infrastructure Designation (CID) process under the Queensland Sustainable Planning Act 2009.

2.2 General site description

The Coopers Gap site is located approximately 175 km northwest of Brisbane, 45 km southwest of Kingaroy and 55 km north-northeast of Darby in the Coorang North region of inland Queensland, shown in Figure 1.

The site consists of predominantly cleared land used for farming, scattered vegetation and small areas of dense forestry. The Bunya Mountains National Park is located at approximately 8 km southeast of the proposed Coopers Gap site. Topography of the site appears to be characterised by moderate slopes and rolling hills that vary in elevation between approximately 535 m and 840 m with more rugged terrain to the south. GH has not visited the site.

2.3 Proposed Wind Farm layout

AECOM has supplied the layout of the wind farm, which is composed of 114 turbines with a maximum possible hub height of up to 100 m and rotor diameter of up to 120 m. These dimensions have been used for the EMI assessment.

A list of co-ordinates of proposed turbine locations has been provided by AECOM [2], with the grid coordinates given in MGA Zone 56 (GDA94 datum). Figure 2 shows the proposed turbine layout at the proposed Coopers Gap wind farm.

2.4 House locations

A list of the co-ordinates of dwellings in the vicinity of the wind farm has been provided by AECOM [2], with the grid co-ordinates given in MGA Zone 56 (GDA94 datum).

3 PLANNING GUIDELINES

In QLD there are no specific guidelines for the assessment of the electromagnetic impact of wind turbines.

The Environmental Protection and Heritage Council (EPHC), in conjunction with Local Governments and the Planning Ministers Council released a draft version of the National guidelines for wind farm development in July 2010 [4]. The draft guidelines cover a range of issues spanning the different stages of wind farm development.

The main purpose of the draft guidelines is to provide detailed methodologies to assess issues related to wind farms including community consultations, shadow flicker, noise monitoring, electromagnetic interference, impacts on landscapes, and flora and fauna. Other issues that are covered to a lesser extent in the draft guidelines include aircraft safety, blade glint, risk of fire and indigenous heritage.

In relation to EMI, the draft guidelines provide advice and methodologies to identify likely affected parties, assess the EMI impacts, consult with affected parties and develop mitigation steps to address the likely EMI impacts. As the guidelines remain in draft form only, they are likely to be subject to change.

This assessment has been undertaken in accordance to the draft EPHC guidelines released in July 2010.

4 METHODOLOGY, ANALYSIS AND RESULTS

If not properly designed, wind farms have the potential to interfere with radiocommunications services. Two services that are most likely to be affected include analogue television broadcast signals and microwave signals. Analogue broadcast signals are still commonly used to transmit domestic television, while microwave 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.

A part of the methodology for assessing potential radiocommunications interference involves locating all of the telecommunication towers within 75 km of the proposed wind farm, and then assessing the telecommunication licences attached to these towers.

Other services operating within the vicinity of the proposed wind farm have also been identified, and the potential for interference to those services discussed.

4.1 Telecommunication towers

An image of the ACMA database dated December 2010 was used for this assessment [1]. From the database, there are 437 telecommunication towers within a nominal 75 km of the wind farm. This is an appropriate distance to ensure that all transmission vectors that are likely to pass in close proximity to the site are captured in the licence survey. The locations of these telecommunication towers are shown in Figure 3 relative to the proposed wind farm.

4.2 Fixed licences of point-to-point (microwave) type

4.2.1 Diffraction

Wind turbines can potentially cause interference, or diffraction, of point-to-point microwave signals and in some cases, point-to-point UHF signals. It is possible to design around this issue as the path and interference zone of these signals are well known. The frequency of common microwave signals varies from approximately 1 GHz to 30 GHz. For this analysis GH has examined signals within a wider and more conservative frequency range of 0 to 50 GHz. 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 criteria used for avoiding diffraction effects of point-to-point signals are normally based on an exclusion zone of circular cross-section around the direct path from the transmitter to the receiver (often called boresight) [4,5,6]. This exclusion zone is defined in terms of Fresnel zones. The n^{th} Fresnel zone is comprised of all points for which, if the radio 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.

To avoid interference to point-to-point signals, wind turbines, including the blades, should be kept outside the second Fresnel zone. The radius of the 2^{nd} Fresnel zone varies along the length of the signal, and is given by:

$$R_{F2} = \sqrt{\frac{2\lambda d_1 d_2}{D}}$$

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, i.e. $d_1+d_2 = D$

The registered communications licences for each tower according to the ACMA database were analysed to determine the transmission paths of licence links that may experience interference from wind turbines. Each individual link is given an "Assignment ID" by the ACMA so it can be readily identified. The paths resulting from the towers analysed are shown in Figure 4. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some Country Fire Authority (CFA) towers.

A review of the ACMA database shows that there is no link passing over the proposed wind farm site with the closest tower at approximately 1 km south of the site. Details of the point-to-point link coming from this tower are presented in Table 3.

4.2.2 Near-field effects and scattering

The recently released draft National Wind Farm Development Guidelines [4] mention the possibility of interference to point-to-point microwave links from two additional mechanisms, near field effects and scattering.

According to the draft guidelines, near-field effects are usually limited to approximately 720 m from a communication tower and it is recommended that consultation is required if a turbine is within 1 km of a telecommunication site. The Draft National Guidelines also state that scattering is best avoided by placing wind turbines more than 2 km from a communication tower.

The near field distance of an antenna can be determined as follows:

$$D_{nf} = N_{nf}\eta D_a^2/\lambda$$

Where: N_{nf} is a constant, typically 1 or 2, setting the degree of conservatism;
η is the efficiency of the antenna (in the range of 0.0 to 1.0);
D_a is the diameter of antenna physical aperture;
λ is the wavelength.

The communications tower closest to any proposed wind turbines is the "Telstra Exchange Terminal" at Cooranga North, which is located approximately 1.8 km from the nearest turbine. The near field zone for the point-to-point link operating from this tower was calculated and it was determined that the the nearest turbine is not located within the near-field zone. Additionally, as the link is directed away from the wind farm, it is unlikely that interference will occur due to scattering. However, as per the recommendation in the Draft National Guidelines regarding scattering, Telstra has been contacted to provide feedback on the potential impact of the Coopers Gap wind farm on their services. Telstra have indicated that they do not forsee any impact to their services, but have noted that they require "protection of their underground telecommunications infrastructure that may be impacted by activities on the site".

4.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of 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 licence register. A point-to-multipoint licence

allows communication between one or more static sites and multiple points or between the points. The point-to-multipoint type is usually licensed for a defined operational area.

Administratively, the ACMA database details the location of the static station for a fixed licence of point-to-multipoint type. Hence, the location of the transmission vectors is not readily identifiable. A review of fixed licences of point-to-multipoint types was undertaken and 61 Assignment ID's were identified within approximately 75 km of the proposed turbines. These licences are shown in Figure 5. The details of the licence holders as per the ACMA database are provided in Table 4.

The nearest point-to-multipoint station is located at Mt Mowbullan, approximately 17.5 km to the southeast of the site (Assignment ID 137603-1164). This station is owned by the Bureau of Meteorology (BoM).

A consultation process to seek feedback from the operators of point-to-multipoint stations in the vicnity of the proposed Coopers Gap wind farm has been carried out, to determine if there is the potential for interference to their services. This consultation process has involved an initial request for feedback, and follow-up correspondence if no response was received. For the majority of the licenses considered, either the operator has responded to indicate that they do not forsee any interference to their services from the wind farm, or GH has deemed that the station is sufficiently distant from the wind farm that interference is unlikely. Table 5 shows a summary of the responses received.

4.4 Other licence types

A review of the ACMA database for other licences was conducted. The licences identified can generally be described as base to mobile station style communications, including radio broadcasting, commercial and private mobile telephony. These licences are shown in Table 6. 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. Should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

It is noted that some of the licences are of type aeronautical or radiodetermination, both of which are often used for aircraft navigation. These licences are mainly operated by the Department of Defence and Airservices Australia. As discussed further in section 4.6, it is noted that these organisations will be consulted by Hart Aviation as part of their independent study.

4.5 Emergency Services

A review of the ACMA database was conducted to identify emergency services with licences for radiocommunications assets operating in the vicinity of the wind farm. Five groups were identified and are listed below:

- Queensland Police Service,
- Department of Community Safety (Queensland Ambulance Service),
- Department of Community Safety (Queensland Fire and Rescue Service),
- St John Ambulance Australia, and
- Moore Linville Bush Fire Brigade (Department of Community Safety).

The groups identified are listed in Table 7 along with their contact details. These organisations have been contacted by GH to assess the likely impact of the proposed Coopers Gap Wind Farm on their services. All except the Moore Linville Bush Fire Brigade responded, however the Department of Community Safety indicated that they were able to respond on behalf of the Moore Linville Bush Fire Brigade.

St John Ambulance Australia responded indicating that they had "no concerns in relation to electromagnetic interference resulting from the proposed wind farm". The Department of Community Safety indicated that they had concerns regarding impact to mid-band VHF mobile communications if the wind turbines were to be in close proximity to their repeater stations, but concluded that "[f]ollowng a review of the wind farm location, DCS considers that the proposed placement of the wind turbines are unlikely to cause any EMI issues to nearby DCS radio sites". The Queensland Police Service responded that "it doesn't appear that the wind farm project will interfere with our fixed linking infrastructure", but raised concerns regarding impacts to UHF mobile communications. Impacts to these services are deemed unlikely, and are considered in sections 4.4 and 4.11.

4.6 Aircraft Navigation Systems

AECOM has commissioned Hart Aviation to conduct an independent study of the impact of the wind farm on aviation [3]. As a result of this assessment, it has been concluded that the proposed wind farm will cause minimal impact to aviation operations. It is noted that any impacts to aircraft navigation systems will be covered as part of the consultation process associated with this assessment.

It is also noted that as part of the consultation process, AirServices Australia, the Civil Aviation Safety Authority (CASA), the Department of Defence and Aerial Agricultural Association are to be contacted by Hart Aviation regarding any impact to aircraft navigation systems from the Coopers Gap Wind Farm.

4.7 Aviation radar

Primary surveillance radar (PSR) is used for air traffic control and requires line-of-sight to the target object for successful detection. PSR transmits a pulse of energy that is reflected back to the radar receiver by the target object. Some combinations of turbine orientation and blade angle can cause significant Doppler returns to the illuminating radar, thereby creating false targets on the radar screen. The sporadic nature of these false positives makes them difficult to filter with current radar software. Further, turbines may create a radar obstruction or "shadow" where aircraft are not detected. In Australia, PSR installations are located at major airports and typically have a range of approximately 50 nautical miles (93 km).

Secondary surveillance radar (SSR) is less vulnerable to interference from wind turbines as SSR does not rely on reflections from objects for detection. Aircraft are required to carry a transponder, which replies to radar interrogations. However, SSR may still be affected by a wind farm as an aircraft transponder may respond to a reflected signal and give a false position reading, or SSR may be obstructed by a wind farm similar to PSR. SSR installations are also typically located at major airports, and have a range of approximately 250 nautical miles (463 km) when detecting aircraft at high altitude. However, at or near ground level, the range of SSR is expected to be less.

The draft national wind farm development guidelines released by the EPHC recommend that radar operators be notified of the development of wind farms within 250 nautical miles (463 km) of aviation radar operators [4]. Radar installations are typically located at major airports. The proposed Coopers Gap wind farm is located approximately 176 km from Brisbane International Airport, 800 km from the Sydney International Airport and 970 km from Canberra airport.

GH has been advised that that consultation with the Department of Defence, CASA and AirServices Australia will be carried out by Hart Aviation to determine the likely impact of the proposed wind farm on radar services.

4.8 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather stations across Australia and uses radar instruments for measuring wind speeds in the upper atmosphere (known as wind finding radar), and determining rain and storm activity (known as weather watch radar).

The "wind finding" radar uses radar echoes from a target to determine the wind speeds and direction. The radar target is attached to a balloon and tracked by the ground radar. The "weather watch" radar, or "weather surveillance" radar, consists of a rotating antenna located on a building, and kept free from any physical obstruction. The antenna is used to direct a thin beam of radio energy upward into the atmosphere which is then reflected back by a cloud mass. The location of the cloud is then determined by the direction and travel time of the reflected beam.

Wind profile measurements are used to ensure the safe and economical operation of aircraft and provide an important source of data for the Bureau's general weather forecasting system. "Weather watch" radars monitor weather situations and are able to indicate the possibility of severe storms out to a distance of 250 km or more. Hence, whilst 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.

Wind farms located at distances greater than 5 km from a BoM field station are unlikely to affect wind finding operations [4]. However, wind farms can impact upon weather watch radar when located within several hundred kilometres of a radar station. Generally, the optimal coverage area for "weather watch" radar extends approximately 200 km from the radar installation at a height of approximately 3000 m [7, 8], and approximately 100 km at a height of 1000 m [4]. Due to the curvature of the earth, and intervening terrain, the range at or near ground level is generally less.

According to the draft set of guidelines for wind farm developments issued by the Environment Protection and Heritage Council (EPHC), consultations with operators of weather stations within 250 nautical miles of the proposed wind farm should be undertaken [4]. It has been identified that the BoM operates six weather stations within that range with the closest station "Gympie (Mt Kanigan)" located 136 km northeast of the proposed Coopers Gap wind farm site [7]. The details of each station can be found in Table 9.

It is not expected that the wind farm will cause interference with BoM radar installations, as given the distance between the site and radar installations, and the nature of the intervening terrain, it is likely that radar signals will be intercepted before they are able to be influenced by the wind farm. However, the BoM has been contacted to provide feedback on the potential impacts of Coopers Gap wind farm on their meteorological radar operations. This consultation process has involved an initial request for feedback, and follow-up correspondence if no response was received. The BoM have not yet provided a formal response.

4.9 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes. Some trig points may host surveying equipment such as 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 to 5 km while microwave systems can measure distances up to 150 km. However, such systems are not limited by the line of sight or affected by visibility [9].

The Australian Fiducial Network (AFN) is fundamental to the whole Geodetic network of Australia [10]. The AFN consists of eight permanent stations equipped with EDM devices and GPS receivers and transmit data to GeoScience Australia via phone lines, internet and/or satellite [11,12]. A review of the AFN has been undertaken by GH and the closest station is found near Townsville, approximately 925 km away from the proposed wind farm. Due to the significant distance of the station from the wind farm, it is unlikely that the station would be impacted by the wind farm.

GH has also undertaken a review of the Primary Geodetic Network of Australia [12] and it has been observed that the proposed Coopers Gap wind farm is located in outside a region of second-order triangulation, in a region of high-density trilateration. 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 will then be used for second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

According to the database from Geoscience Australia [13], there are 49 trig points within 75 km of the Coopers Gap site boundary. The details of all 49 trig points are provided in Table 8 and illustrated in Figure 7.

Although it is unlikely that the trig points in close proximity to the wind farm host EDM devices or other equipment that is likely to be subject to electromagnetic interference Geoscience Australia and the Queensland Department of Environment and Resource Management have been contacted regarding the potential for interference from the Coopers Gap wind farm. Both these organisations responded indicating that they did not foresee any impacts to trigonometrical stations in the vicinity of the wind farm.

4.10 RFID

GH has been advised of a company (Aleis International) operating in the vicinity of the proposed Coopers Gap wind farm, who develop and market a product for tagging and tracking of livestock [14]. The product relies on radio-frequency identification (RFID) technology, which permits an exchange of information between a reader (which usually consists of a fixed antenna) and a small tag which can be easily embedded in a small card or device, or in this case implanted in an animal. The tag can be used to uniquely identify an animal, as it passes a reader.

Aleis have indicated that their system operates at a frequency of 134.2 kHz and the devices typically have a range of approximately 2 m. The system utilises passive RFID tags, meaning the tags do not have their own source of power, but rely on an electromagnetic field generated by the antenna in the reader, in order to permit a signal to be transmitted from the tag to the reader.

Aleis have advised that strong electromagnetic fields can cause problems for their system. Discussions with Aleis have indicated that they have encountered problems when operating in close proximity to large electric motors, such as those used in feed lots and abattoirs.

The location at which Aleis conducts development and testing of its systems is understood to be in close proximity to dwelling CG (as shown in Table 11 and Figure 14) which is approximately 2 km from the nearest turbine on the Coopers Gap wind farm.

There are two mechanisms by which wind turbines can hypothetically cause interference with an electromagnetic signal. The first is by electromagnetic radiation from the turbine, and the second is by the physical structure of the turbine itself.

The first of these mechanisms is unlikely to cause interference to RFID signals, or any electromagnetic signal, as the level of electromagnetic radiation emitted from a modern wind turbine is very low, and in most cases is undetectable from background radiation levels beyond approximately 100 m from the base of a wind turbine [15,16]. There is therefore a small possibility that RFID signals may experience interference when operating in very close proximity to the turbine (within approximately 100 m), but it is extremely unlikely that Aleis will experience such interference given that their testing location is approximately 2 km from the nearest wind turbine.

The turbines physical structure is also unlikely to cause interference to RFID signals, as the signal would need to be transmitted through or in close proximity to a wind turbine for it to be influenced by the turbine. Given that the range of the RFID signals is very short, and the Aleis development and testing location is approximately 2 km from a wind turbine, this is extremely unlikely.

Aleis have also indicated that they have successfully operated the system at a distance of approximately 750 m to 1 km from the Portland wind farm, which also suggests that interference from wind turbines is unlikely to be a problem for their systems.

4.11 Citizens 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. 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.

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

The 27 MHz CB radio service was legalised in Australia in the 1970s as a temporary move to switch to UHF CB over the following five years. 27 MHz CB transmit signals in either AM 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 27 MHz CB radio service has declined and has been replaced by UHF CB radio service.

UHF CB radio service is unique in Australia and uses the FM transmission mode. It provides clear communication over 5-20 km and is less susceptible to power line noise. However, UHF CB radio service requires "line-of-sight" and is easily hindered by hilly terrain and forested areas. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. Repeater stations are 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.

Since users of CB radio service 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. The impact of the Coopers Gap wind farm on CB radio service is expected to be minimal. In the event of interference from the wind turbines, simple steps such as moving a short distance until the signal strength improves would help to mitigate the impact.

4.12 Mobile phones

Mobile phone networks operate at frequencies of either between 800 and 900 MHz, or between 1800 and 2100 MHz. At such frequencies, signals are likely to be affected by physical obstructions such as buildings and wind turbines. However, those 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, wind turbines could cause some interference to the signal.

Mobile phone network coverage maps have been obtained for Telstra and Optus [17, 18]. Figure 8 and Figure 9 show the Telstra and Optus network coverage for the Coopers Gap area. The overall site area has little mobile GSM coverage for Telstra and in some locations, only mobile satellite coverage is available. The Optus mobile network coverage in the area is also marginal with most locations requiring an external antenna. For those areas, the signal might be susceptible to interference if a wind turbine intercepts the signal between a mobile phone and the tower. Telstra NextG network coverage is generally marginal in the area. Figure 10 shows the NextG network coverage for the Coopers Gap wind farm development area.

In cases of marginal network coverage, simple mitigation procedures such as moving a short distance to a new location until the signal strength improves or installing an external antenna may improve the signal quality.

4.13 Wireless Internet

A high level review of wireless internet service providers operating in the Cooranga region has been undertaken by GH and it has been observed that internet access in the area surrounding the wind farm is likely to be provided via the 3G mobile phone network [19].

Please refer to Section 4.12 of this report for additional comments on the likely impact of Coopers Gap Wind Farm on the mobile phone network.

4.14 Satellite Television and Internet

In some rural or remote areas, television and internet access can be provided through satellite only. Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. The satellite transmits television signals to the user's antenna at two frequency bands; the C band at between 4 GHz and 8 GHz, and the K_u band at 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 while signals in the K_u band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. GH understands that there are currently 10 satellites that transmit television signals that can be received in Australia [20].

In case of satellite internet, the user's computer is connected to a satellite modem which is in turn linked to a satellite dish/antenna mounted on the building roof. When the user browses a webpage, a request is sent to the operation centre of the satellite internet provider via the satellite antenna. The webpage information is then sent back to the user's computer via the same path as shown in the following figure.

2 way connection to the Internet via Satellite [21]

According to the Australian ISP directory [19], there are at least eight satellite internet providers operating in the vicinity of Coopers Gap wind farm, as shown in Table 10. These satellite internet providers have been contacted to determine if their services are likely to be impacted by the proposed Coopers Gap wind farm. All but three of the providers have responded, and to date none have indicated that they forsee an impact to their services. One of the providers (Skymesh) recommended that as a "precautionary measure, remote sites using these services should be located more than 1km away from Coopers Gap site", however GH deems that this recommended buffer is overly conservative, for the following reason.

Skymesh uses the IPStar service which relies on the Thaicom-4 satellite. From the Coopers Gap site this satellite has an elevation of approximately 42.9° [22]. A review of the line of sight between the Thaicom-4 satellite and houses identified in the region of Coopers Gap wind farm has been undertaken. It has been found that no turbines are likely to intercept the line of sight between this satellite and the houses considered.

A number of residents in the vicinity of the Coopers Gap wind farm may have access to satellite television. The main satellite for Pay TV and free-to-air TV in Australia is the Optus C1 satellite. From the Coopers Gap wind farm site, the Optus C1 satellite has an elevation of approximately 58.4° [22]. It is unlikely that the proposed Coopers Gap wind farm will impact upon the line of sight from this satellite to any dwelling.

A review of the line of sight between the Optus C1 satellite and houses identified in the region of the Coopers Gap wind farm has been undertaken. It has been found that no turbines are likely to intercept the line of sight between this satellite and the houses considered. It is noted that some houses are located in valleys where the terrain is likely to intercept the line of sight to the Optus C1 satellite.

There are a number of other satellites broadcasting TV signals that can be received in eastern Australia, however, it is considered to be unlikely that these satellites will be utilised by residents in the vicinity of the wind farm.

4.15 Radio broadcasting

GH has assumed that broadcast radio includes both Amplitude Modulation (AM) and Frequency Modulation (FM) radio used to broadcast audio signals. In Australia, AM radio operates in the Medium Wave (MW) band at frequencies of between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency band (VHF) at between 87.5 MHz and 108 MHz. The locations of the AM and FM broadcast transmitters in the vicinity of the proposed Coopers Gap wind farm are shown in Figure 6.

4.15.1 AM Radio

AM radio waves are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also 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 relatively small physical obstructions on the surface of the earth (such as wind turbine), however they do not propagate easily through some dense building materials such as brick, concrete and aluminium.

The distance over which AM radio waves 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.

As AM radio signals are able to propagate around obstructions such as turbines, it is expected that a wind farm would not cause significant interference for a receiver. Additionally, due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [23]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna and/or amplifier.

4.15.2 FM Radio

FM radio waves are more suited to short range broadcasting. Unlike lower frequency signals, they are not reflected or refracted off the ionosphere. The waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon, however they may be blocked by significant terrain features. FM radio stations therefore tend to have only local coverage and this 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. Reflection or scattering of radio waves by physical structures can reduce 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 cause hissing or distortion to be heard by a listener. However, generally any interference will only be likely in the immediate vicinity of the wind turbine [23], and should be easily rectified through the installation of a high quality antenna and/or amplifier.

4.15.3 Digital Radio

Digital radio services have been introduced in metropolitan licence areas from 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 [24]. According to the digital radio coverage map available on the ABC website [25], digital radio is not yet available in the Coorang region.

4.16 Television Broadcasting

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

- proximity of wind turbines to television broadcast tower;

- proximity of wind turbines to receivers (dwellings);
- location of wind turbines in relation to dwellings and television broadcast towers;
- the rotor blade material, rotor speed and rotor blade direction (always into the wind);
- type of receiving antenna (e.g. directional and height); and
- frequency and power of the television broadcast signal.

For broadcast signals large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay TV transmitters are more commonly found in rural areas. Primary TV transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay TV transmitters [5], while a clearance of at least 6 km is recommended for primary TV transmitters.

4.16.1 Digital television

The switch over to digital television for the Darling Downs in Queensland, is scheduled for the second half of 2011 [30]. From this point onwards, analogue television signals will cease operation, meaning that it is likely that analogue television signals will be unavailable by the time the wind farm is constructed. The interference zones highlighted in the following section can be considered relevant for digital television signals, however generally digital television will be less susceptible to interference from wind turbines than analog television. GH has experience in situations where dwellings were able to receive adequate digital television reception in an area of adequate signal strength where the digital television signal is passing through a wind farm.

A recent report published by the UK telecommunications regulator Ofcom [31], states the following with regard to interference to digital television 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".

GH has drawn two conclusions from this report:

- Firstly that digital television is very robust and does not suffer from ghosting. In most cases digital television reception should be satisfactory in and around wind farm developments.
- Secondly, that areas of weak signal can experience interruptions to their reception should new reflections appear, such as those from nearby wind turbines.

According to the ABC Reception Advice website [28], the area around the Coopers Gap wind farm is likely to be able to receive a digital television signal from the Darling Downs Mt Mowbullan transmitter, with adequate coverage as shown in Figure 12.However, it is noted that the wind farm is located in a coverage area which appears to be adversely affected by the Bunya Mountains to the southeast of the site. As such, there is a risk that some dwellings in the vicinity of the wind farm may be screened from the transmitter, and may receive a reflected signal from the wind turbines that is stronger than the signal from the transmitter, potentially causing problems for digital television reception. In this situation, it might be possible for the residents impacted to apply for digital television via satellite. However, satellite applications for the Coopers Gap area are not possible yet [32]. Other mitigation options as discussed in Section 4.16.3 could also help to reduce the impact of Coopers Gap wind farm on digital television reception at some dwellings.

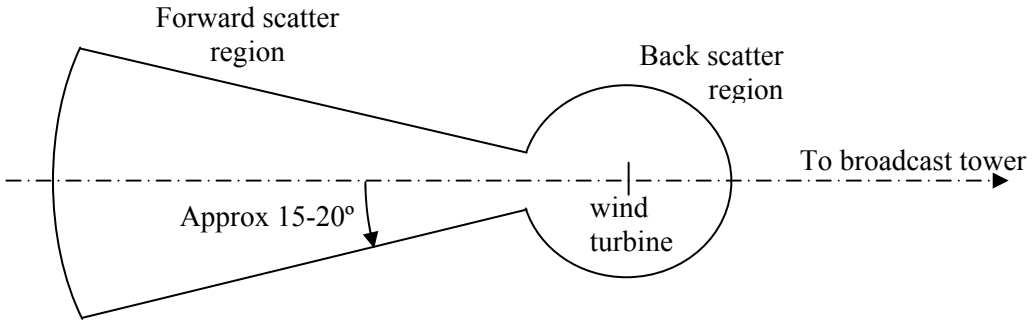
4.16.2 Analogue Television

Local interference to analogue television could potentially occur to individual houses in and around the proposed wind farm. A wind turbine has the potential to scatter analogue television waves both forward and back. Figure 11 shows the regional analog TV coverage for Queensland. According to the ACMA, residents in the vicinity of the Coopers Gap wind farm receive analog TV signals from the Darling Downs transmitter. The analog TV coverage network from the Darling Downs transmitter is shown in greater detail in Figure 13, which shows that the Coopers Gap wind farm is located in the main coverage area for this transmitter.

Forward scatter will only occur if a wind turbine is located approximately between the dwelling and the broadcast site. The forward scatter region is as shown in the following figure, and generally does not extend further than 5 km for the worst combination of factors [5, 27]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the wind turbines. The effect of the forward scatter is to potentially cause the brightness of the television picture to vary with the rotation of each blade. Modern television sets usually incorporate Automatic Gain Compensators (AGC) which act to lessen or eliminate variations in picture gain or brightness.

Back scattered signals arrive at the dwelling delayed relative to the source signal from the broadcast tower. The back scatter region is as shown in the figure next page, and generally does not extend further than 500 m [5, 27]. If a dwelling is within 500 m of a wind turbine and its receiving antenna is not sufficiently directional to discriminate between the original and delayed signal, then a pulsating ghost or secondary signal may appear on the television screen.

The combination of the forward and back scatter regions, as shown in the following figure, resembles a keyhole.



Potential analogue 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.

As an alternative, it is best to identify those dwellings or areas that are most likely to experience potential analogue television interference based on the forward and back scatter regions. This is often referred to as the keyhole approach. The keyhole approach methodology is to combine multiple keyholes that are placed over each turbine location. The union of each individual keyhole forms a region where there may be the potential for television interference. The keyhole approach usually results in only a few areas of potential impact.

To assist in identifying those houses that may be subject to television interference due to the proposed Coopers Gap wind farm, both back and forward scatter regions have been determined based on the proposed wind farm layout.

Therefore, the regions where there may be the potential for television interference have been identified using the keyhole approach based on Darling Downs, Mt Mowbullan tower with the results shown in Figure 14. The figure also shows the location of nearby dwellings as provided by AECOM [28].

As shown in the figure, there are several dwellings that fall within the potential analogue TV EMI regions based on each broadcast tower and a list of houses likely to be affected by the Darling Downs tower is shown in Table 11.

The potential for impact may be reduced if some of the houses are already using set top boxes to receive digital television, as a digital TV signal is less susceptible to interference from a wind farm.

The method used here to assess the potential interference to analogue television signals from the Coopers Gap wind farm represents a simplified approach which is expected to capture locations where interference is most likely to occur. This simplified analysis is deemed appropriate as the implications of potential analogue television interference are minimal given the large range of mitigation options available, as discussed in the following section.

4.16.3 Mitigation Options

As television interference from wind turbines is readily identifiable, appropriate mitigation measures can be readily taken if required.

In the event that TV interference is an issue during wind farm construction or after wind farm commissioning, there are several amelioration options available, in approximate order of cost:

1. Realigning the householder's TV antenna more directly towards their existing transmitter;
2. Tuning the householder's antenna into alternative sources of the same or suitable TV signal;
3. The installation of more directional and/or higher gain antenna at the affected dwelling;
4. Relocating the antenna to a less affected position;
5. The installation of cable/satellite TV at the affected dwelling; and
6. Installation of a TV relay station.

In the event that digital television reception is not acceptable, satellite television represents a potential amelioration option. Satellite based television comprises of both free to air and subscription based broadcasts, although free to air satellite services are generally only available in remote coverage areas that are unable to receive terrestrial broadcasts.

5 CONCLUSION

Broadcast towers and transmission paths around the proposed Coopers Gap wind farm were investigated to see if EMI would be experienced as a result of the development of the proposed Coopers Gap wind farm. The proposed wind farm would involve the installation of 114 turbines, with a hub height of 100 m, rotor diameter of 120 m, corresponding to a maximum blade tip height of 160 m.

5.1 Fixed point-to-point links

No fixed point-to-point link has been identified crossing over the proposed wind farm and consequently, it has been found that no turbines from the Coopers Gap wind farm are expected to cause interference to those links. The closest communication tower is located at Cooranga North, 1.8 km away from the wind farm and is operated by Telstra. Telstra was contacted to determine the likely impact of the wind farm on the communication tower, and provided a formal response stating that they do not foresee any impact to their communications assets from the proposed development.

5.2 Fixed point-to-multipoint links

Several point-to-multipoint type fixed licences were identified proximate to the Coopers Gap wind farm site. The nearest licence is approximately 17.5 km from the site, at Mt Mowbullan near Wengenville and is operated by the Bureau of Meteorology (BoM). Operators of point-to-multipoint links operating in the vicinity of the Coopers Gap Wind Farm were contacted to assess the likely impact of the wind farm on their operating services. For the majority of the licenses, the operator has either responded indicating that they do not forsee any impact to their services, or GH has deemed that no interference likely due to the expected use of the point-to-multipoint station and/or its distance from the proposed wind farm.

5.3 Other licence types

A review of other licences was conducted. The licences identified can broadly be described as base to mobile station style communication, and include radio broadcasting, commercial and private mobile telephony. 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. For most services, should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

It is noted that some of the licences identified are potentially used for aircraft navigation purposes. GH has been advised that consultation with AirServices Australia and the Department of Defence will be undertaken by Hart Aviation as part of the independent study.

5.4 Emergency Services

Emergency services with radiocommunication assets in the vicinity of the Coopers Gap wind farm have been identified and contacted to determine if there is a potential EMI impact to their services resulting from the development of the proposed wind farm. All emergency services do not foresee impacts to their fixed communications assets however the Queensland Police Service held reservations regarding potential impacts to UHF mobile communications. Impact to these services is expected to be unlikely, as discussed in sections 4.4 and 4.11

5.5 Aircraft navigation systems and aviation radar

AECOM has commissioned Hart Aviation to undertake an independent study of the impact of the wind farm on aviation. A list of organisations whose services may be impacted has been identified and GH has been advised that Hart Aviation will undertake the necessary consultations with those organisations.

5.6 Meteorological radar

GH has also undertaken an assessment of the BoM radar stations operating in the vicinity of the proposed wind farm and the closest station is located at approximately 143 km northeast of the site. Due to the distance between the station and the site, and the intervening terrain, it is unlikely that the wind farm would have an impact on meteorological radar operations. The BoM has contacted to assess the likely EMI impact to their services resulting from the development of the Coopers Gap wind farm. To date, no formal response has been received.

5.7 Trigonometrical stations

A total of 49 trigonometrical stations have been identified in the vicinity of the proposed wind farm and the closest AFN station is located in Townsville, at approximately 925 km northeast of the wind farm. As per the recommendations of the EPHC draft guidelines [4], Australia and the Queensland Department of Environment and Resource Management were consulted to determine the potential EMI impact from the Coopers Gap wind farm on their operations. Both parties do not foresee any impacts to the trig points in the area from the proposed development.

5.8 RFID

Aleis, a company who develops and markets systems for livestock tracking based on RFID technology operates a testing facility approximately 2 km from the wind farm. It is not expected that Aleis' systems will experience interference from the wind turbines at this distance.

5.9 Citizens Band Radio

Users of Citizen Band radio do not require a licence and GH is not able to identify the users of the service and their locations. The channels are shared equally among the different users without the right of protection from interference. If interference is experienced it should be possible to improve signal quality by moving a short distance. It is therefore considered that the impact of the wind farm on the CB radio service shall be minimal.

5.10 Mobile phones

A review of the mobile GSM and NextG network coverage has been undertaken for the proposed wind farm. It has been found that area around the Coopers Gap wind farm has marginal network coverage and in some areas, turbines may potentially cause some interference to the signal. In such cases, the installation of an external antenna or moving a short distance until the signal strength improves may help to improve the signal quality.

5.11 Wireless Internet

A review of the Australian ISP directory revealed that internet access in the region of Coopers Gap wind farm is provided via 3G mobile phone coverage. Section 4.12 of this report describes the likely impact of the wind farm on the mobile phone network.

5.12 Satellite Television and Internet

Residents in the vicinity of the wind farm may also have access to satellite television. GH has reviewed the line-of-sight of all usable satellite TV for eastern Australia and it has been found that no turbine intercepts the line-of-sight of the most common TV satellite used in Australia.

According to the Australian ISP directory [19], there are at least eight satellite internet providers operating in the vicinity of Coopers Gap wind farm. The contact details of these providers are given in Table 10 and they have been contacted to assess the likely impact of Coopers Gap wind farm on the operating services. All but three of the providers have responded indicating that they do not foresee any impact to their services. One of the providers has recommended that sites using their service should be at least 1 km from a turbine, however based on a review of turbine, house and satellite locations, GH believes that this setback is overly conservative.

5.13 Radio broadcasting

An examination of the likely impact of the wind farm on radio broadcasting has also been carried out. It is unlikely that the proposed wind farm will have an impact on AM radio as the signals are able to propagate around obstructions and buildings. FM signals however may be susceptible to interference from objects such as wind turbines, resulting in hissing and distortion of the signal. This can be mitigated by the installation of a high quality antenna. At present, digital radio is available only in the metropolitan areas. However, once implemented in the Coorang North region, it is unlikely that the wind farm will have an impact on digital radio provided adequate signal quality is available.

5.14 Television Broadcasting

Broadcast towers around the proposed Coopers Gap wind farm were investigated to see if television interference would be an issue for the current proposal. Television interference mechanisms are complex to calculate and can have limited predictive accuracy. Television interference around wind turbines is generally limited to less than 5 km and is a function of the visibility of the wind turbines and the transmitter from the receptor.

Work presented here highlights the areas around the proposed Coopers Gap wind farm site where television interference could potentially occur. A total of 24 houses have been identified that are most likely to experience interference to analogue television when tuned to the Darling Downs transmitter. It is also expected that the switch from analogue to digital television will occur in the second half of 2011 for the Coopers Gap area. Due to the potential impact of the Bunya Mountains on the digital television signal, it is possible that some houses in addition to the listed 24 above may experience interference to digital television signals from the wind farm. In such a situation, it may be possible for the residents to apply for digital television via satellite.

Should interference be encountered that is attributable to the wind farm, the amelioration options below should be followed in order to rectify the problem:

1. Realigning the householders TV antenna more directly towards their existing transmitter;
2. Tuning the householders into alternative sources of the same or suitable TV signal;
3. The installation of a more directional and/or higher gain antenna at the affected building;
4. Relocating the antenna to a less affected position;
5. The installation of a cable or satellite TV receiver at the affected dwelling; and
6. Installation of a TV relay station.

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No of turbines	114
Hub height (m)	100
Rotor blade length (m)	60
Rotor diameter (m)	120
Total Height to tip (m)	160

Table 1 Turbine option under consideration by AGL

Turbine ID	Easting[1] (m)	Northing[1] (m)	Turbine ID	Easting[1] (m)	Northing[1] (m)
1	337773.00	7050621.00	40	336024.00	7046571.00
2	337960.00	7050322.00	41	335100.00	7046514.00
3	338755.00	7050308.00	42	347876.00	7046493.00
4	338986.00	7049900.00	43	336769.17	7046559.09
6	339105.00	7049349.00	44	337736.08	7046387.77
7	337660.00	7049302.00	45	346796.00	7046109.00
9	335838.00	7049000.00	46	335199.00	7046103.00
10	338060.00	7048979.00	47	335430.00	7045820.00
11	336367.00	7048769.00	48	347720.00	7045742.00
12	339986.00	7047560.00	50	347337.00	7045299.00
13	338342.00	7048716.00	51	348454.00	7045292.00
14	336746.00	7048557.00	52	342501.09	7045273.86
15	335512.00	7048418.00	53	347696.00	7045043.00
16	339407.00	7048380.00	54	339914.00	7045037.00
17	336999.00	7048284.00	55	348963.00	7045032.00
18	339679.00	7048085.00	56	341913.46	7045054.00
19	337178.00	7047981.00	57	344957.00	7044879.00
20	339133.00	7047861.00	58	340341.00	7044814.00
21	337923.00	7047665.00	59	348574.00	7044735.00
22	347063.00	7047640.00	60	342069.02	7044884.46
23	339272.00	7047543.00	61	339473.85	7044803.07
24	335318.00	7047511.00	62	345169.00	7044585.00
25	346933.00	7047293.00	63	348003.00	7044508.00
26	348057.00	7047284.00	64	340439.00	7044491.00
27	335504.00	7047212.00	65	348772.00	7044440.00
28	340513.00	7047126.00	67	345340.00	7044281.00
29	339303.12	7047020.75	68	340765.00	7044240.00
30	336175.00	7046938.00	69	348060.00	7044177.00
31	348063.00	7046907.00	70	345841.00	7044120.00
32	337315.00	7046902.00	71	346868.00	7044047.00
33	346910.00	7046897.00	72	341066.00	7043969.00
34	334964.00	7046872.00	73	346303.54	7043955.26
36	336591.00	7046759.00	74	348096.00	7043842.00
39	341163.00	7046594.00	76	341430.00	7043666.00

Note: 1. Coordinate system used is Zone 55 H, GDA94 datum

Table 2 Proposed turbine layout for Coopers Gap wind farm (continued)

Turbine ID	Easting[1] (m)	Northing[1] (m)	Turbine ID	Easting[1] (m)	Northing[1] (m)
78	348880.00	7043540.00	108	345389.00	7040497.00
79	348264.00	7043528.00	109	346819.00	7040497.00
80	347419.00	7043397.00	110	344505.00	7040495.00
81	341682.00	7043389.00	111	347553.00	7040495.00
82	348581.00	7043220.00	112	348460.00	7040442.00
84	347945.00	7042979.00	113	343477.00	7040402.00
85	342085.00	7043000.00	114	345799.00	7040178.00
86	341599.00	7042861.00	115	348983.00	7040107.00
88	347324.21	7042217.76	116	347550.00	7040104.00
91	347380.00	7042002.00	117	344344.00	7040040.00
93	346317.51	7041869.30	118	346261.00	7039962.00
94	345305.00	7041919.00	119	347998.00	7039797.00
95	347639.00	7041646.00	120	344767.00	7039789.00
96	345160.00	7041562.00	121	349000.00	7039768.00
98	340860.55	7041256.71	122	348373.00	7039576.00
99	347740.00	7041323.00	123	345562.00	7039539.00
101	347963.00	7041037.00	124	345010.00	7039510.00
102	341056.00	7041003.00	125	343849.00	7039423.00
103	341678.00	7040889.00	126	349079.00	7039378.00
104	346557.00	7040839.00	127	345872.00	7039427.00
105	348341.00	7040760.00	128	343291.00	7039320.00
106	342958.00	7040703.00	129	348385	7039226
107	342209.00	7040573.00	130	346225	7039277

Note: 1. Coordinate system used is Zone 55 H, GDA94 datum

Table 2 Proposed turbine layout for Coopers Gap wind farm (concluded)

Assignment ID	Licence Number	Frequency (Hz)	Postal Address
Point to point link at the south of Coopers Gap site boundary			
41035 – 120739	83896	1734500000	**Telstra Corporation Ltd 15/242-282 Exhibition Street Melbourne VIC 3000**

Table 3 Details of point-to-point licence at the south of Coopers Gap site boundary

Assignment ID	ACMA Licence No	Site ID	Location[1]	Contact Details
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	Telstra Corporation Ltd 15/242-282 Exhibition St Melbourne VIC 3000
1139100-2209744	1136386	16325	56 H 387745 m E 7066815 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
344404-88475	86680	14730	56 H 325400 m E 6991600 m N	
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	

Note: 1. Coordinate system used is Zone 55H, AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Coopers Gap wind farm (continued)

Assignment ID	ACMA Licence No	Site ID	Location[1]	Contact Details
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	Telstra Corporation Ltd 15/242-282 Exhibition St Melbourne VIC 3000
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1401689-1401520	1403190	12775	56 H 260400 m E 7119400 m N	
43857-88475	86680	14730	56 H 325400 m E 6991600 m N	
344404-88475	86680	14730	56 H 325400 m E 6991600 m N	
43857-88475	86680	14730	56 H 325400 m E 6991600 m N	
1401682-1401518	1403188	14787	56 H 267885 m E 7049275 m N	
1401681-1401518	1403188	14787	56 H 267885 m E 7049275 m N	
1401682-1401518	1403188	14787	56 H 267885 m E 7049275 m N	
1401681-1401518	1403188	14787	56 H 267885 m E 7049275 m N	
1401685-1401519	1403189	14844	56 H 262150 m E 7091550 m N	
1401687-1401519	1403189	14844	56 H 262150 m E 7091550 m N	
1401685-1401519	1403189	14844	56 H 262150 m E 7091550 m N	
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1401688-1401520	1403190	12775	56 H 260400 m E 7119400 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1401688-1401520	1403190	12775	56 H 260400 m E 7119400 m N	
1401689-1401520	1403190	12775	56 H 260400 m E 7119400 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138677-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1138675-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138676-2209443	1136208	14732	56 H 327870 m E 6992005 m N	
1138674-2209441	1136208	14732	56 H 327870 m E 6992005 m N	
1138672-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1401687-1401519	1403189	14844	56 H 262150 m E 7091550 m N	
1139100-2209744	1136386	16325	56 H 387745 m E 7066815 m N	

Note: 1. Coordinate system used is Zone 55H, AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Coopers Gap wind farm (continued)

Assignment ID	ACMA Licence No	Site ID	Location[1]	Contact Details
1139130-2209759	1136380	16356	56 H 361678 m E 7024515 m N	Telstra Corporation Ltd 15/242-282 Exhibition St Melbourne VIC 3000
1139101-2209744	1136386	16325	56 H 387745 m E 7066815 m N	
1138673-2209440	1136208	14732	56 H 327870 m E 6992005 m N	
1139131-2209759	1136380	16356	56 H 361678 m E 7024515 m N	
1139130-2209759	1136380	16356	56 H 361678 m E 7024515 m N	
1139101-2209744	1136386	16325	56 H 387745 m E 7066815 m N	
1139131-2209759	1136380	16356	56 H 361678 m E 7024515 m N	
1404650-1403689	1407379	14590	56 H 408620 m E 6978820 m N	Toowoomba Regional Council PO Box 3021 Toowoomba QLD 4350
1404659-1403689	1407379	14590	56 H 408620 m E 6978820 m N	
1404650-1403689	1407379	14590	56 H 408620 m E 6978820 m N	
1404659-1403689	1407379	14590	56 H 408620 m E 6978820 m N	
169726-26993	523828	54758	56 H 373595 m E 6964515 m N	
1412698-1409985	1415361	402084	56 H 407691 m E 7102228 m N	Gympie Regional Council PO Box 9 Kilkivan QLD 4600
1412697-1409985	1415361	402084	56 H 407691 m E 7102228 m N	
1412697-1409985	1415361	402084	56 H 407691 m E 7102228 m N	
1412698-1409985	1415361	402084	56 H 407691 m E 7102228 m N	
59623-27000	126104	16335	56 H 384098 m E 7063829 m N	South Burnett Regional Council PO Box 336 Kingaroy QLD 4610
8285730-8314540	1930622	9009726	56 H 256905 m E 7019505 m N	Australia Pacific LNG Pty Ltd GPO Box 148 Brisbane QLD 4001
8285726-8314536	1930618	9010093	56 H 281600 m E 6980540 m N	
65055-1571	147293	14527	56 H 416991 m E 6967314 m N	Energex Ltd GPO Box 1461 Brisbane QLD 4001
353802-1572	147294	14527	56 H 416991 m E 6967314 m N	
65056-1572	147294	14527	56 H 416991 m E 6967314 m N	
65056-1572	147294	14527	56 H 416991 m E 6967314 m N	
65055-1571	147293	14527	56 H 416991 m E 6967314 m N	
353802-1572	147294	14527	56 H 416991 m E 6967314 m N	
1412883-1410139	1415537	14527	56 H 416991 m E 6967314 m N	
1412882-1410139	1415537	14527	56 H 416991 m E 6967314 m N	
1412883-1410139	1415537	14527	56 H 416991 m E 6967314 m N	
1412882-1410139	1415537	14527	56 H 416991 m E 6967314 m N	

Note: 1. Coordinate system used is Zone 55H, AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Coopers Gap wind farm (continued)

Assignment ID	ACMA Licence No	Site ID	Location[1]	Contact Details
353801-1571	147293	14527	56 H 416991 m E 6967314 m N	Energex Ltd GPO Box 1461 Brisbane QLD 4001
353801-1571	147293	14527	56 H 416991 m E 6967314 m N	
1415288-1412144	1417242	16406	56 H 362825 m E 7023895 m N	Ergon Energy Corporation Ltd PO Box 1090 Townsville QLD 4810
358565-27451	172154	16296	56 H 395940 m E 7104495 m N	
1415288-1412144	1417242	16406	56 H 362825 m E 7023895 m N	
358565-27451	172154	16296	56 H 395940 m E 7104495 m N	
80266-27451	172154	16296	56 H 395940 m E 7104495 m N	
1406951-1405217	1409305	14527	56 H 416991 m E 6967314 m N	
1406944-1405217	1409305	14527	56 H 416991 m E 6967314 m N	
1406951-1405217	1409305	14527	56 H 416991 m E 6967314 m N	
1415287-1412144	1417242	16406	56 H 362825 m E 7023895 m N	
1406944-1405217	1409305	14527	56 H 416991 m E 6967314 m N	
1415287-1412144	1417242	16406	56 H 362825 m E 7023895 m N	
80266-27451	172154	16296	56 H 395940 m E 7104495 m N	
1406805-1405107	1408972	401141	56 H 393500 m E 6970650 m N	Toowoomba Regional Council PO Box 3021 Toowoomba QLD 4350
8246238-8267123	1918771	9010598	56 H 424371 m E 7115198 m N	Gympie Regional Council PO Box 9 Kilkivan QLD 4600
8246239-8267124	1918771	9010598	56 H 424371 m E 7115198 m N	
8246238-8267123	1918771	9010598	56 H 424371 m E 7115198 m N	
8246239-8267124	1918771	9010598	56 H 424371 m E 7115198 m N	
1406917-1405193	1409253	401181	56 H 387350 m E 7090000 m N	South Burnett Regional Council PO Box 336 Kingaroy QLD 4610
1406921-1405193	1409253	401181	56 H 387350 m E 7090000 m N	
1406917-1405193	1409253	401181	56 H 387350 m E 7090000 m N	
1406921-1405193	1409253	401181	56 H 387350 m E 7090000 m N	
1417515-1414107	1420220	150556	56 H 346703 m E 7019796 m N	Western Downs Regional Council PO Box 551 Dalby QLD 4405
1404646-1403693	1407374	400709	56 H 261715 m E 7035865 m N	
57750-25310	116874	14714	56 H 328059 m E 6992464 m N	
1417516-1414107	1420220	150556	56 H 346703 m E 7019796 m N	
1417516-1414107	1420220	150556	56 H 346703 m E 7019796 m N	
1417515-1414107	1420220	150556	56 H 346703 m E 7019796 m N	

Note: 1. Coordinate system used is Zone 55H, AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Coopers Gap wind farm (continued)

Assignment ID	ACMA Licence No	Site ID	Location[1]	Contact Details
137603-1164	433911	402542	56 H 360900 m E 7024955 m N	Bureau of Meteorology Comms Section GPO Box 1289 Melbourne VIC 3001
1807520-2224623	1149753	135649	56 H 421891 m E 6962753 m N	
1615181-1613020	1621563	16377	56 H 391550 m E 7034790 m N	Thiess Pty Ltd Locked Bag 2009 South QLD 4101
1615182-1613020	1621563	16377	56 H 391550 m E 7034790 m N	
1615181-1613020	1621563	16377	56 H 391550 m E 7034790 m N	
1615182-1613020	1621563	16377	56 H 391550 m E 7034790 m N	
1823825-2239447	1916806	138600	56 H 373703 m E 7051603 m N	Fresser Farming Pty Ltd 877 Burrandowan Rd Kingaroy QLD 4610
1420758-1416512	1424224	16401	56 H 392040 m E 7037040 m N	Tarong Energy Corporation PO Box 15 Nanango QLD 4615
8232269-8249355	1911915	9009665	56 H 295765 m E 7001114 m N	Arrow Energy Ltd GPO Box 5262 Brisbane QLD 4001
8232268-8249354	1911915	9009665	56 H 295765 m E 7001114 m N	
8232268-8249354	1911915	9009665	56 H 295765 m E 7001114 m N	
8242175-8261920	1916810	9010356	56 H 315308 m E 6969613 m N	
8242174-8261919	1916810	9010356	56 H 315308 m E 6969613 m N	
8242175-8261920	1916810	9010356	56 H 315308 m E 6969613 m N	
8242174-8261919	1916810	9010356	56 H 315308 m E 6969613 m N	
8232269-8249355	1911915	9009665	56 H 295765 m E 7001114 m N	
1482204-1492008	1451421	480723	56 H 419194 m E 6974255 m N	Ross Desmond Stuhmcke 385 Forestry Rd Gatton QLD 4343
1482203-1492008	1451421	480723	56 H 419194 m E 6974255 m N	
1482204-1492008	1451421	480723	56 H 419194 m E 6974255 m N	
1482203-1492008	1451421	480723	56 H 419194 m E 6974255 m N	
8260125-8284916	1923316	400413	56 H 376650 m E 7086500 m N	Sunwater Ltd PO Box 3247 Bundaberg QLD 4670
8260126-8284917	1923316	400413	56 H 376650 m E 7086500 m N	
8260126-8284917	1923316	400413	56 H 376650 m E 7086500 m N	
8260125-8284916	1923316	400413	56 H 376650 m E 7086500 m N	

Note: 1. Coordinate system used is Zone 55H, AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Coopers Gap wind farm (concluded)

Licensee	Response	GH Comment
Telstra Corporation Ltd	"…no potential for undue interference"	
Toowoomba Regional Council	No response received.	Distance from site (74 to 84 km) means interference very unlikely
Gympie Regional Council	Received map showing council boundaries and locations of communication sites.	Distance from site means interference very unlikely.
South Burnett Regional Council	No formal response received	Distance from site (58 km) means interference very unlikely.
Australia Pacific LNG Pty Ltd	No formal response received	Distance from site (80 km) means interference very unlikely.
Energex Ltd	No formal response received	
Ergon Energy	No formal response received	
Western Downs Regional Council	"does not appear that the proposed development will impact upon Council's radio communication services or assets"	
Bureau of Meteorology	No formal response received	
Thiess Pty Ltd	No formal response received	Distance from site (41 km) means interference very unlikely.
Fresser Farming Pty Ltd	No formal response received	Used for control of irrigation system. Likely to be within property boundaries only. Interference very unlikely
Tarong Energy Corporation	No formal response received	Distance from site (41 km) means interference very unlikely.
Arrow Energy Ltd	"…no reason why it should cause interference to our company's telecommunication systems"	
Ross Desmond Stuhmcke	"do not foresee any conflict with our telecommunications, at this time"	
Sunwater Ltd	"Given the information … provided … no reason why [wind farm] should cause interference to our companies telecommunication systems"	

Table 5 Summary of responses from operators of point-to-multipoint licenses. within 75 km of the proposed Coopers Gap wind farm

Licence Type	Licence Category	Number of Instances
ACA	ACA Assigned	4
Aeronautical	Aeronautical Assigned System	19
Amateur	Amateur Beacon	1
Amateur	Amateur Repeater	5
Broadcasting	Broadcasting Service	69
Broadcasting	Narrowband Area Service Station	4
Broadcasting	Narrowcasting Service Station	30
Broadcasting	Narrowcasting Service Station (HPON)	3
Earth Receive	Earth Receive	1
Fixed	Point to Multipoint – Land Mobile Spec	1
Fixed Receive	Fixed receive	1
Land Mobile	Ambulatory System	20
Land Mobile	CBRS Repeater	7
Land Mobile	Land mobile system - > 30 MHz	282
Land Mobile	Land mobile system 0 – 30 MHz	5
Land Mobile	Paging System – Exterior	19
Land Mobile	Paging System – Interior	7
PTS	PMTS Class B (2110 – 2170 MHz)	36
PTS	PMTS Class B (935 – 960 MHz)	42
Radiodetermination	Radiodetermination	6
Scientific	Scientific Assigned	1
Spectrum	1.8 GHz Upper Band	1
Spectrum	2 GHz Upper Band A	2
Spectrum	2 GHz Upper Band B	2
Spectrum	500 MHz Lower Band	26
Spectrum	500 MHz Upper Band	23
Spectrum	800 MHz Lower Band	47
Spectrum	800 MHz Upper Band	48

Table 6 Details of other licences identified within 75 km of the proposed Coopers Gap wind farm

Service	Contact details
Queensland Police Service	20 Pickering St Alderley QLD 4051
Department of Community Safety (Queensland Ambulance Service)	Attn Mgr Systems Support Service GPO Box 1425 Brisbane QLD 4001
Department of Community Safety (Queensland Fire and Rescue Service)	Attn Mgr Systems Support Service GPO Box 1425 Brisbane QLD 4001
St John Ambulance Australia	Attn Stephen Carter PO Box 3895 Manuka ACT 2603
Moore Linville Bush Fire Brigade	1 Main Street South Moore QLD 4306

Table 7 Emergency services with radiocommunication assets in the vicinity of Coopers Gap wind farm.

Trig Point	Easting (m)[1]	Northing (m)[1]
Archookoora	378708.1	7045679.0
Binga Fire Tower	392156.3	7007098.0
Bluff	371816.3	7097441.0
Booie	389392.4	7071721.0
Brigooda	344741.1	7095696.0
Brooklands	379809.0	7039346.0
C 210	327750.3	7043540.0
C 211	325039.8	7081786.0
C 215	349534.3	7068404.0
Cookes	383582.1	6994866.0
Cookes	383584.6	6994865.0
Cooyar	377179.6	7018859.0
DA 1	326299.6	7011870.0
Dalby WT	328059.7	6992468.0
Dangore	360889.5	7072756.0
Fair Hill	373747.1	7006473.0
Googa	401365.8	7014579.0
Halys	352781.4	7038352.0
Halys Round	369845.7	7037653.0
High Camp	390302.2	7005992.0
Karingal	328284.6	7004533.0
KG 1	301200.7	7010537.0
KG 1	301539.2	7010219.0
Kiangarow	355635.5	7031453.0
Main Camp Hill	329514.6	7013012.0
McEuen	374239.9	7095998.0
Melrose	363559.8	7087403.0
Memerambi	386751.2	7070652.0
Memerambi	386771.5	7070654.0
Mocatta	369562.5	7014487.0
Moola	351666.7	7002235.0
Mowbullan	360924.1	7024935.0
Murgon WT	393280.4	7097257.0
Nanango South	396921.8	7041350.0
NM B 276	351842.6	7073495.0
Peranga	371292.8	6996264.0
South Nanango	395541.9	7039457.0
Squaretop	342472.1	7010692.0
Squaretop Minor	343016.9	7010770.0
Sunnyvale	348692.7	7024725.0
Turkey	287297.7	7084128.0
Upper Coalbank	382010.6	7001952.0
Upper Yarraman	383044.8	7021402.0
Ushers Hill	387254.6	7057156.0
Warra	294994.0	7019822.0
Whiteheads	398582.9	7065730.0
Wooroolin	380994.5	7065435.0
Yagoona	376605.2	7086383.0
Yarraman	390244.8	7029438.0

Note: 1. Coordinate system used is Zone 56 H, AGD66 datum

Table 8 Trigonometrical Stations in the vicinity of Coopers Gap wind farm

BoM Radar site	Location[1]	Distance from Coopers Gap wind farm/km
Brisbane	27.718°S 153.240°E	203
Grafton	29.620°S 152.970°E	347
Gympie	25.957°S 152.577°E	136
Marburg	27.610°S 152.540°E	139
Moree	29.500°S 149.850°E	341
Warrego	26.440°S 147.350°E	397

Note: 1. Coordinate system used is Lat/Long GDA94 datum

Table 9 BoM Radar sites in the vicinity of Coopers Gap wind farm

Service Provider	Contact Details
Activ8me	Telephone: 1300 760 219 Email: sales@activ8.net.au
ClearNetworks	Telephone: 1300 855 215 Email: sales@clearnetworks.com.au
Genius8	Telephone: 1300 654 302 Email: info@genius8.com.au http://www.genius8.com.au
OptusNet	Telephone: 1800 504 504 Website: http://www.optus.com.au/home/broadband/
ReachNet	Telephone: 1300 798 007 Email: helpdesk@reachnet.com.au
Skymesh	Telephone: 1300759 637 Email: sales@skymesh.com.au
Telstra Bigpond	Telephone: 137663 Website: www.bigpond.com/internet/plans
WestNet	Telephone: 131960 Email: sales@westnet.com.au

Table 10 Potential Satellite Internet service providers for residents in the vicinity of Coopers Gap wind farm

House ID	Location[1]	Potential TV EMI from
		Darling Downs
A	339979 mE 7046198 mN	√
B	336836 mE 7045548 mN	√
C	336736 mE 7049481 mN	√
D	336573 mE 7049861 mN	√
E	341554 mE 7046981 mN	√
F	341587 mE 7046889 mN	√
G	346130 mE 7042704 mN	√
H	346063 mE 7042688 mN	√
I	343300 mE 7043622 mN	√
J	340969 mE 7045325 mN	√
L	338163 mE 7044337 mN	√
M	339394 mE 7042729 mN	√
N	339381 mE 7042686 mN	√
O	339635 mE 7041433 mN	√
AR	346862 mE 7049078 mN	√
AS	346988 mE 7049038 mN	√
AT	344991 mE 7046539 mN	√
AU	342556 mE 7048030 mN	√
AV	342449 mE 7047963 mN	√
BC	340387 mE 7049573 mN	√
BD	340358 mE 7049200 mN	√
BE	340545 mE 7049279 mN	√
BF	334980 mE 7050556 mN	√
CG	332693 mE 7046535 mN	√

Note: 1. Coordinate system used is UTM zone 56, WGS84 datum

Table 11 List of houses with the potential to experience EMI to analogue television from Darling Downs and Bell broadcast towers for the Coopers Gap wind farm.

Figure 1 Location of Coopers Gap wind farm

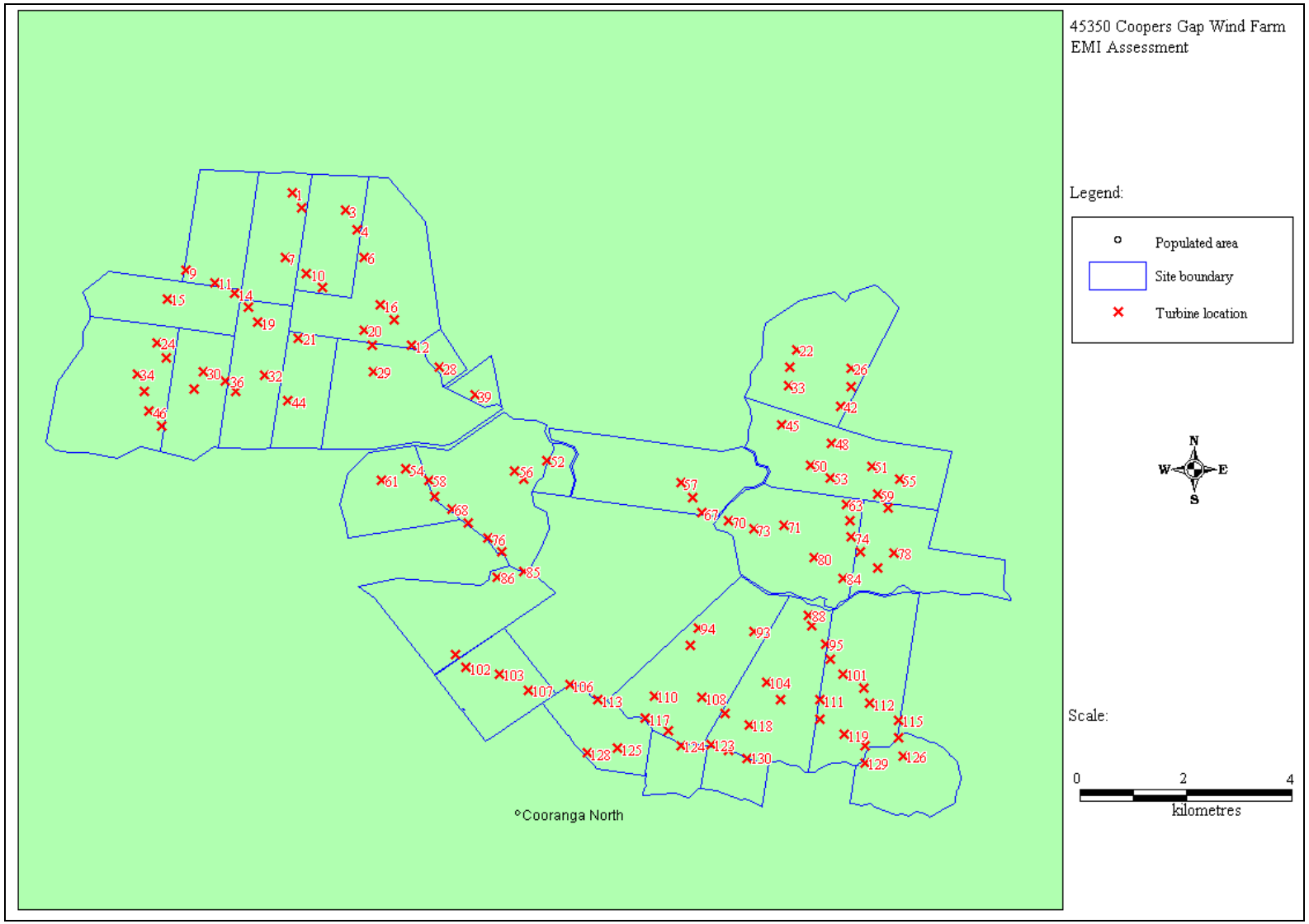

Figure 2 Layout of Coopers Gap wind farm

GL Garrad Hassan

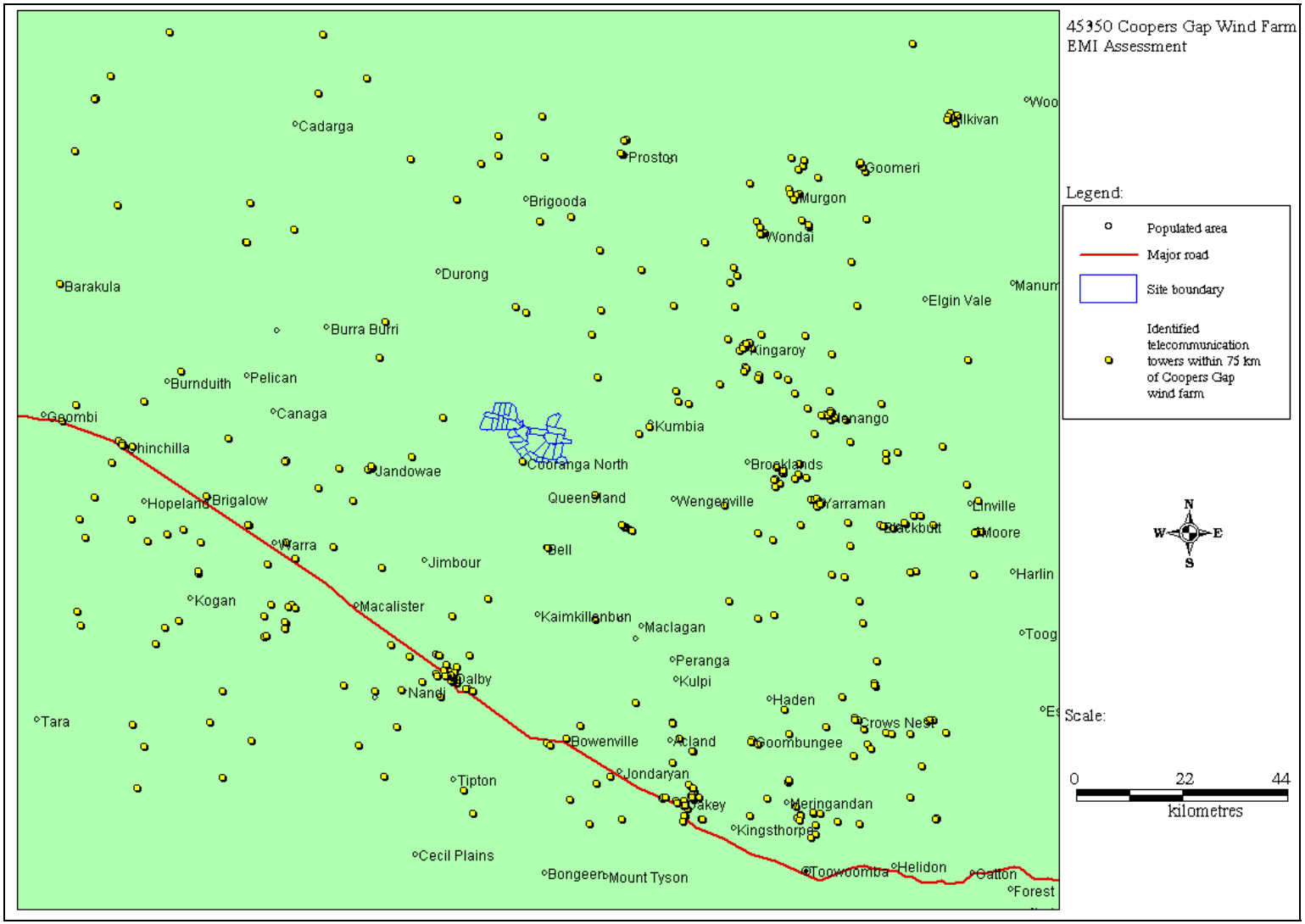

Figure 3 Location of identified proximate radiocommunication sites

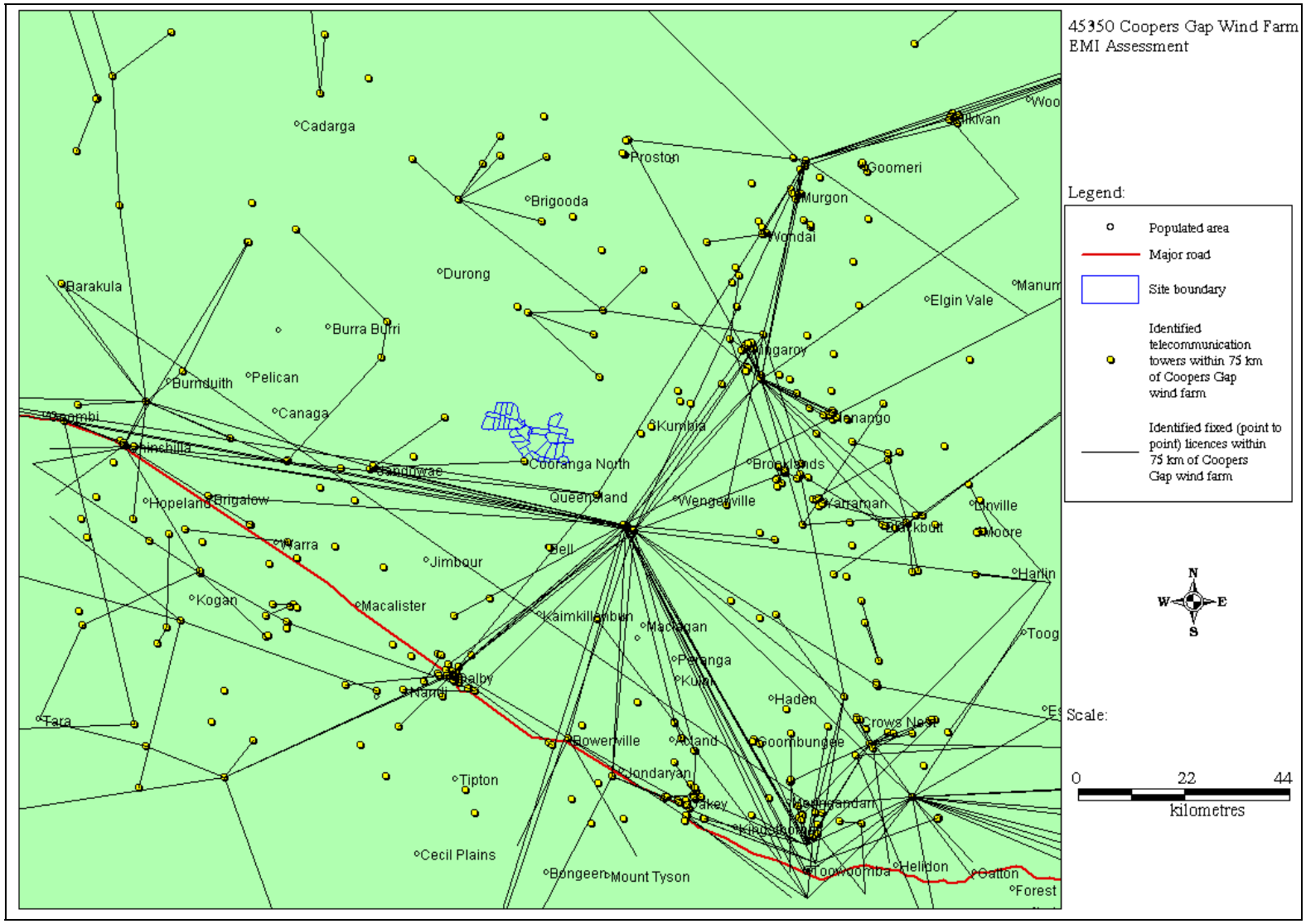

Figure 4 Identified transmission vectors for fixed licences of point-to-point type proximate to Coopers Gap wind farm

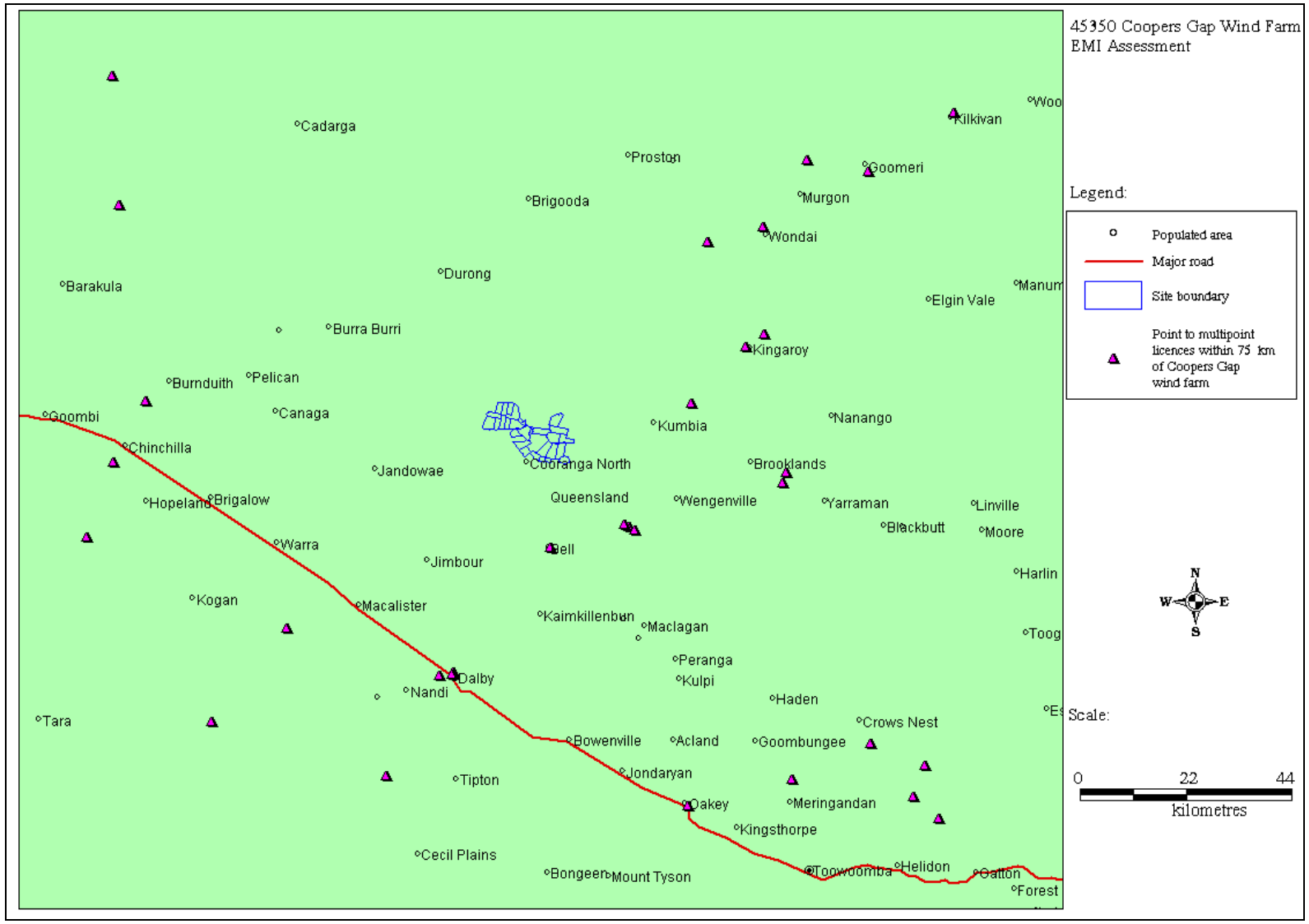

Figure 5 Location of point-to-multipoint stations within 75 km of Coopers Gap wind farm

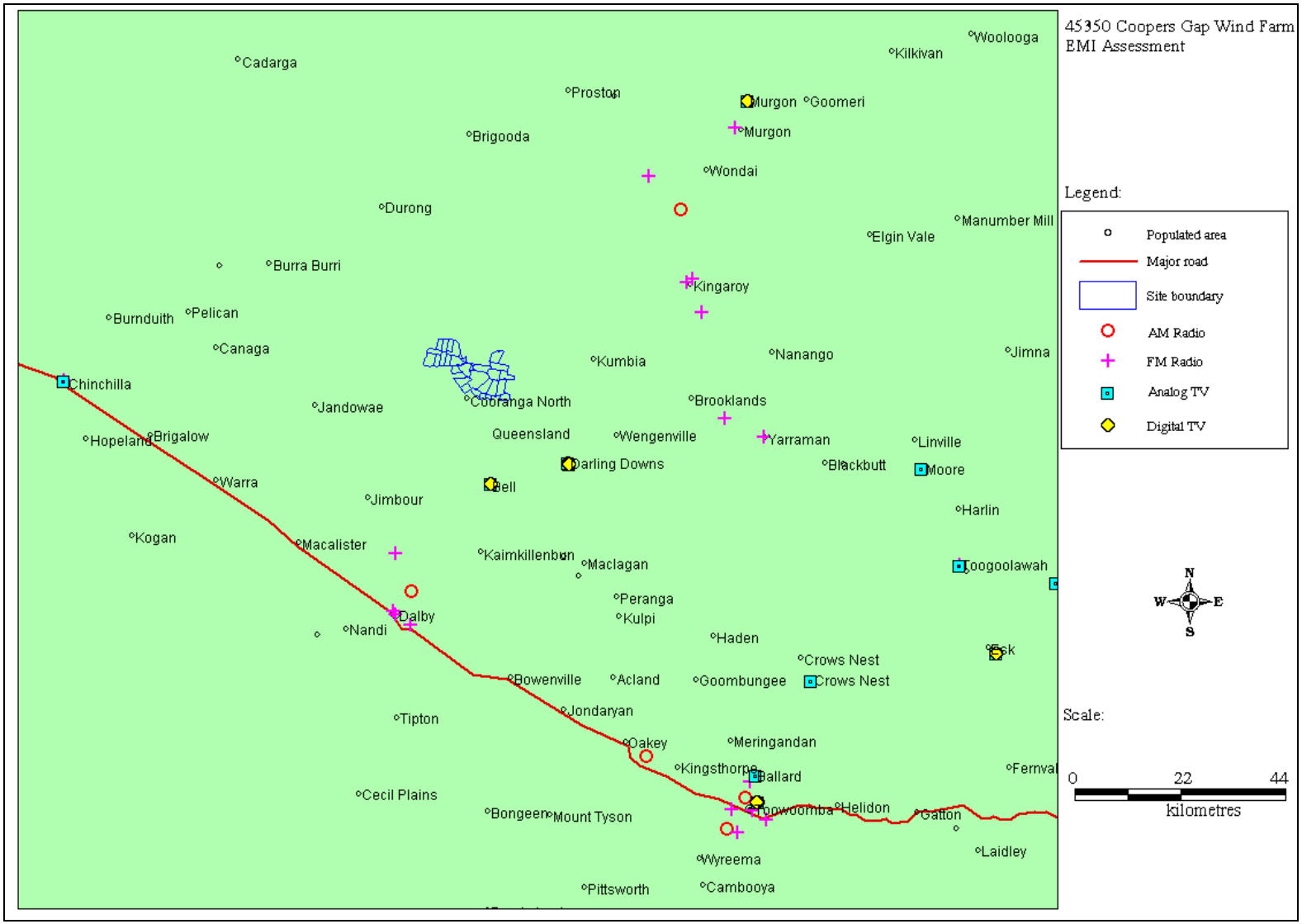

Figure 6 Location of broadcast transmitters in the vicinity of Coopers Gap wind farm

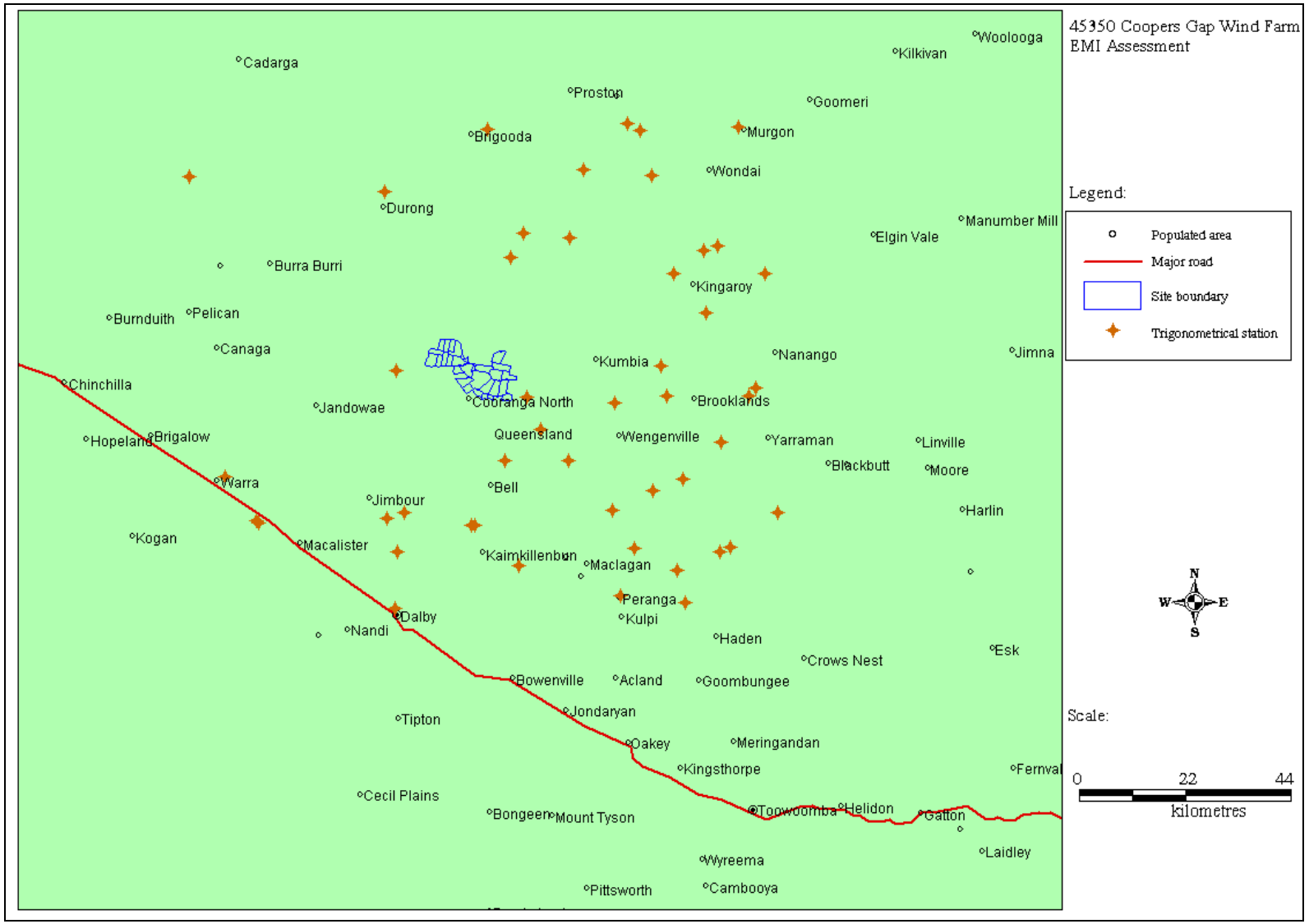

Figure 7 Location of Trig stations within 75 km of Coopers Gap wind farm

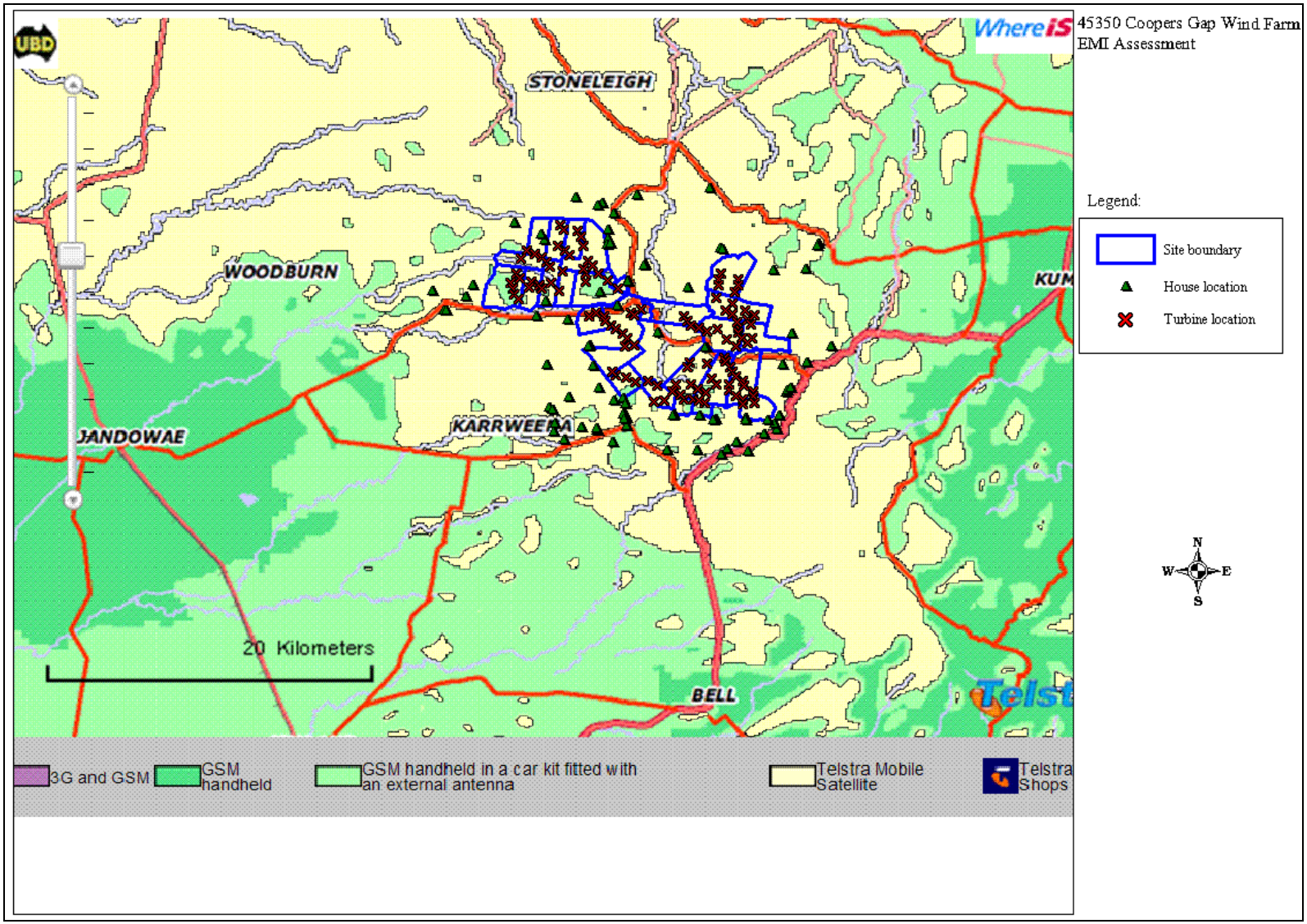

Figure 8 Telstra GSM Mobile phone coverage for Coopers Gap wind farm

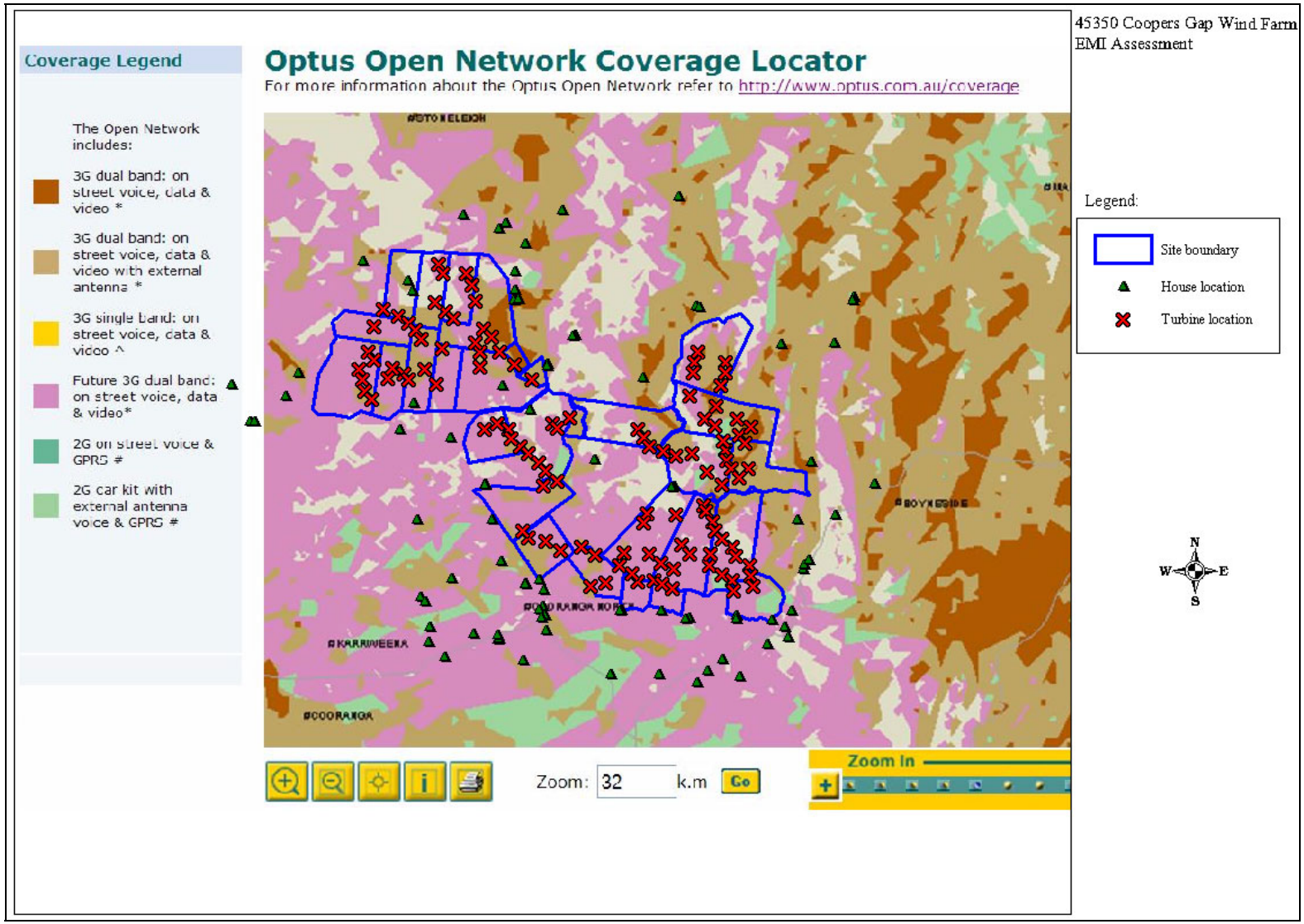

Figure 9 Optus GSM Mobile phone coverage for Coopers Gap wind farm

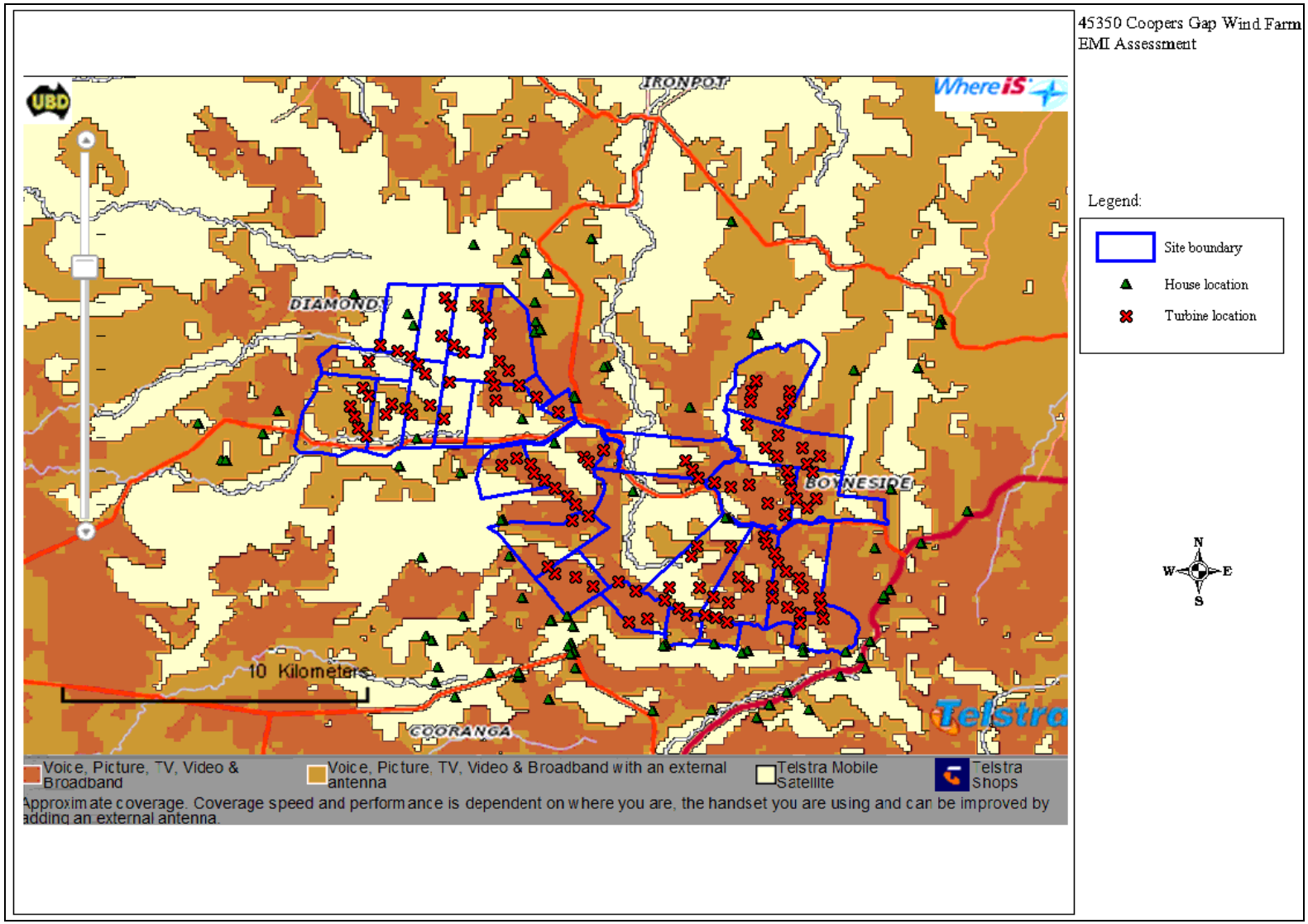

Figure 10 Telstra NextG network coverage map

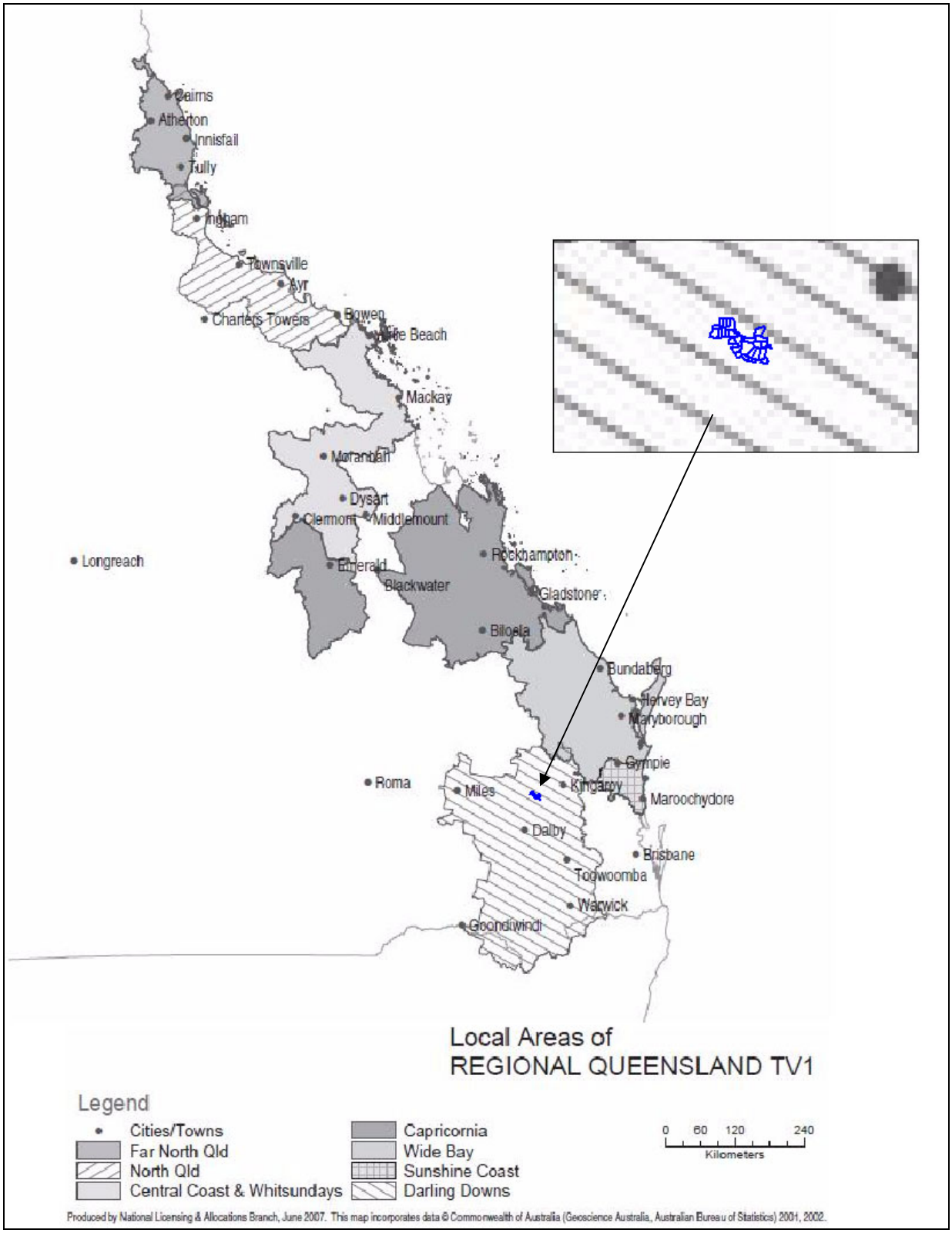

Figure 11 Regional TV1 coverage for Queensland

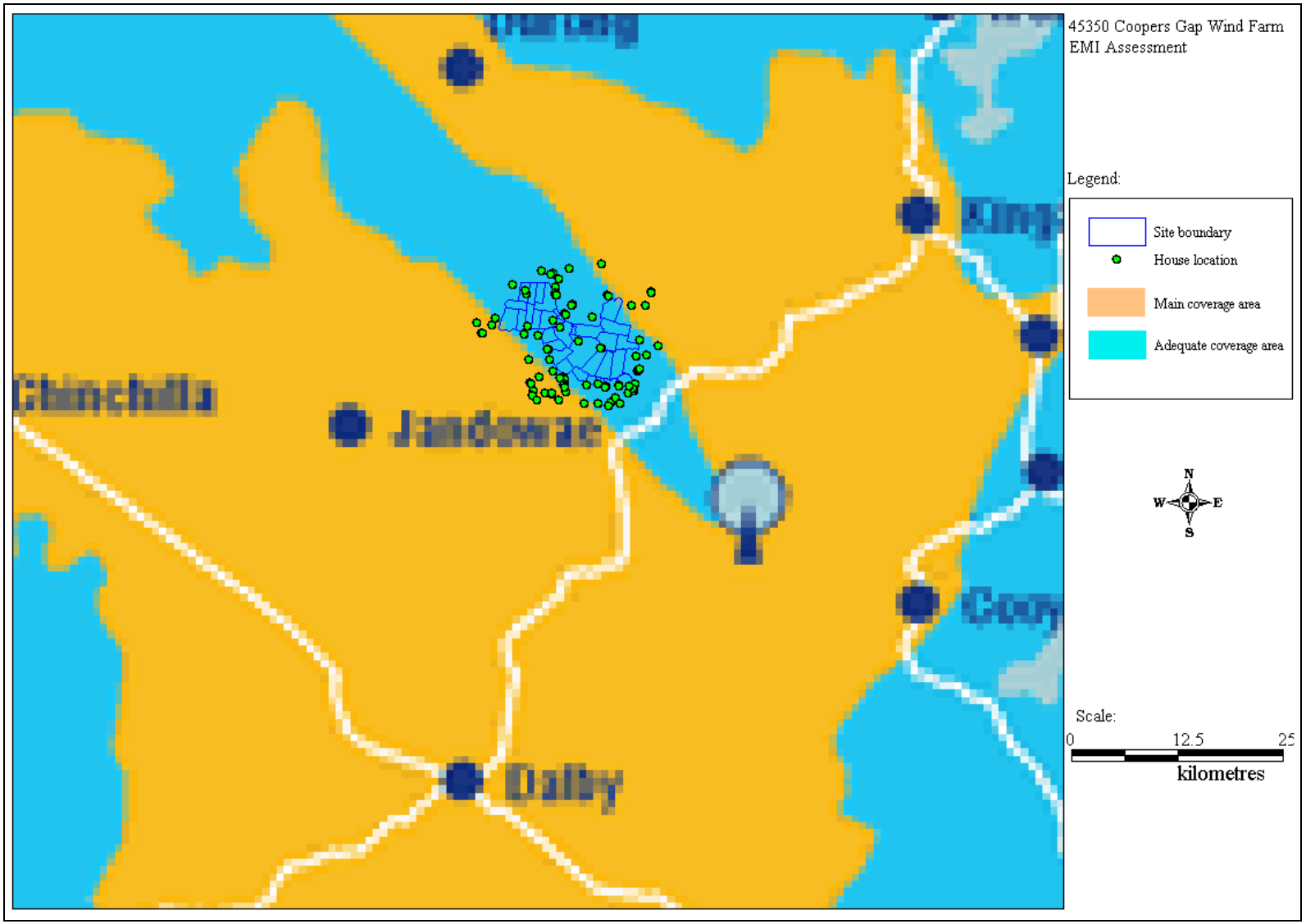

Figure 12 Digital TV coverage from Darling Downs transmitter at Mt Mowbullan

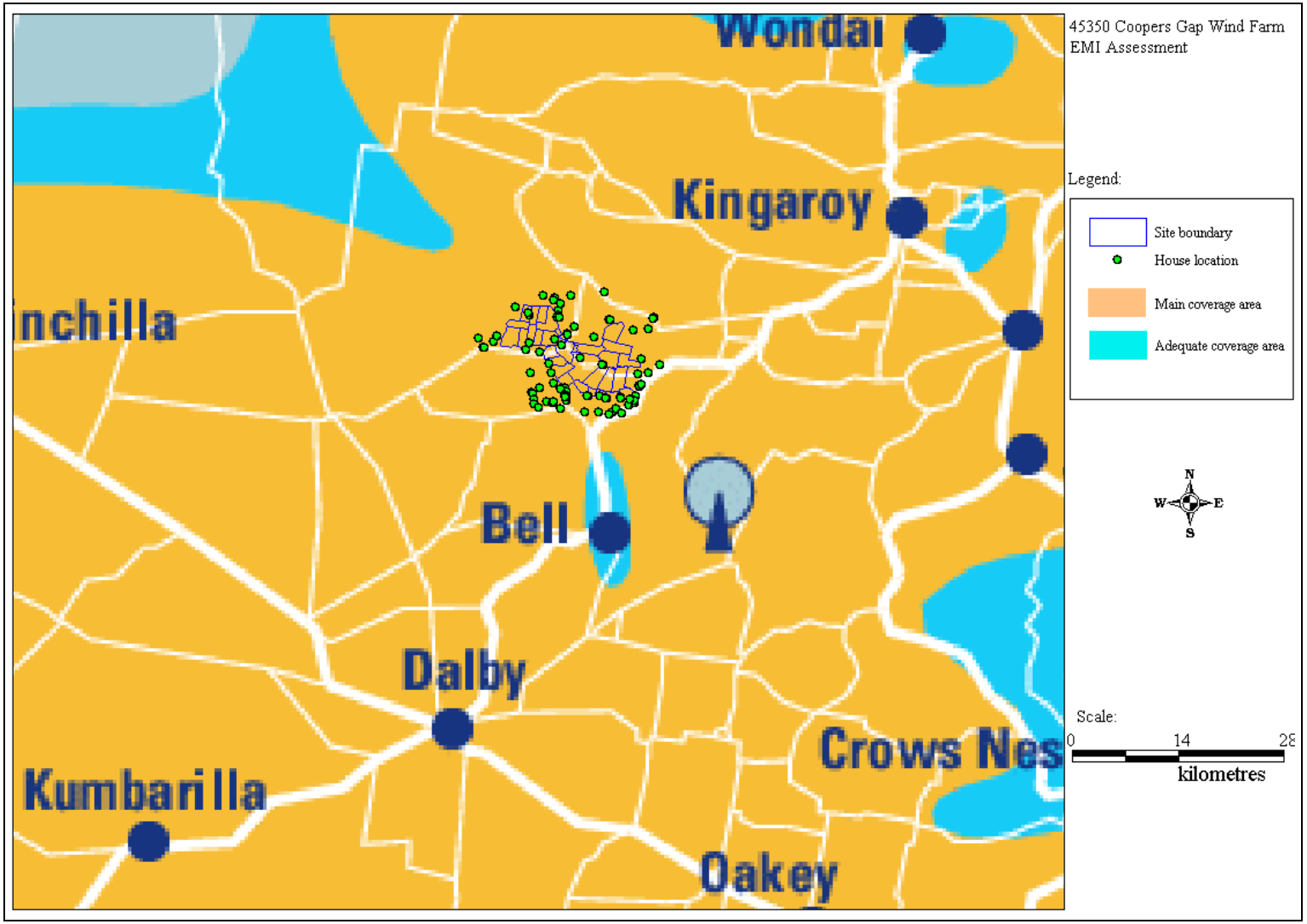

Figure 13 Analogue TV coverage from the Darling Downs transmitter at Mt Mowbullan

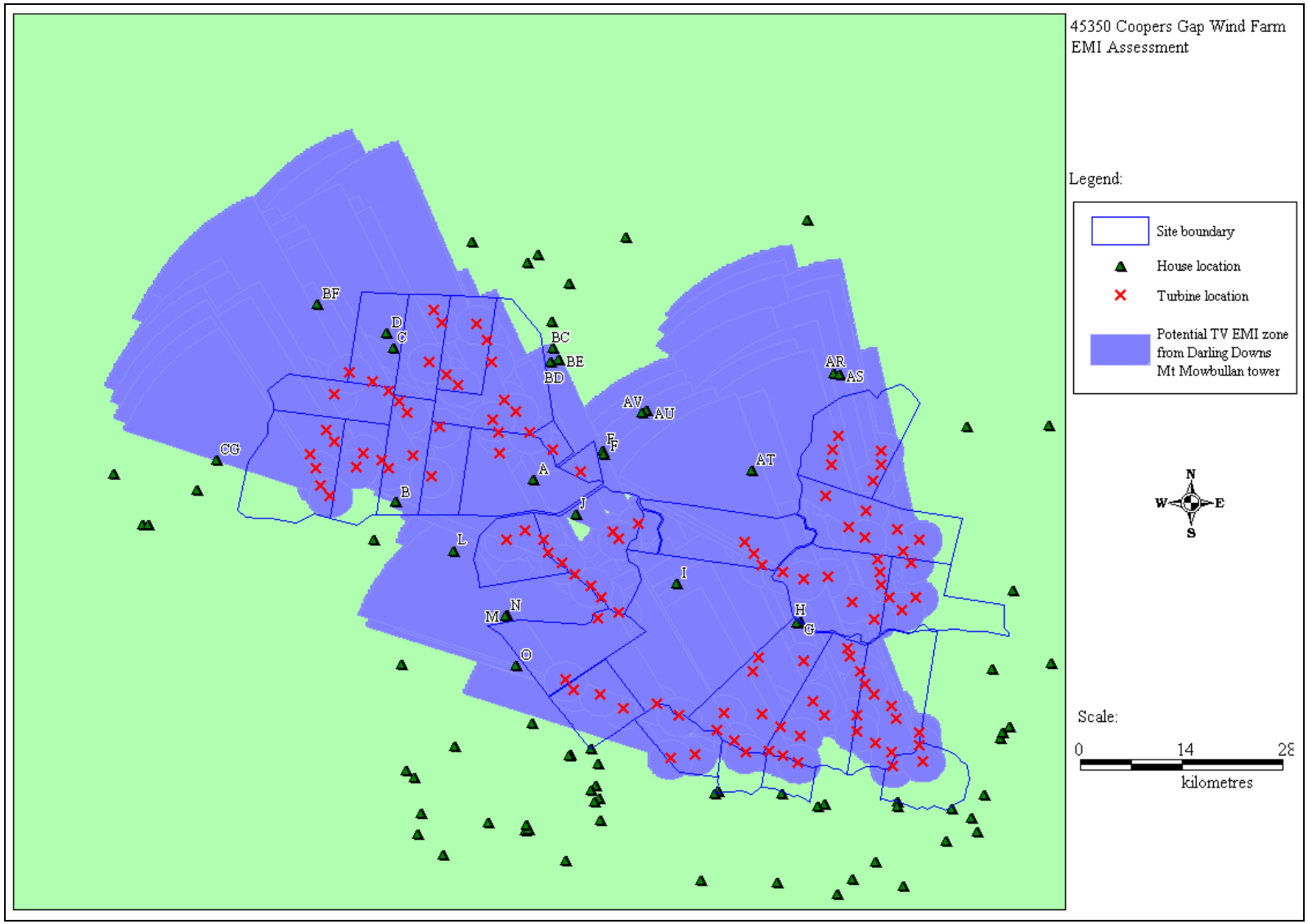

Figure 14 Potential TV EMI zone from Darling Downs transmitter