GL Garrad Hassan

ASSESSMENT OF ELECTROMAGNETIC INTERFERENCE ISSUES FOR THE PALING YARDS WIND FARM

Client	Union Fenosa Wind Australia Pty Ltd
Contact	Lucia Calvo
Document No	45393/PR/01
Issue	F
Status	Final
Classification	Client's Discretion
Date	29 November 2012

Author:

M Clifton-Smith

Checked by:

T Gilbert

Approved by:

M Bechly

Garrad Hassan Pacific Pty Ltd
Level 8, 401 Docklands, Docklands, Victoria 3008, Australia
Phone +61 3 9600-1993 Facsimile +61 3 9602-1714
ABN 19 094 520 760

IMPORTANT NOTICE AND DISCLAIMER

1. This report ("Report") is prepared and issued by Garrad Hassan Pacific Pty Ltd ("GL GH" or "Garrad Hassan") for the sole use of the client named on its title page (the "Client") on whose instructions it has been prepared, and who has entered into a written agreement directly with Garrad Hassan. Garrad Hassan's liability to the Client is set out in that agreement. Garrad Hassan shall have no liability to third parties (being persons other than the Client) in connection with this Report or for any use whatsoever by third parties of this Report unless the subject of a written agreement between Garrad Hassan and such third party. The Report may only be reproduced and circulated in accordance with the Document Classification and associated conditions stipulated or referred to in this Report and/or in Garrad Hassan's written agreement with the Client. No part of this Report may be disclosed in any public offering memorandum, prospectus or stock exchange listing, circular or announcement without the express written consent of Garrad Hassan. A Document Classification permitting the Client to redistribute this Report shall not thereby imply that Garrad Hassan has any liability to any recipient other than the Client.

2. This report has been produced from information relating to dates and periods referred to in this report. The report does not imply that any information is not subject to change.

KEY TO DOCUMENT CLASSIFICATION

Strictly Confidential	:	Recipients only
Private and Confidential	:	For disclosure to individuals directly concerned within the recipient's organisation
Commercial in Confidence	:	Not to be disclosed outside the recipient's organisation
GL GH only	:	Not to be disclosed to non GL GH staff
Client's Discretion	:	Distribution at the discretion of the client subject to contractual agreement
Published	:	Available to the general public

REVISION HISTORY

Issue	Issue date	Summary
A	9.9.11	Original issue (electronic version only)
B	13.10.11	Minor Revision.
C	23.2.12	Minor Revision.
D	10.09.12	Update ACMA database search, revised turbine dimensions.
E	19.09.12	Minor Revision
F	29.11.12	Final Release.

Circulation	Copy No.
UFWA	Electronic
GL GH Pacific	Electronic

Copy No: Electronic

CONTENTS

EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd (GL GH) has been commissioned by Union Fenosa Wind Australia Pty Ltd (UFWA) to independently assess the electromagnetic interference issues associated with the proposed Paling Yards Wind Farm. This report summarises the results of an EMI assessment conducted on the site. Up to date information relating to nearby telecommunication licences has been obtained from the Australian Communications and Media Authority (ACMA) [1].

In accordance with the NSW Director Generals Requirements for the proposed Paling Yards Wind Farm, 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. Radiocommunication services operating in the vicinity of the proposed Paling Yards 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 Paling Yards Wind Farm, with the nearest broadcast tower being at least 37 km from the site, at Wades Hill, Crookwell. However it is unlikely that residents in the vicinity of the Paling Yards Wind Farm receive analogue television broadcasts from this transmission tower. 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, analogue television is gradually being replaced by digital television which is less susceptible to interference from wind turbines. Based on a television reception survey provided by UFWA, digital television signals from Canberra, Orange, Sydney and Wollongong may currently service parts of the area around the Paling Yards wind farm, however there are known areas where residents report digital reception to be marginal, and may therefore be susceptible to interference from the wind farm. There are a range of mitigation options available to rectify difficulties encountered with television reception, however, it is also noted that that the Paling Yards site is in a location for which there is no predicted digital terrestrial television coverage according to the Australian Government [32], and residents are likely to be eligible to receive access to the Government-funded satellite television service.

Wind turbines can potentially cause interference to fixed point-to-point links 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. A transmission tower with fixed licences of point-to-point type is located inside the proposed Paling Yards wind farm boundary to the

west of the site. It has been found that several fixed links utilise this site, and one link utilising this tower intersects with wind turbine locations for the proposed Paling Yards wind farm. An exclusion zone has been established around each point-to-point link based on a standard industry methodology. Three of the turbines proposed for the Paling Yards site are located within one of the exclusion zones. GL GH has contacted the owner of the link, the NSW Rural Fire Service (NSW RFS), who have informed GL GH that the NSW RFS are upgrading their communications. The planned upgrade involves increasing the link frequency to 7.5 GHz (from 450 MHz). This requires an antenna height of 60 m for a reliable link, hence the existing 10m antenna is likely to be upgraded or replaced. However, even with planned upgrade there remain three turbines within the exclusion zone. A number of mitigation options may be possible, namely moving these three turbines or relocating the communications tower. GL GH understands that UFWA will resolve this issue through further consultation with NSW RFS either by relocating the repeater station or relocation of turbines in the vicinity of the link. A second link utilising the tower does not intersect with any proposed turbine locations, however one turbine location has the potential to cause interference through reflection / scattering. GL GH have contacted the owner of the link, NSW Police Force (NSW PF), who have informed GL GH that they plan to decommission the tower in question and hence do not have any objections to the proposed Paling Yards wind farm. A third point-to-point link passes over the eastern region of the wind farm, however an exclusion zone calculated for this link does not intersect any proposed turbine locations as UFWA have proposed smaller rotor diameters for the two turbines closest to the link. GL GH have contacted the owner of the link, Telstra, who have stated that they do not foresee any interference resulting from the Paling Yards wind farm.

Wind turbines can also cause interference with fixed point-to-multipoint links; 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]. There are no point-to-multipoint base stations listed in the ACMA database within 20 km of the proposed Paling Yards Wind Farm boundary. There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, GL GH has contacted operators of the majority of these stations to assess any potential impact that the wind farm could have on their services. To date GL GH have not been informed of any potential impacts by these parties.

In general, Very High Frequency (VHF) and Ultra High Frequency (UHF) frequency 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 NextG 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 Paling Yards Wind Farm have been identified. With the exception of the point-point services identified above, the majority of the licences identified can be broadly described as base to mobile station style communications. As per the above paragraph, these services are essentially unaffected by wind farm development. GL GH has contacted operators of these stations to assess any potential impact that the wind farm could have on their services. To date GL GH have not been informed of any potential impacts by these parties, other than those related to the point-to-point services identified above.

It is possible that wind turbines could cause interference to satellite television and internet services if a wind turbine intercepts the signal between a satellite and ground based receiver. For the Paling Yards Wind Farm, it is expected that interference to satellite television or internet services resulting from the development and operation of the proposed wind farm is unlikely.

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.

GL GH has not considered impact to aircraft navigation systems or aviation radar, as it is understood that impact to these services has been considered as part of the aviation impact study conducted by Aviation Projects.

Wind turbines have the potential to interfere with meteorological and aviation radars. Reflection of radar signals by wind turbine blades may give false readings or create a radar "shadow" behind the turbines. Due to the distance from radar assets, and the high probability that the turbines will lie below the radar line-of-sight, it is unlikely that the proposed Paling Yards Wind Farm will cause interference to aviation radar, or any significant interference to meteorological radar. The Bureau of Meteorology has informed GL GH that the proposed Paling Yards Wind Farm will not cause interference to their meteorological radars. GL GH understands that the Aviation Projects aviation impact study will assess any impact on aviation radar.

There is a possibility that wind farms can interfere with trigonometric stations. To assess these potential impacts GL GH has consulted Geoscience Australia and the New South Wales Land and Property Management Authority (LPMA). Neither organisation has raised any objections to the proposed Paling Yards Wind Farm.

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

1 INTRODUCTION

Union Fenosa Wind Australia Pty Ltd (UFWA) is developing the proposed Paling Yards Wind Farm in New South Wales, Australia. UFWA has instructed Garrad Hassan Pacific Pty Ltd (GL GH) to carry out an independent analysis of 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 GL GH proposal P1150/PP/01 Issue D dated 9 March 2011, and is subject to the terms and conditions contained therein.

The Director-General's Requirements (DGRs) for the preparation of an Environmental Assessment (EA) for the Paling Yards Wind Farm state that the EA must include the identification of possible effects on telecommunication systems. Potential hazards and risks associated with electric and magnetic fields must also be assessed.

In accordance with the DGRs, 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,
- Aviation and meteorological radar,
- Trigonometrical stations,
- Citizens Band (CB) radio and mobile phones,
- Wireless internet
- Broadcast radio,
- Satellite television and internet,
- Broadcast television.

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].

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

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 General site description

The site is located on the western extent of the Great Diving Range, 60 km south of Oberon, 60 km north of Goulburn in NSW and approximately 140 km west of Sydney, as shown in Figure 1.

The site consists of moderately complex terrain with undulating hills and some areas of steep slopes. The elevation across the site ranges between approximately 900 m and 1065 m.

Two options have been assessed to achieve grid connection:

- a connection to the Mt Piper to Bannaby 500 kV transmission line which bypasses the north and east of the site; or
- a 55 km overhead transmission line connection to the approved Crookwell 2 Wind Farm substation which connects to the Yass to Bannaby 330 kV transmission line.

UFWA has indicated that in consideration of the concerns raised through the stakeholder consultation process regarding the potential impact of the proposed extensive transmission lines infrastructure southbound, towards Crookwell 2 Wind Farm substation, it has decided to only propose the northern transmission line route, due to the shorter length and reduced potential impacts.

2.2 The Project

Union Fenosa Wind Australia Pty Ltd (UFWA), the proponent, is seeking project approval for the construction and operation of a wind energy facility to be known as the Paling Yards Wind Farm (the project).

The project comprises a number of elements, including up to 59 individual wind turbines standing a maximum of 175 m at top of blade tip with a maximum rotor diameter of 136 m and a capacity of up to 4.5 MW each [2,3,4].

A turbine layout comprising 59 turbines has been provided by UFWA [3] and has been used for the purpose of the EMI study. Figure 2 shows a map of the site with the proposed turbine layout, elevation contours, and locations of houses in the vicinity of the wind farm as provided by UFWA [5].

2.3 Planning guidelines

The Paling Yards Wind Farm DGRs cite two guidelines relevant to the assessment of EMI. The NSW Wind Energy Facilities Draft EIA Guidelines [6] and the Auswind Best Practice Guidelines [7].

However, in NSW there are no specific guidelines for the assessment of the electromagnetic impact of wind turbines that provide detailed methodologies to assess issues related to EMI from 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 [8]. The draft guidelines cover a range of issues spanning over 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 draft guidelines remain in draft form only, they are likely to be subject to change.

GL GH considers that the recommendations of EPHC draft national guidelines meet, if not exceed, the recommendations of both the NSW Wind Energy Facilities EIA Guidelines and the Auswind Best Practice Guidelines.

The NSW government recently released draft NSW Planning Guide lines for Wind Farms [9]. Although the guidelines were released following the issue of the DGR's for the Paling Yards Wind Farm, GL GH considers that the approach used in this report meets the requirements of the new NSW Draft Guidelines regarding electromagnetic interference.

3 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 fixed point-to-point 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.

The draft guidelines recommend a radial distance of 50-60km from the centre of the wind farm would normally capture all of the potentially affected services in the area. However, the methodology for assessing the potential radiocommunications interference in this assessment is to locate all of the telecommunication towers within 75 km of the proposed wind farm boundary, and then assess the telecommunication licences attached to these towers.

Other services with the potential to experience interference from the project have also been identified, and the potential for interference to those services discussed.

The guidelines in Section 2.3 are met, if not exceeded by this approach.

3.1 Telecommunication towers

An image of the ACMA database dated June 2012 was used for this assessment [1]. From the database, there are 417 telecommunication towers within a nominal 75 km of the wind farm. The locations of these telecommunication towers are shown in Figure 1 relative to the proposed wind farm.

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

3.2.1 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 GL GH has used 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) [8,10,11]. 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 2nd 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 3. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some Country Fire Authority (CFA) towers.

A review of the ACMA database shows that there are three links passing over the proposed wind farm site. These links are shown in greater detail in Figure 4.

References [8,10,11] state that turbines should be located outside of either the first or second Fresnel zone in order to avoid interference to that link. For each of the identified links around the site, an exclusion zone has been established based on their operating frequencies, the second Fresnel zone plus the blade length for turbines with a 136 m rotor diameter. The potential exclusion zones are also shown in Figure 4.

It is common practice to have multiple assignment ID's for the same physical link to cover practicalities such as licensing for sending and/or receiving signals. Accordingly, the Fresnel zone setback has been calculated on the Assignment ID with the lowest frequency. Details of the links are provided in Table 3.

As shown in Figure 4, there are a number of fixed point-to-point links passing over the Paling Yards site. There is also one telecommunications tower within the site boundary. The draft guidelines recommend consultation is required if a turbine is within 2 km of a telecommunication site or if a turbine is located within the 2nd Fresnel zone of a point-to-point link.

There are a number of turbines located within 2 km of a communications tower (Mt Defiance Trig, ACMA site ID 202200). Based on GL GH's site visit, inspection of aerial photos, and GIS files from UFWA, GL GH believes that coordinates in the ACMA database may be inaccurate. The NSW Rural Fire Service (NSW RFS, who utilises the site) has since confirmed to GL GH that the ACMA database coordinates are inaccurate. NSW RFS have supplied the coordinates (-34.145778, 149.750094, WGS84 datum) for the site. These coordinates rather than those used in the ACMA database have been used in this assessment. The closest turbine to the communications tower (P37) is approximately 129 m away. There are three turbines within the 2nd Fresnel zone of link 1218072-1213594 (P41, P42 and P43) and link 8151458-8141887 passes through the site close to turbine P37. Whilst no turbines are located within the exclusion zone for link 8151458-8141887, interference is still possible (via the scattering mechanism described in Section 3.2.2), due to the close proximity of the turbines to the communications tower.

There are also three turbines in the vicinity of the interference buffer zone for link 1235667-1228700 which passes over the eastern side of the site and is operated by Telstra. Turbine P23 is just outside this buffer, however turbines P21 and P22 are within this buffer. UFWA have instructed GL GH that if any turbines are within the interference buffer of link 1235667-1228700 a smaller turbine rotor (117 m) will be selected for these particular turbines. If this smaller rotor is used for turbines P21 and P22 they will be located outside of this buffer. GL GH has contacted Telstra who do not foresee any interference issues arising from the proposed Paling Yards Wind Farm.

GL GH has contacted the owners of the licenses which utilise the Mt Defiance Trig communications tower (ACMA site ID 202200). Both NSW RFS and NSW Police Force (NSW PF) raised concerns that the Paling Yards Wind Farm layout (as currently designed) would deteriorate the communications systems identified by GL GH. However, both the NSW PF and NSW RFS have informed GL GH that they will be upgrading their telecommunications systems in the area. The NSW PF will no longer be utilising the Mt Defiance trig communications tower and hence do not foresee any potential interference resulting from the Paling Yards Wind Farm. The NSW RFS will be upgrading the point-to-point link from a 450 MHz link to a 7.5 GHz link which will be less susceptible to interference from reflection and scattering off wind turbines. This will require an antenna height of 60 m for a reliable link, hence the existing 10m antenna to be upgraded or replaced.

However, even with the upgrade there are still three turbines located in the exclusion zone of the new NSW RFS link as shown in Figure 5.

A number of mitigation options may be available, including moving the three turbines in question outside of the exclusion zone or relocating the communications tower. However it should be noted that there may be significant costs associated with relocating the communications tower. GL GH understands that UFWA has initiated further consultation with NSW RFS and that the UFWA will resolve this issue through consultation with NSW RFS either by relocating the repeater station or relocating turbines in the vicinity of the link. GL GH notes that the NSW RFS requests if the three turbines are moved then that they are sent the revised layout to reassess potential interference.

An assessment was carried out to determine if the links pass over the proposed wind farm at a height that was well above the highest point of the turbines (Hub height + blade length = 175 m). This was achieved by examining the elevation and tower heights at each end of the link, as well as the approximate elevation of the areas within the wind farm boundaries over which the links cross. It was determined that the links do cross the site at a height which has the potential to intersect with turbine blades.

3.2.2 Near field effects and scattering

The recently released draft National Wind Farm development Guidelines [8] 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 guidelines also state that scattering is best avoided by placing wind turbines more than 2 km from a communication tower.

The only communication tower within 2 km from of a planned turbine location tower is the Mt Defiance Trig station. As discussed above, GL GH has contacted the operators of licenses utilising this communications tower. All other communication towers are greater than 2 km from the proposed Paling Yards wind farm and therefore are not expected to receive interference due to near field effects or scattering.

3.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of the point-to-point type. The difference between them is administrative. A point-to-point licence permits communication between two static sites, where the locations of the sites are detailed in the 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 the 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 79 Assignment ID's were identified within approximately 75 km of the proposed site boundary. These licences are shown in Figure 6. The details of the licence holders as per the ACMA database are provided in Table 4.

There are no point-to-multipoint base stations listed in the ACMA database within 20km of the proposed Paling Yards Wind Farm boundary. There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, GL GH has contacted operators of the majority of stations within 60km from the centre of the Paling Yards project to assess any potential impact that the wind farm could have on their services. To date GL GH have not been informed of any potential impacts by these parties.

3.4 Other licence types

A review of the ACMA database for other licences was conducted. These licences are shown in Table 5.

Many of the licences identified can be broadly described as base to mobile station style communications, including 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. Should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services, and are broadly covered in Sections 3.14 and 3.15.

A number of aeronautical licences, and radiodetermination licences which may be used for aircraft navigation, have been identified. Potential impacts to these services have been highlighted as part of the aviation study conducted by Aviation Projects.

3.5 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. The groups identified are listed in Table 7 along with their contact details. While no direct interference to services have been determined (apart from those identified in Section 3.2.1), GL GH has contacted each service with a site located within 60km from the centre of the wind farm as part of the consultation process. Apart from the parties already identified in Section 3.2.1, no potential issues have been raised.

3.6 Aircraft Navigation Systems

GL GH understands that Aviation Projects has been commissioned to perform an independent study of the impact of the wind farm on aviation systems. Therefore, these potential impacts are not considered here.

3.7 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 aircrafts 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 due to terrain obstructions and curvature of the earth.

The Draft National Wind Farm Development Guidelines recommend that radar operators be notified of the development of wind farms within 250 nautical miles (463 km) of aviation radar operators [8]. Radar installations are typically located at major airports. As shown in Figure 8, the proposed Paling Yards wind farm is located approximately 140 km from Canberra airport and 130 km from the Sydney international airport. GL GH understands that there is no radar installation at Goulburn airport, which is located approximately70 km from the site.

Due to the significant distance from major airports, and the high probability that the turbines will lie below the radar line-of-sight, it is unlikely that the Paling Yards wind farm will cause interference with aviation radar. GL GH assumes that Aviation Projects will assess the impact of the proposed Paling Yards wind farm on aviation radar.

3.8 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 as 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 [8]. 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 [12, 13], and approximately 100 km at a height of 1000 m [13]. Due to the curvature of the earth, and intervening terrain, the range at or near ground level is generally less.

According to the Draft National Wind Farm Development Guidelines, consultations with operators of weather stations within 250 nautical miles of the proposed wind farm should be undertaken [8]. It has been identified that the BoM operates eight weather stations within that range with the closest station "Sydney" located approximately 100 km east of the proposed Paling Yards wind farm site. The locations of these stations are shown in Figure 8 and the details of each station can be found in Table 6.

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.

The draft guidelines recommend that the Bureau of Meteorology be contacted regarding the potential for interference from the any proposed wind farm development. GL GH has contacted the Bureau of Meteorology regarding potential interference to their infrastructure from the Paling Yards Wind Farm. The Bureau of Meteorology has informed GH that the proposed Paling Yards wind farm should not cause interference to any of their radars under nominal atmospheric and microwave propagation conditions.

3.9 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 [14].

The Australian Fiducial Network (AFN) is fundamental to the whole Geodetic network of Australia [15]. 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 [16].

GL GH has also undertaken a review of the Primary Geodetic Network of Australia [17] and it has been observed that the proposed Paling Yards wind farm is located in the region of second-order triangulation. 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 [18], there are 35 trig points within 30 km of the Paling Yards site boundary. The details of all 35 trig points are provided in Table 8 and illustrated in Figure 9. One Trig point, 'Defiance', is located within the wind farm boundary.

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, GL GH has contacted Geoscience Australia and the New South Wales Land and Property Management Authority (LPMA) regarding the potential for interference from the Paling Yards Wind Farm.

Geoscience Australia has informed GL GH that they foresee no potential issues arising from the Paling Yards Wind Farm development.

LPMA has requested that UFWA preserve the integrity of the Defiance trig point on the basis of historical preservation. Whilst LPMA have informed GL GH that there will be a shadowing effect of the trig station by two of the turbines, but they do not object to the proposed design. If the turbine layout is altered, a new approval will be required.

3.10 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 Paling Yards 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.

3.11 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, it is theoretically possible that wind turbines could cause some interference to the signal, although there is little evidence of this in the literature.

Mobile phone network coverage maps have been obtained for Telstra and Optus [19, 20]. Telstra's website [19] states that there is currently no cellular mobile coverage (3G or GSM) in the Paling Yards area. Figure 10 show the Optus network coverage for the Paling Yards area. The Optus mobile network coverage in the area is marginal. There is no coverage in most locations in the vicinity of the wind farm and the areas with coverage require 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 also marginal in the area with only higher elevation locations having reception, and some of those locations requiring an external antenna. Figure 11 shows the NextG network coverage for the Paling Yards wind farm development area.

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

3.12 Wireless Internet

Ace Internet Sevices hold point-to-multipoint licences in East Bowral and Joadja. Their website states that "coverage is also possible throughout the Southern Highlands (subject to signal test...)" [21]. As the locations of Ace Internet customers are not known, it is not possible to determine whether there is the potential for interference to Ace Internet's service. However, as the nearest licensed base station is located 55 km from the Paling Yards site, it is unlikely that stations at this distance will be servicing customers in the vicinity of the proposed wind farm.
Additionally, residents in the vicinity of the wind farm have indicated they utilise Telstra NextG wireless broadband services. The NextG wireless broadband service utilises the same network as the NextG mobile phone service, and therefore the comments made in Section 3.11 are applicable here.

Specifically, the presence of wind turbines is unlikely to cause any interference. However should interference occur, the simple mitigation options given in Section 3.11 may be applicable.

3.13 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. GL GH understands that there are currently 21 satellites that provide television to the east coast of Australia [22].

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

2 way connection to the Internet via Satellite [23]

Due to marginal coverage of some communication services, a number of residents in the vicinity of the Paling Yards wind farm may utilise satellite television and internet. The survey of reception patterns from landowners at the Paling Yards site supplied by UFWA confirmed that satellite internet services are utilised [5].

According to the Australian ISP directory [24], there are a number of satellite ISPs servicing the area and the majority of them are using a single IPSTAR satellite, Thaicom-4. Some may be using the Telstra Bigpond service which relies on the AsiaSat-3S satellite. From the Paling Yards Wind Farm site, the Thaicom-4 satellite has an elevation of approximately 39.2° [25], hence a turbine would need to be within 216 m of a house to impact upon the line of sight of this satellite, assuming the house and turbine are at the same elevation. The Asiasat-3S satellite, has an elevation of 28.7° at the Paling Yards site, and would require a turbine to be within 320 m of a house at the same elevation in order to intersect the line of sight between the house and satellite. A review of the relative horizontal position and height of all turbine and house locations at the Palings yard site has been carried out, and it is unlikely that the signals from these two satellites will be intercepted by turbines at the wind farm at any of the existing house locations considered.

The main satellite for pay TV and free-to-air TV in Australia is the Optus C1 satellite. From the Paling Yards wind farm site, the Optus-C1 satellite has an Elevation of approximately 49.3° [25]. As above, it is unlikely that the proposed Paling Yards wind farm will impact upon the line of sight from this satellite to any house.

A review of the line of sight between all usable TV and internet satellites and houses identified in the region of Paling Yards wind farm has been undertaken. It has been found that no turbines intercept the line–of-sight of the internet satellite or TV satellites commonly used in Australia.

3.14 Radio broadcasting

GL 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 Paling Yards wind farm are shown in Figure 12.

3.14.1 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 [26]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna and/or amplifier.

3.14.2 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 [26], and should be easily rectified through the installation of a high quality antenna and/or amplifier.

3.14.3 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 [27]. According to the digital radio coverage map available on the ABC website [28], digital radio is not yet available in the Paling Yards region.

3.15 Television Broadcasting

3.15.1 Analogue Television

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 (houses);
- location of wind turbines in relation to houses 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 [10], while a clearance of at least 6 km is recommended for primary TV transmitters.

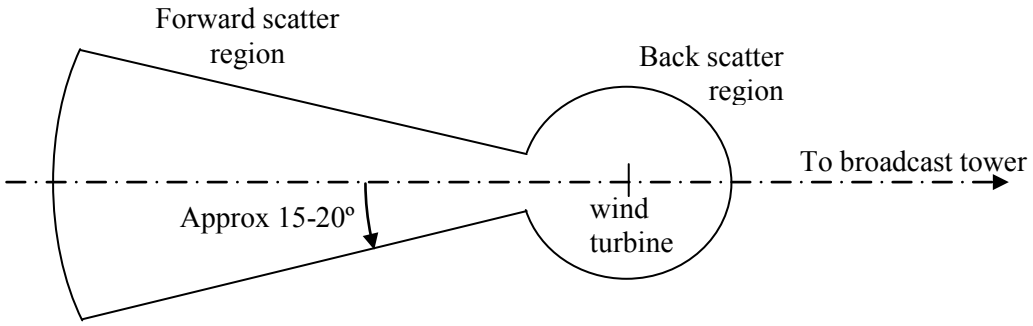
The Broadcast Transmitter Database [29] was examined to identify broadcasters nearby to the proposed wind farm, with those found shown in Figure 13.

Local interference to analogue television signals could potentially occur at individual houses in and around the proposed wind farm. A wind turbine has the potential to scatter analogue television waves both forward and back.

Forward scatter will only occur if a wind turbine is located approximately between the house 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 [10, 30, 33]. Interference may extend beyond 5 km if the houses are screened from the broadcast tower, but do have line-of-sight to the wind turbines [33]. 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 (AGCs) which act to lessen or eliminate variations in picture gain or brightness.

Back scattered signals arrive at the house 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 [10, 30]. If a house 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 houses 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 Paling Yards wind farm, both back and forward scatter regions have been determined based on the proposed wind farm layout.

The nearby broadcast towers were examined utilising reception coverage maps provided on the ABC Reception Advice website [31] and a survey of reception patterns from landowners at the Paling Yards site [5]. It was apparent that that the preferred sources of television signals for the area around the wind farm are Black Mountain in Canberra, Central Tablelands transmitter at Mount Canobolas (near Orange), the Illawarra transmitter at Knights Hill (near Wagga Wagga) and the Sydney transmitter at Gore Hill.

Therefore, the regions where there may be the potential for television interference have been identified using the keyhole approach based on Black Mountain, Mount Canobolas, Illawarra and Sydney broadcast towers, with the results shown in Figure 14. Each figure also shows the location of nearby houses as provided by UFWA [2].

As shown in the figures, there are several houses that fall within the potential analogue TV EMI regions based on each broadcast tower and a list of houses likely to be affected by one or several of the towers is shown in Table 9. It should be mentioned that some houses affected by the TV EMI zone from one specific transmitter may already be tuned to another transmitter.

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.

It should be noted that analogue television is being phased out across Australia. The majority of the analogue transmitters currently operating in regional areas of southern NSW will be switched off during 2012 [33]. Therefore, transmissions from most of the analogue transmitters whose signals can be received in the vicinity of the wind farm may have been ceased by the time the wind farm is constructed.

The method used here to assess the potential interference to analogue television signals from the Paling Yards 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.

3.15.2 Digital television

The introduction of digital television broadcasts provides an attractive amelioration option for houses in and around wind farms as digital television signals are generally unaffected by wind turbines. GL GH has experience in situations where houses 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.

However, a document recently published by the UK telecommunications regulator Ofcom [33], 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".

GL 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 should be a satisfactory amelioration option for 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 [31], the area around the Paling Yards wind farm is just outside the adequate coverage areas to be able to receive a digital television signal from the Black Mountain, Mount Canobolas, Illawarra and Sydney broadcast towers. In other words the coverage maps suggest there may be areas around the site with marginal or no digital reception.

The survey of reception patterns from landowners at the Paling Yards site supplied by UFWA [5] confirmed that residents utilise some digital television broadcasts whilst others utilised analogue television broadcasts or a mixture of the two. Digital reception is marginal at some of the existing residences and dependent on signal boosters or better quality set top boxes. In the event that the wind farm causes interference to digital television signals, the mitigation options below may be used to rectify the problem.

It is also noted that that the Paling Yards site is in a location for which there is no predicted digital terrestrial television coverage according to the Australian Government Digital Ready mySwitch website [32]. It is therefore likely that if digital reception is marginal, residents in the vicinity of the Paling Yards Wind Farm will be eligible to receive access to the Government-funded satellite television service to view free-to-air television.

3.15.3 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 increasing 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 house;
4. Relocating the antenna to a less affected position;
5. The installation of a digital set top box (and UHF antenna if required);
6. The installation of cable/satellite TV at the affected house; and
7. Installation of a TV relay station.

In the event that digital TV does not provide an acceptable amelioration option, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription based broadcasts.

4 CONCLUSIONS

Broadcast towers and transmission paths around the proposed Paling Yards Wind Farm were investigated to see if EMI would be experienced as a result of the development of the proposed Paling Yards Wind Farm. The proposed wind farm would involve the installation of up to 59 turbines, with a rotor diameter of up to 136 m, and maximum blade tip height of 175 m.

4.1 Fixed point-to-point microwave links

Several point-to-point microwave links were identified with a path over, or near to the proposed wind farm boundary. Of these links, two links (involving six fixed licences in total) were identified passing through wind turbine locations. Further analysis showed that those links passed close enough to the ground over the proposed wind farm site such that turbines could potentially interfere with the signal. The interference zones around these point-to-point links have been identified and it has been found that five turbines from the Paling Yards Wind Farm have the potential to cause interference to the links.

For the first link, operated by Telstra, two turbines may interfere with the link when a rotor diameter of 136 m is considered. However UFWA has indicated they intend to reduce the rotor diameter of these turbines to 117 m, which would mean the turbines are unlikely to interfere with the link. Telstra, have informed GL GH that they do not foresee any interference issues arising from the proposed Paling Yards Wind Farm.

For the second link, operated by the NSW RFS, three turbines may interfere with the link. A number of mitigation options may be available, including moving the three turbines in question outside of the exclusion zone or relocating the communications tower. However it should be noted that there may be significant costs associated with relocating the communications tower. GL GH understands that UFWA will resolve this issue through further consultation with NSW RFS either by relocating the repeater station or relocation of turbines in the vicinity of the link. GL GH notes that the NSW RFS requests if the three turbines are moved then that they are sent the revised layout to reassess potential interference.

4.2 Point-to-multipoint microwave links

There are no point-to-multipoint base stations listed in the ACMA database within 20km of the proposed Paling Yards Wind Farm boundary. There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. It is not possible to determine if there are any potential impacts without knowing the locations of each station in the multipoint network. However, it is unlikely that stations at this distance will be servicing customers in the vicinity of the site. GL GH has contacted operators of the majority these stations to assess any potential impact that the wind farm could have on their services. To date GL GH have not been informed of any potential impacts by these parties.

4.3 Other licence types

A review of other licences within 75 km of the proposed Paling Yards site was conducted. Many of 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.

A number of aeronautical and radiodetermination licenses have been identified. It is assumed that impact to these services will be assessed as part of the Aviation Projects study on the impact of the wind farm on aviation.

4.4 Emergency Services

Emergency services with radiocommunications assets in the vicinity of the site have been identified and contacted to determine if there is the potential for impact to their services. No concerns, apart from those identified in Section 4.1, have been raised.

4.5 Aircraft Navigation Systems

GL GH understands that Aviation Projects will complete an independent study of the impact of the wind farm on aviation.

4.6 Aviation radar

The proposed Paling Yards Wind Farm is located approximately 140 km from Canberra Airport and 130 km from Sydney International Airport. Due to the significant distance of the major airports from the wind farm and the high probability that the turbines will lie below the aviation radar line-of-sight, it is unlikely that the proposed Paling Yards Wind Farm will have an impact on aviation radar.

GL GH assumes that the Aviation Projects study will include an independent study of the impact of the wind farm on aviation radar.

4.7 Meteorological radar

GL GH has also undertaken an assessment of the Bureau of Meteorology (BoM) radar stations operating in the vicinity of the proposed wind farm and the closest station is located at approximately 150 km southeast 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, however in accordance with the Draft National Wind Farm Development Guidelines; the BoM has been consulted regarding potential impact to their services. The BoM has informed GH that the proposed Paling Yards wind farm should not cause interference to the Wollongong or Sydney radars under nominal atmospheric and microwave propagation conditions.

4.8 Trigonometrical stations

A total of 35 trigonometrical stations have been identified in the vicinity of the proposed Paling Yards wind farm, and although they are unlikely to host equipment that is susceptible to electromagnetic interference, Geoscience Australia and the New South Wales Land and Property Management Authority (LPMA) have been contacted to confirm there is no potential for interference from the Paling Yards Wind Farm.

Geoscience Australia has informed GL GH that they foresee no potential issues arising from the Paling Yards Wind Farm development.

LPMA has requested that UFWA preserve the integrity of the Defiance trig point on the basis of historical preservation. Whilst LPMA have informed GL GH that there will be a shadowing effect of the trig station by two of the turbines, but they do not object to the proposed design. If the turbine layout is altered, a new approval will be required.

4.9 Citizens Band Radio

Users of Citizen Band radio do not require a licence and GL 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.

4.10 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 the general area around the Paling Yards 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 will help to improve the signal quality.

4.11 Wireless Internet

Ace Internet Services may provide wireless internet services to houses in the vicinity of the Paling Yards Wind Farm, however it is not possible to identify customers who are using the Ace Internet service. It is unlikely that stations at this distance will be servicing customers in the vicinity of the site,

4.12 Satellite Television and Internet

Residents in the vicinity of the wind farm may also have access to satellite television and internet. GL GH has reviewed the line-of-sight of the commonly used TV and internet satellite and it has been found that no turbine intercepts the line-of-sight between houses in the vicinity of the wind farm and these satellites.

4.13 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 not available in the Paling Yards area.

4.14 Television Broadcasting

Broadcast towers around the proposed Paling Yards 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 Paling Yards wind farm site where interference to analogue television could potentially occur. A total of 11 houses could potentially experience interference when tuned to the Canberra transmitter at Black Mountain, 16 houses if tuned to the Central Tablelands transmitter at Mount Canobolas, 10 houses if tuned to the Gore Hill transmitter in Sydney and 6 houses if tuned to the Knights Hill transmitter at Illawarra.

However it should be noted that analogue television is being phased out across Australia. The majority of the analogue transmitters currently operating in regional areas of southern NSW will be switched off during 2012 [33]. Therefore, transmissions from most of the analogue transmitters whose signals can be received in the vicinity of the wind farm may have been ceased by the time the wind farm is constructed.

In addition the Paling Yards site is in a location for which there is no predicted digital terrestrial television coverage according to the Australian Government Digital Ready mySwitch website [32]. It is therefore likely that if digital reception is marginal, residents in the vicinity of the Paling Yards Wind Farm will be eligible to receive access to the Government-funded satellite television service to view free-to-air television.

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 antenna 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 digital set top box (and UHF antenna, if required);
6. The installation of a cable or satellite TV receiver at the affected house; and
7. Installation of a TV relay station.

5 REFERENCES

1. "Record of Radiocommunications Licences (RRL)", Australian Communications and Media Authority (ACMA), issued June 2012-06-01
2. "RE: 45393 RE: 20120411- Paling Yards, EMI Variation", Email from Lucia Calco, UFWA to M Clifton-Smith, GL GH, 11 April 2012.
3. Turbines coordinate data set, provided by UFWA, 18th March 2011.
4. "RE: 45393 RE: 20120411- Paling Yards, EMI Variation", Email from Lucia Calco, UFWA to T Gilbert, GL GH, 12 September 2012.
5. "Paling Yards, Door-Knock v2", email from L Calvo UF to M Clifton-Smith of GL GH, 10 August 2011.
6. Planning NSW, "Wind Energy Facilities" draft Environmental Impact Assessment Guidelines", June 2002.
7. Auswind, "Best practice Guidelines for Implementation of Wind Energy Projects in Australia", December 2006.
8. EPHC, "National Wind Farm Development Guidelines- Public Consultation Draft", released July 2010, http://www.ephc.gov.au/sites/default/files/Draft_National_Wind_Farm_Development_Guidelines__Oct09.pdf
9. NSW Planning and Infrastructure, "Draft NSW Planning Guidelines, Wind Farms", December 2011
10. Hall, S.H, 1992, "The assessment and avoidance of Electromagnetic Interference due to Wind farms", Wind Engineering, Vol 16 No 6, pp 326-338
11. Bacon, D.F., "Fixed-link wind-turbine exclusion zone method", Version 1.1, 28 October 2009
12. "Optimal radar coverage areas", Bureau of Meteorology, accessed 30 June 2009, http://www.bom.gov.au/weather/radar/about/radar_coverage_national.shtml
13. "Radar Frequently Asked Questions", Bureau of Meteorology, accessed 30 June 2009, http://www.bom.gov.au/weather/radar/about/radarfaq.shtml
14. Nascarella J, 2000, "Equipment database-EDM", Department of Geomatics, University of Melbourne, http://www.geom.unimelb.edu.au/SurveyNetworksSite/SurveyNetworks/Console/Info/Equipment/equipmentdb.html
15. "Geodesy and GDA", Land and Property Management Authority, New South Wales Government, http://www.lpma.nsw.gov.au/survey_and_maps/geodesy
16. "Australian Fiducial Network", Geoscience Australia, Australian Government, http://www.ga.gov.au/geodesy/argn/afngiff.jsp

17. "Fundamentals of Mapping- Survey for Mapping", Intergovernmental Committee on Surveying and Mapping (ICSM), http://www.icsm.gov.au/mapping/surveying1.html
18. GeoScience Australia, "National Geospatial Reference System", 20 July 2011, http://webmap.ga.gov.au/ngrs/
19. "Telstra Mobile coverage maps", Telstra, 2011, viewed 19 July 2011 http://www.telstra.com.au/mobile/networks/coverage/maps.cfm
20. "Optus Network Coverage", Optus, 2011, viewed , viewed 20 July 2011 http://www.optus.com.au/aboutoptus/About+Optus/Network+Coverage
21. Ace Internet Services, Airstream, accessed on 15 June 2012, http://www.acenet.com.au/airstream
22. HanTrex Australian Satellite TV", accessed on 15 July 2011, http://www.australiansatellitetv.com/whatcaniwatch.htm
23. "Bentley Walker: Internet via Satellite Anywhere", accessed on 15 July 2011, http://www.bentley-walker.com/technology.php
24. "The Australian ISP directory", accessed 15 July 2011, http://bc.whirlpool.net.au/
25. http://www.dishpointer.com/
26. Spera, D.A. (ed.), "Wind Turbine Technology", ASME Press, 1994.
27. "Digital Radio", Australian Communications and Media Authority (ACMA), accessed 30 June 2010, http://www.acma.gov.au/WEB/STANDARD/pc=PC_9191
28. "Sydney digital radio coverage map", ABC Radio, viewed 20 July 2011 http://www.abc.net.au/radio/digital/
29. "List of licensed broadcasting transmitters", Australian Communications and Media Authority, 2011, viewed 20 July 2011, http://www.acma.gov.au/WEB/STANDARD/pc=PC_9150
30. "Assessment of the impairment caused to television reception by a wind turbine", Recommendations ITU-R BT.805, 1992
31. "ABC Transmitter Frequencies- ABC Reception Advice", Australian Broadcasting Corporation, accessed 20 July 2011, http://www.abc.net.au/reception/freq/
32. "mySwitch", Australian Government, 2012, viewed 24 August 2011, http://www.digitalready.gov.au/MySwitch.aspx.
33. "Southern and central NSW, the ACT and MIA", Digital TV Switchover Australia, Australian Government, viewed 24 August 2012, http://www.digitalready.gov.au/SNSW.aspx
34. "Tall structures and their impact on broadcast and other wireless services", Ofcom, http://licensing.ofcom.org.uk/radiocommunication-licences/fixed-terrestrial-links/guidance-for-licensees/wind-farms/tall_structures/, 26 August 2009.
35. http://web.acma.gov.au/pls/radcom/register_search.search_dispatcher

LIST OF TABLES

LIST OF FIGURES

Turbine Model	Maximum Values of all models under consideration
No of Turbines	59
Turbine capacity	4.5
Rotor diameter (m)	136
Total Height to tip (m)	175
Total Wind Farm Capacity (MW)	250

Table 1. Turbine dimensions under consideration by UFWA with the greatest potential for EMI.

Turbine ID	Easting[1] (m)	Northing[1] (m)	Turbine ID	Easting[1] (m)	Northing[1] (m)
P1	747801	6214761	P32	751654	6217234
P2	748312	6214437	P33	751942	6217474
P3	748520	6214803	P34	752209	6217766
P4	748804	6214973	P35	751953	6218025
P5	749055	6215129	P36	753234	6217980
P6	749245	6213667	P37	753414	6218296
P7	749278	6214044	P38	753670	6217768
P8	749638	6214879	P39	753790	6218102
P9	750046	6215203	P40	753716	6219273
P10	750488	6215520	P41	753756	6218710
P11	750673	6216153	P42	753851	6219051
P12	750521	6215025	P43	753990	6219495
P13	750856	6215277	P44	754258	6219703
P14	751065	6215503	P45	754453	6219950
P15	750791	6214083	P46	754724	6220154
P16	751181	6214433	P47	754673	6220559
P17	751425	6214787	P48	755149	6220270
P18	751942	6215115	P49	755527	6220446
P19	751765	6215480	P50	756080	6220346
P20	751924	6215913	P51	756446	6220552
P21	752759	6214377	P52	757360	6219305
P22	752945	6214652	P53	757575	6219025
P23	753154	6215077	P54	757656	6218768
P24	753359	6216136	P55	757565	6218414
P25	752937	6216108	P56	757293	6218235
P27	752654	6216325	P57	757117	6217957
P28	752167	6216399	P58	756711	6217870
P29	752969	6216601	P59	757016	6217565
P30	752971	6216909	P60	757375	6217237
P31	751295	6216935			

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

Table 2 Proposed turbine layout for Paling Yards wind farm.

Assignment ID	Licence Number	Frequency (MHz)	Postal Address
Point-to-point links originating within the Paling Yards boundary			
1218073-1213594	1212495	450.7	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142 ABN 25003129221
1218073-1213595	1212495	450.7	
1216232-1213594	1212495	460.2	
1216232-1213595	1212495	460.2	
8151458-8141887	1229049	853.2	NSW Police Force Level 4 151-241 Goulburn St SURRY HILLS NSW 2010 ABN 43408613180
8151458-8141883	1229049	853.2	
8151462-8141892	1229049	929.2	
8151462-8141898	1229049	929.2	
Point-to-point links crossing eastern side of the Paling Yards boundary			
1235667-1228700	1231888	10558	Telstra Corporation Limited 15/242-282 Exhibition St (R Curtis) MELBOURNE VIC 3000
1235667-1228699	1231888	10558	
1235666-1228700	1231888	10623	
1235666-1228699	1231888	10623	

Table 3 Details of point-to-point links in the vicinity of Paling Yards wind farm (continued)

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
1222061-1216718	1217864	203217	262740E 6180120N Zone 56	72	Bowral Golf Club PO Box 934 BOWRAL NSW 2576
1222062-1216718	1217864	203217	262740E 6180120N Zone 56	72	
1235565-1228611	1231600	205697	762941E 6172939N Zone 55	45	Bureau of Meteorology GPO Box 1289 (Comms Section) MELBOURNE VIC 3001
1235572-1228618	1231607	205701	752927E 6150092N Zone 55	67	
1235592-1228638	1231627	205714	763482E 6245455N Zone 55	30	
1235564-1228610	1231599	9480	224000E 6170700N Zone 56	51	
1235574-1228620	1231609	35638	245752E 6186489N Zone 56	54	
1235575-1228621	1231610	54625	254880E 6193300N Zone 56	59	
1235576-1228622	1231611	205704	266300E 6217700N Zone 56	66	
1235582-1228628	1231617	9297	258056E 6246815N Zone 56	66	
1235584-1228630	1231619	9308	247609E 6248912N Zone 56	58	
1235585-1228631	1231620	205709	245343E 6278602N Zone 56	78	
1235586-1228632	1231621	9301	263850E 6227070N Zone 56	65	
8237815-8256343	1914551	9004467	702220E 6274850N Zone 55	77	Central Tablelands County Council PO Box 61 BLAYNEY NSW 2799
8237817-8256344	1914551	9004467	702220E 6274850N Zone 55	77	

Note: 1. Coordinate system used is AGD66 datum

Table 4 Details of point-to-multipoint licences within 75 km of Paling Yards wind farm

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
1423200-1418359	1427988	404074	749890E 6148994N Zone 55	68	Endeavour Energy PO Box 6366 (J Chadd K60926) BLACKTOWN DC NSW 2148
1423201-1418359	1427988	404074	749890E 6148994N Zone 55	68	
1424260-1419213	1429638	404074	749890E 6148994N Zone 55	68	
1424261-1419213	1429638	404074	749890E 6148994N Zone 55	68	
1101765-1101964	1103991	10522	679500E 6245300N Zone 55	79	Cowra Shire Council Private Bag 342 COWRA NSW 2794
1101766-1101964	1103991	10522	679500E 6245300N Zone 55	79	
8315252-8352211	1938510	9011047	260920E 6181305N Zone 56	70	Ace Internet Services Pty Ltd 071944959 Locked Bag 4000 BOWRAL NSW 2576
8337834-8379151	1948869	9015800	248842E 6183587N Zone 56	59	
8337835-8379152	1948870	9015800	248842E 6183587N Zone 56	59	
8337836-8379153	1948871	9015800	248842E 6183587N Zone 56	59	
7938-27329	26488	35237	745950E 6152490N Zone 55	65	Goulburn City Council Locked Bag 22 GOULBURN DC NSW 2580
314882-27329	26488	35237	745950E 6152490N Zone 55	65	
1102936-1102855	1105029	100872	774650E 6155890N Zone 55	65	Goulburn Mulwaree Council Locked Bag 22 GOULBURN NSW 2580
1102937-1102855	1105029	100872	774650E 6155890N Zone 55	65	

Note: 1. Coordinate system used is AGD66 datum

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

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
9048-1542	32207	9362	263670E 6183150N Zone 56	72	Endeavour Energy PO Box 6366 (J Chadd K60926) BLACKTOWN DC NSW 2148
16383-1095	52078	9344	277820E 6209670N Zone 56	78	
315345-1542	32207	9362	263670E 6183150N Zone 56	72	
319164-1095	52078	9344	277820E 6209670N Zone 56	78	
1217042-1212663	1213142	9362	263670E 6183150N Zone 56	72	
1217053-1212663	1213142	9362	263670E 6183150N Zone 56	72	
1420863-1416593	1424378	403407	260570E 6175201N Zone 56	73	
1420864-1416594	1424379	403409	267877E 6186055N Zone 56	74	
8175591-8174651	1184813	9002254	238331E 6162368N Zone 56	66	
8175597-8174659	1184813	9002254	238331E 6162368N Zone 56	66	
8216842-8229360	1904656	10338	251107E 6267086N Zone 56	73	
8216845-8229365	1904656	10338	251107E 6267086N Zone 56	73	
8292386-8322828	1933491	10338	251107E 6267086N Zone 56	73	
8292387-8322829	1933491	10338	251107E 6267086N Zone 56	73	

Note: 1. Coordinate system used is AGD66 datum

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

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
8304177-8337869	1937896	10338	251107E 6267086N Zone 56	73	Endeavour Energy PO Box 6366 (J Chadd K60926) BLACKTOWN DC NSW 2148
8304178-8337870	1937896	10338	251107E 6267086N Zone 56	73	
1224830-1218775	1220705	100685	712513E 6236155N Zone 55	45	State Water Corporation Private Bag 2 (C/- A Burrell) WODONGA VIC 3691
1224831-1218775	1220705	100685	712513E 6236155N Zone 55	45	
1224832-1218776	1220706	10652	702120E 6274720N Zone 55	77	
1224833-1218776	1220706	10652	702120E 6274720N Zone 55	77	
1224834-1218777	1220708	9534	706300E 6217500N Zone 55	47	
1224835-1218777	1220708	9534	706300E 6217500N Zone 55	47	
1224836-1218778	1220709	10522	679500E 6245300N Zone 55	79	
1224837-1218778	1220709	10522	679500E 6245300N Zone 55	79	
1232143-1225579	1228355	10428	772767E 6264594N Zone 55	51	
1232144-1225579	1228355	10428	772767E 6264594N Zone 55	51	
1232145-1225580	1228356	10593	777549E 6292318N Zone 55	79	
1232146-1225580	1228356	10593	777549E 6292318N Zone 55	79	

Note: 1. Coordinate system used is AGD66 datum

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

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
1203253-1202154	1202983	200515	774300E 6201900N Zone 55	26	Telstra Corporation Limited 22/35 Collins Street MELBOURNE VIC 3000
1203520-1202154	1202983	200515	774300E 6201900N Zone 55	26	
21958-41707	65291	36699	250785E 6265961N Zone 56	72	
21980-41708	65314	36699	250785E 6265961N Zone 56	72	
323344-41707	65291	36699	250785E 6265961N Zone 56	72	
323366-41708	65314	36699	250785E 6265961N Zone 56	72	
1203252-1202161	1202981	9377	230746E 6199614N Zone 56	35	
1203254-1202133	1202984	200514	239110E 6196722N Zone 56	44	
1203485-1202133	1202984	200514	239110E 6196722N Zone 56	44	
1203529-1202161	1202981	9377	230746E 6199614N Zone 56	35	
1206014-1205301	1204710	10409	230350E 6213820N Zone 56	30	
1207879-1205301	1204710	10409	230350E 6213820N Zone 56	30	
1221840-1216599	1217740	203170	253803E 6265216N Zone 56	73	The Leura Golf Club Ltd Leura Golf Club Sublime Point Road LEURA NSW 2780

Note: 1. Coordinate system used is AGD66 datum

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

Assignment ID	ACMA Licence No	Site ID	Location[1]	Distance to PYWF (km)	Contact Details
81689-27327	178455	41454	728075E 6184610N Zone 55	41	Upper Lachlan Shire Council Upper Lachlan Council PO Box 42 GUNNING NSW 2581
358979-27327	178455	41454	728075E 6184610N Zone 55	41	
1828255-2243775	1932398	139601	761111E 6190131N Zone 55	28	
1828256-2243775	1932398	139601	761111E 6190131N Zone 55	28	
8262242-8287426	1923806	53795	249753E 6266558N Zone 56	71	Vertical Telecoms Pty Limited Vertel Alexandria 14 PO Box 126 ROSEBERY NSW 2018
49615-27354	96701	9362	263670E 6183150N Zone 56	72	Wingecarribee Shire Council PO Box 141 MOSS VALE NSW 2577
348843-27354	96701	9362	263670E 6183150N Zone 56	72	
1824200-2240090	1918930	138680	253024E 6161558N Zone 56	76	
1824201-2240090	1918930	138680	253024E 6161558N Zone 56	76	

Note: 1. Coordinate system used is AGD66 datum

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

Licence Type	Licence Category	Number of Instances
1.8 GHz Lower Band	Spectrum	12
1.8 GHz Upper Band	Spectrum	17
2 GHz Upper Band A	Spectrum	272
2 GHz Upper Band B	Spectrum	222
3.4 GHz Lower Band	Spectrum	3
3.4 GHz Upper Band A	Spectrum	2
800 MHz Lower Band	Spectrum	250
800 MHz Upper Band	Spectrum	237
ACA Assigned	ACA	21
Aeronautical Assigned System	Aeronautical	18
Amateur Repeater	Amateur	74
Ambulatory - Initial	Land Mobile	23
Ambulatory System	Land Mobile	13
Broadcast Service	Broadcasting	156
CBRS Repeater	Land Mobile	18
Land Mobile System - > 30MHz	Land Mobile	849
Land Mobile System 0-30MHz	Land Mobile	5
Narrowband Area Service station(s)	Broadcasting	4
Narrowcasting Service station(s)	Broadcasting	29
Narrowcasting Service stations (HPON)	Broadcasting	3
PABX Cordless Telephone Service	Land Mobile	1
Paging System - Exterior	Land Mobile	41
Paging System - Interior	Land Mobile	5
PMTS Class B (2110-2170 MHz)	PTS	86
PMTS Class B (935-960 MHz)	PTS	248
Radiodetermination	Radiodetermination	20
Sound Outside Broadcast	Fixed	4

Table 5 Details of other licences identified within 75 km of the proposed Paling Yards wind farm

BoM Radar site	Location[1]	Approximate Distance from Paling Yards wind farm [km]
Canberra (Captains Flat)	S35.660° E149.510°	170
Namoi	S31.024° E150.192°	350
Newcastle	S32.730° E152.027°	265
Sydney (Appin)	S34.260° E150.870°	105
Sydney (Terrey Hills)	S33.701° E151.210°	145
Wagga Wagga	S35.170° E147.470°	235
Bairnsdale	S37.890° E147.560°	460
Yarrawonga	S36.030° E146.030°	395

Note: 1. Coordinate system used is Lat/Long WGS84 datum

Table 6 BoM Radar sites in the vicinity of Paling Yards wind farm

Emergency Service	Contact Details	Distance of closest Site from centre of wind farm [km]
Ambulance Service of NSW	Ambulance Service of NSW Locked Bag 105 ROZELLE NSW 2039	19
Australian Federal Police	Australian Federal Police Attention Radio and Electronic Support PO Box 401 CANBERRA ACT 2601	66
Fire and Rescue NSW	Fire and Rescue NSW FRNSW c/o John Williams Locked Bag 13 GREENACRE NSW 2190	36
Laggan and District Bushfire Brigade	Laggan and District Bushfire Brigade PO Box 105 CROOKWELL NSW 2583	34
NSW Police Force	NSW Police Force Level 4 151-241, Goulburn St SURRY HILLS NSW 2010	1
NSW Rural Fire Service	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142	1
NSW Volunteer Rescue Association Inc	NSW Volunteer Rescue Association Inc Secretary 555 Mellors Road MORUNDAH NSW 2700	71
St John Ambulance Australia (N.S.W.)	St John Ambulance Australia (N.S.W.) St John Ambulance Australia Nsw 001738370, 9 Deane Street BURWOOD NSW 2134	69
State Emergency Service (Nsw)	State Emergency Service (Nsw) New South Wales State Emergency Service PO Box 6126 WOLLONGONG NSW 2500	30
Ambulance Service of NSW	Ambulance Service of NSW Locked Bag 105 ROZELLE NSW 2039	19

Table 7 Emergency services with radiocommunication assets in the vicinity of Paling Yards wind farm

Station Name	**Easting**[1]	**Northing**[1]
Binda	724099	6195713
Boyd	783500	6235570
Burraga	742235	6240927
Cockerill	775385	6229225
Cuddyong	724710	6209280
Daisybank	750552	6248962
Defiance	753227	6218007
Drogheda	769397	6239090
Garrynian	754810	6237659
Golspie	744798	6201350
Green	763821	6192240
Guinecor	769531	6196246
Gurnang	761073	6229311
Hughes	764347	6188926
Jamison	761077	6194065
Jaunter	772079	6236168
Laggan	727254	6192215
Leighwood	743655	6209992
Macarthur	755863	6200292
Magpie	718280	6216516
Maloney	756202	6192148
Mares Range	775897	6196761
McAlister	752801	6184436
Nunnery	765923	6192713
Oldbuck	779311	6209543
Plateau	783608	6233450
Redbank	735724	6186877
Reedy	743380	6229891
Shivering	779684	6219566
Shooters Hill	763394	6245324
Single Tree	727505	6220812
Taralga	758151	6189541
Thalaba	732691	6201508
Vulcan	757787	6243485
Werong	767615	6223243

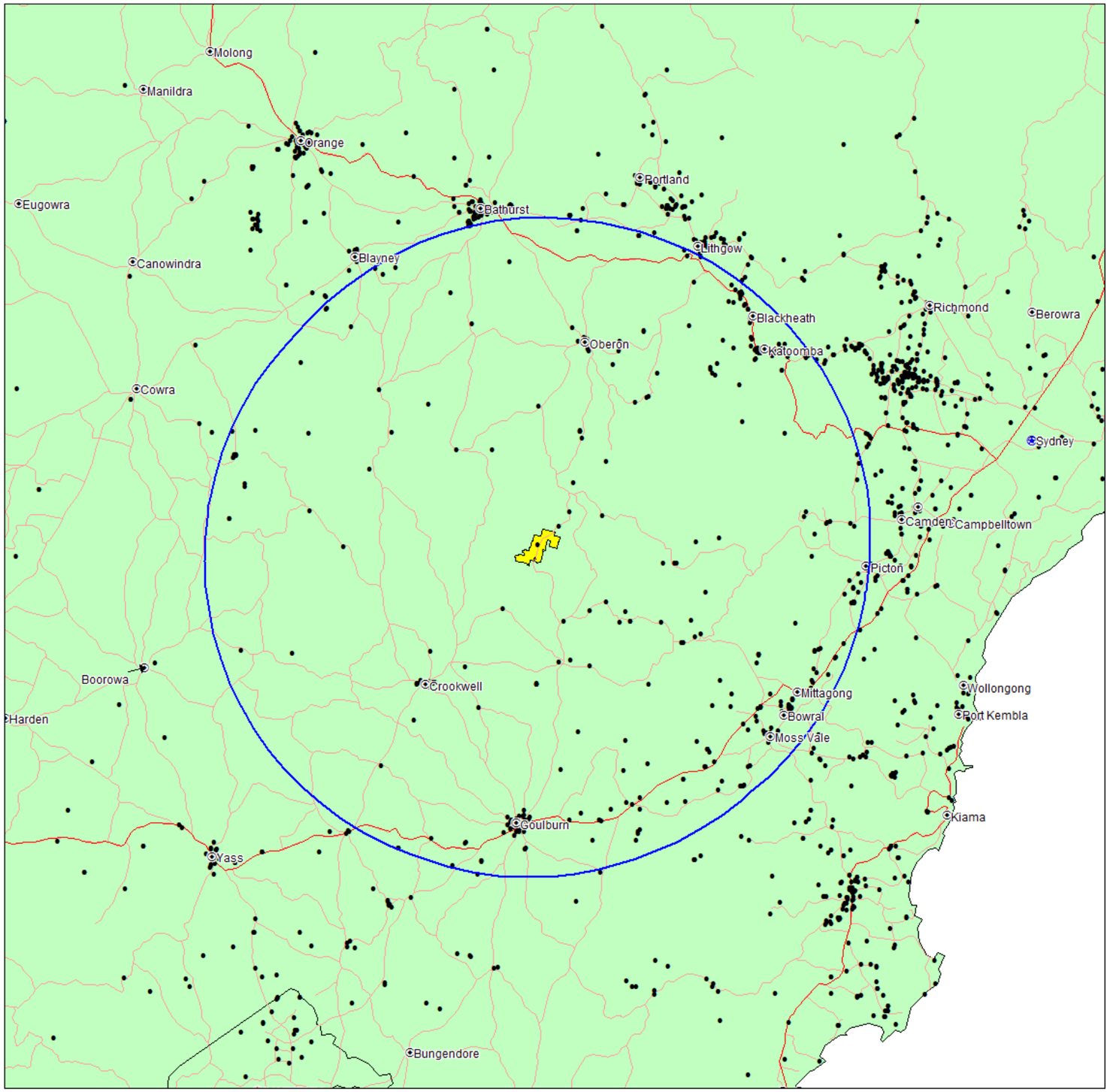
Note: 1. Coordinate system used is Zone 55 H, GDA94 datum

Table 8 Trigonometrical Stations in the vicinity of Paling Yards wind farm

		Within TV EMI zone from Broadcast tower			
House ID	**Location[1]**	Black Mountain	Mount Canoblas	Gore Hill	Knights Hill
House 3	758065E 6222550N	√[2]			
House 4	757528E 6222283N	√			
House 5	757652E 6222233N	√			
House 6	758725E 6221219N	√			
House 6A	759168E 6220843N	√			
House 7[3]	755733E 6219927N	√[2]	√[2]		√
House 7A[3]	754852E 6219783N	√	√	√	√
House 8[3]	752720E 6217349N	√[2]	√	√[2]	
House 8A[3]	752775E 6217645N	√		√	
House 9[3]	752455E 6215508N		√[2]	√[2]	√[2]
House 9A[3]	752297E 6215538N	√	√	√	√
House 9B[3]	752581E 6215711N		√	√	√
House 10	745869E 6215678N			√	√
House 12	744181E 6213996N			√	
House 13	744279E 6213071N			√	
House 15	743708E 6212250N			√	
House 29	755333E 6211123N		√[2]		
House 125	758644E 6214826N		√		
House 126	755608E 6213611N		√		
House 127	760498E 6214494N		√		
House 128	753128E 6211506N		√		
House 135	755459E 6213072N		√		
House 136	761256E 6214418N		√		
House l	759962E 6213024N		√		
House n	754842E 6215362N		√		
House p	761552E 6215874N		√		
House 149	758486E 6223537N	√			

Note 1: Coordinate system used is Zone 55 H, GDA94 datum
2: House survey shows that this service is not used at this house.
3: UFWA have an agreement with this landholder.

Table 9 List of houses with the potential to experience EMI to analogue television from Central Tablelands, Crookwell and Goulburn broadcast towers for the Paling Yards wind farm only (continued).



Proposed Paling Yards Wind Farm

Showing site boundaries for proposed wind farm sites, and identified nearby communications towers

Legend

- Population Centre
- Major Road
- Minor road
- 75km from site boundary
- Proposed wind farm site boundary
- Identified communications tower within 100km of the site boundary

20 0 20 40 60
Kilometers

N W E S

GL Garrad Hassan

Figure 1 Location of the Paling Yards Wind Farm and identified proximate radiocommunication sites

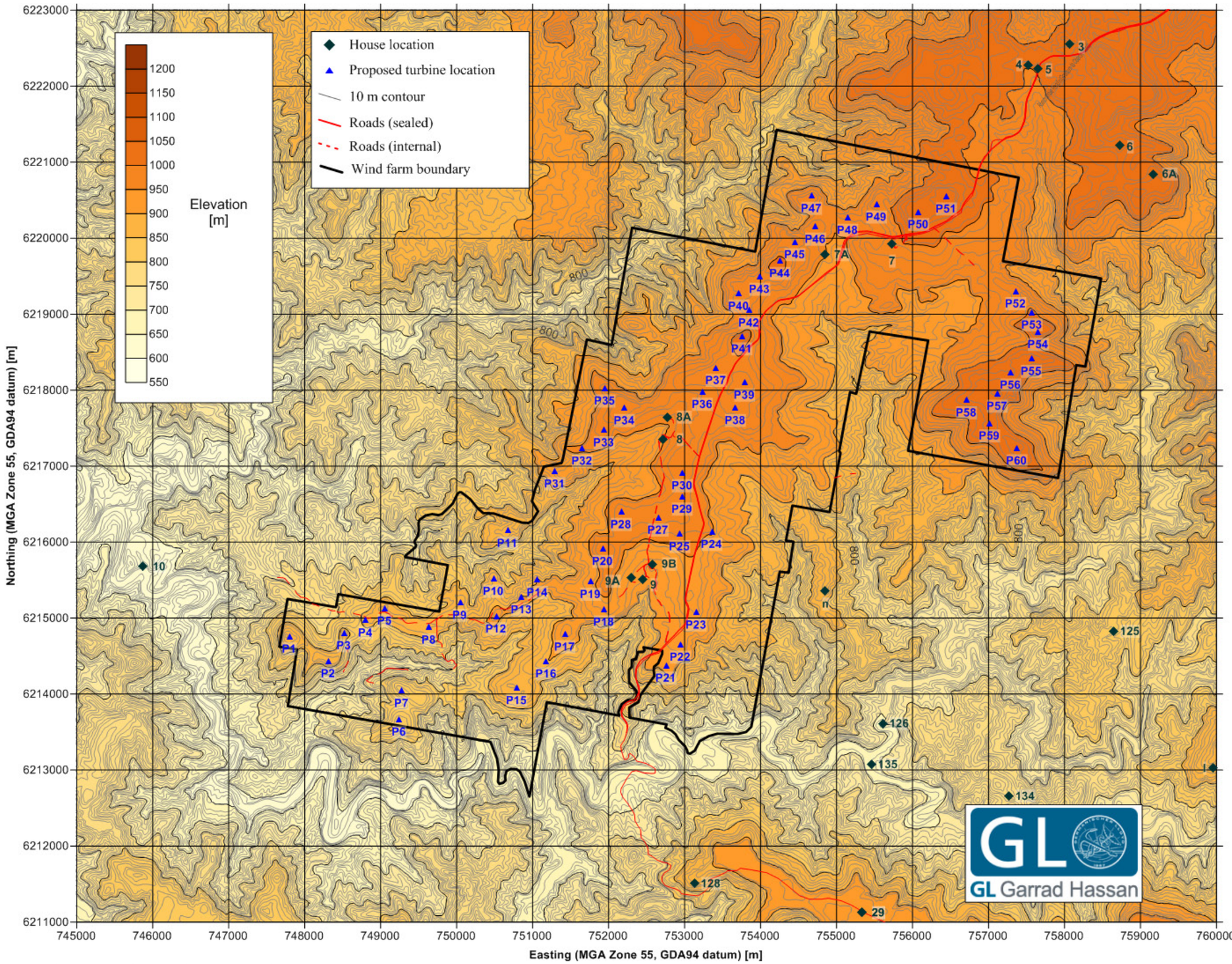


Figure 2 Map of the Paling Yards Wind Farm

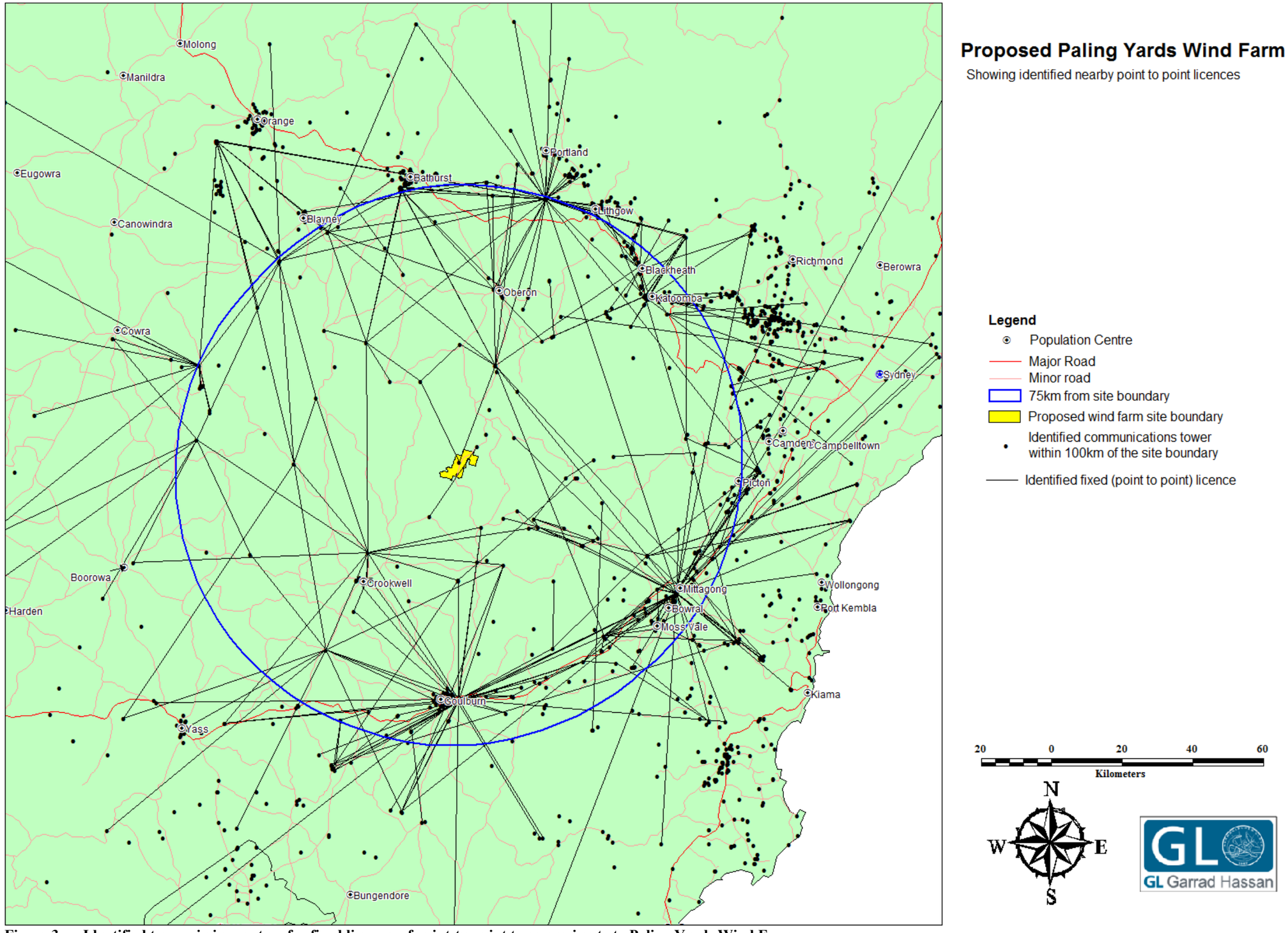


Figure 3 Identified transmission vectors for fixed licences of point-to-point type proximate to Paling Yards Wind Farm

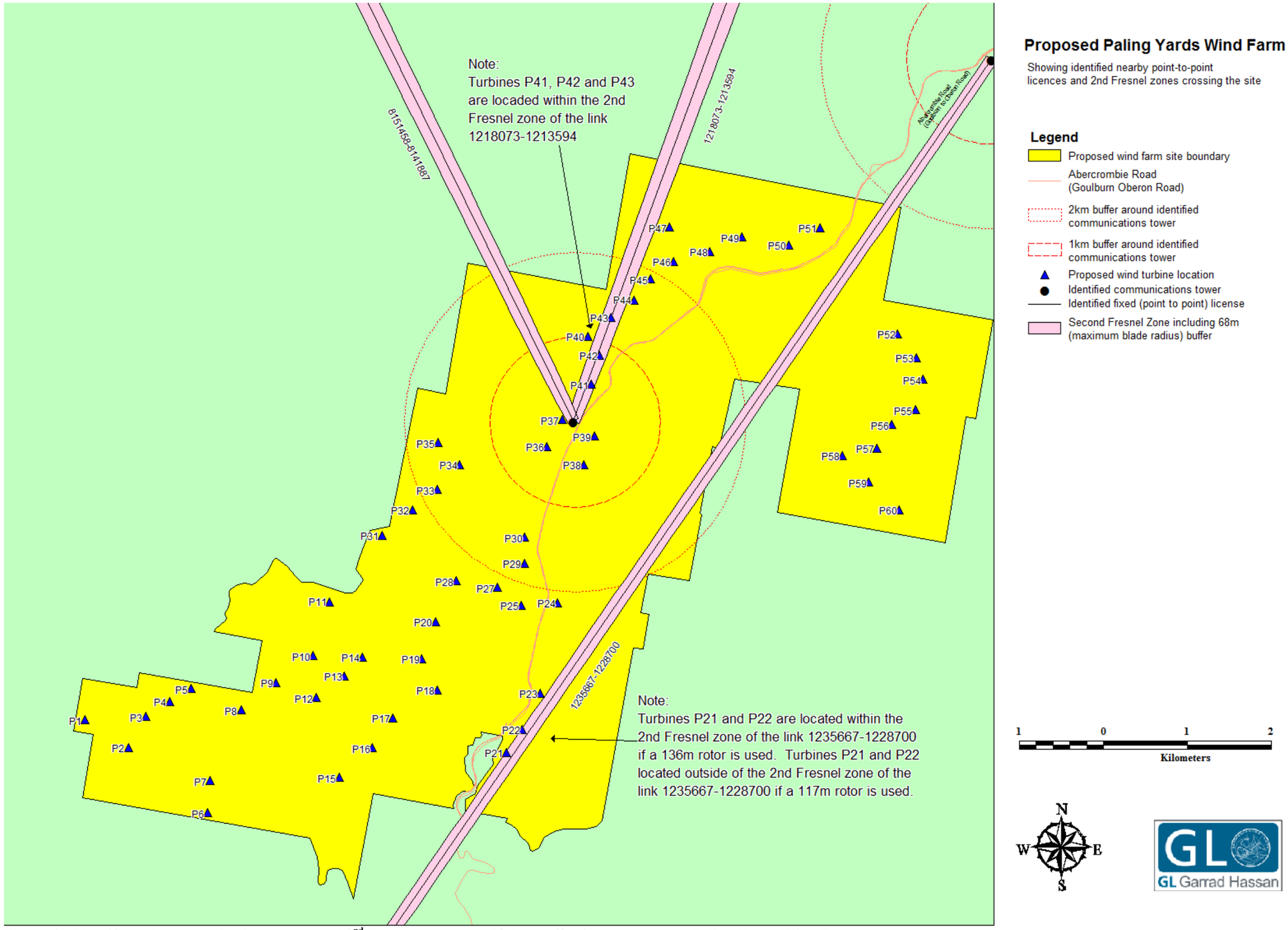


Figure 4 Identified telecommunication vectors and 2nd Fresnel zones plus 58.5 m buffer for the proposed Paling Yards Wind Farm

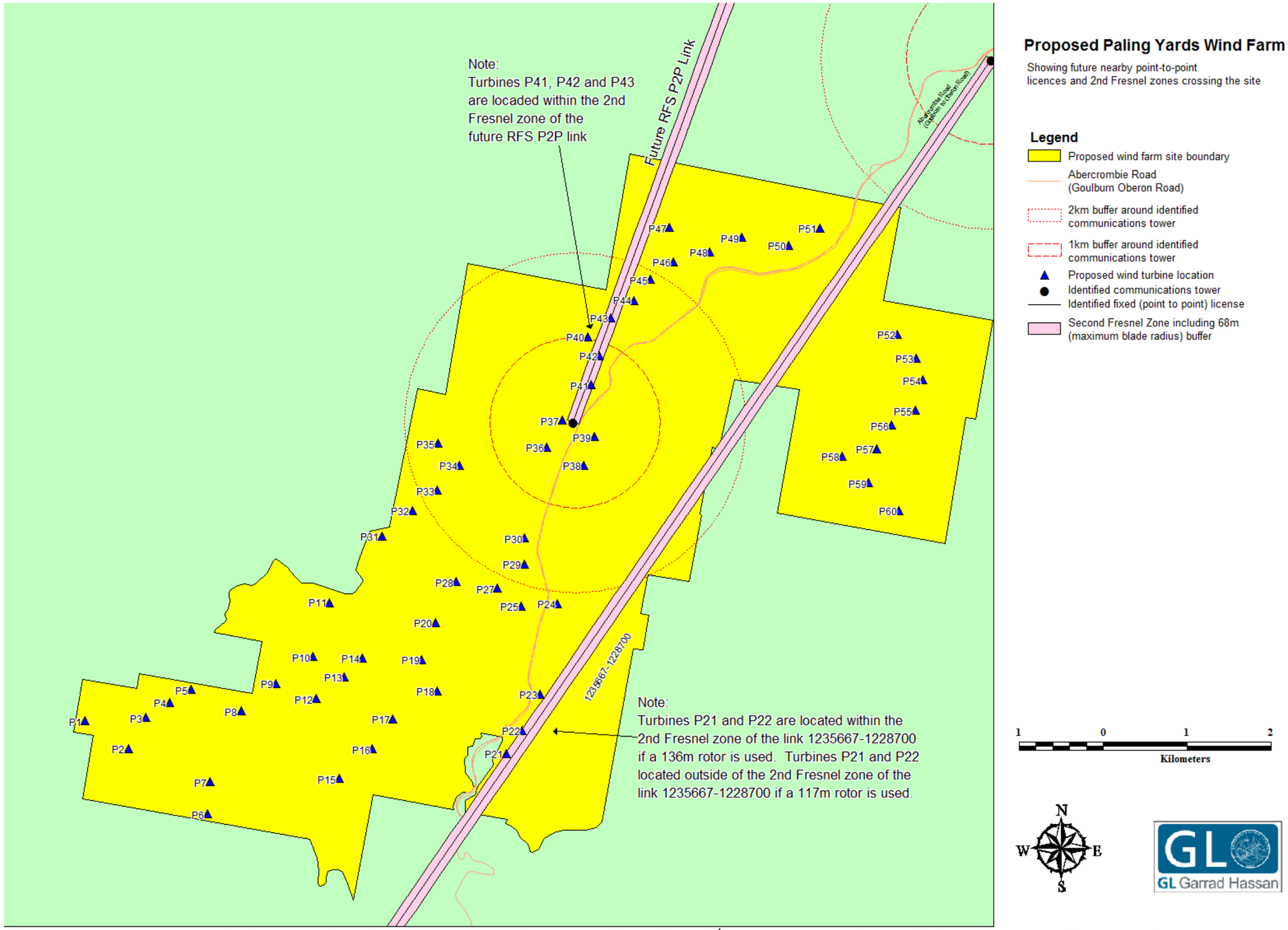


Figure 5 Proposed telecommunication vectors (following consultation with NSW PF and NSW RFS) and 2nd Fresnel zones plus 58.5 m buffer for the proposed Paling Yards Wind Farm

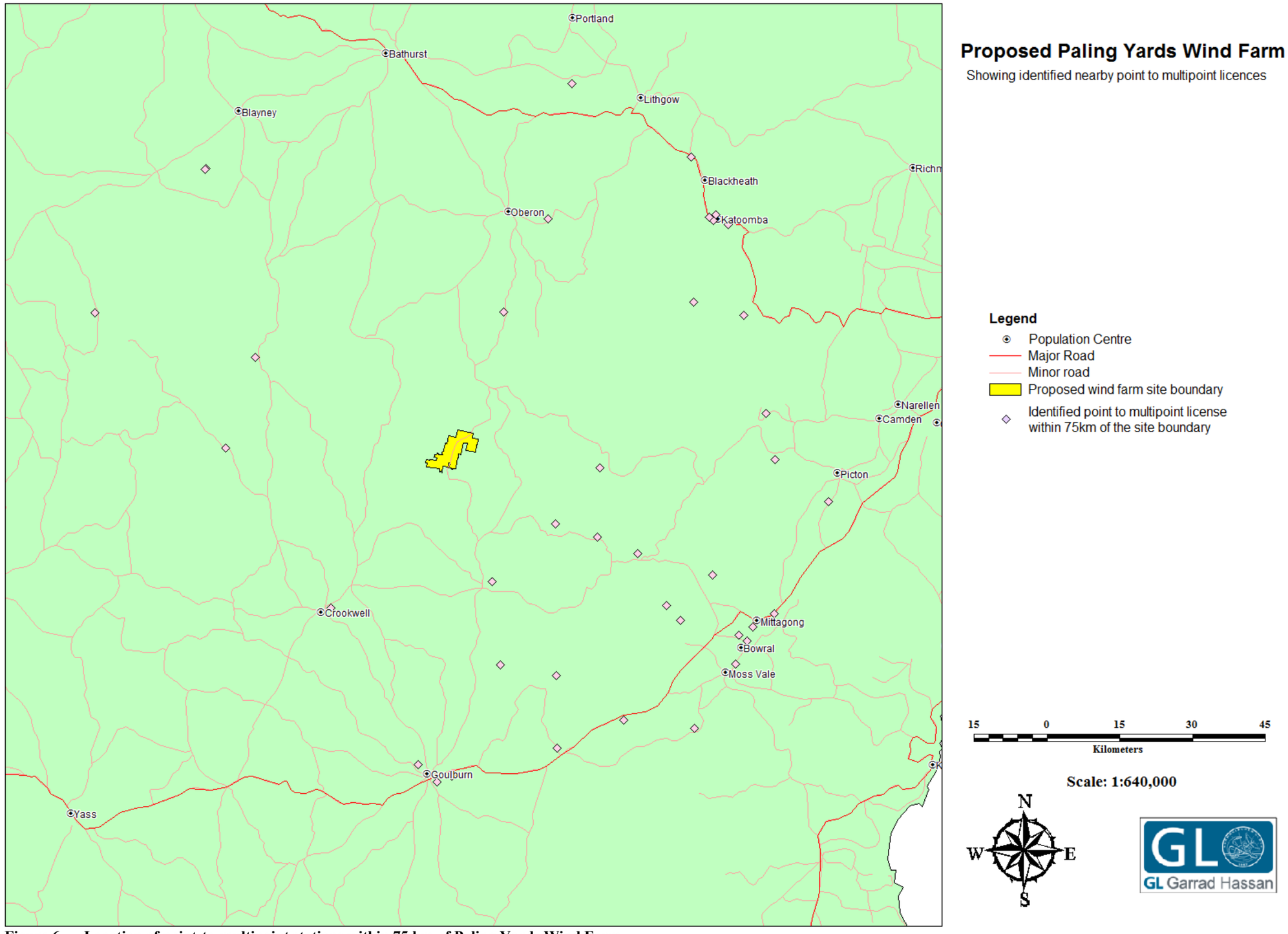


Figure 6 Location of point-to-multipoint stations within 75 km of Paling Yards Wind Farm

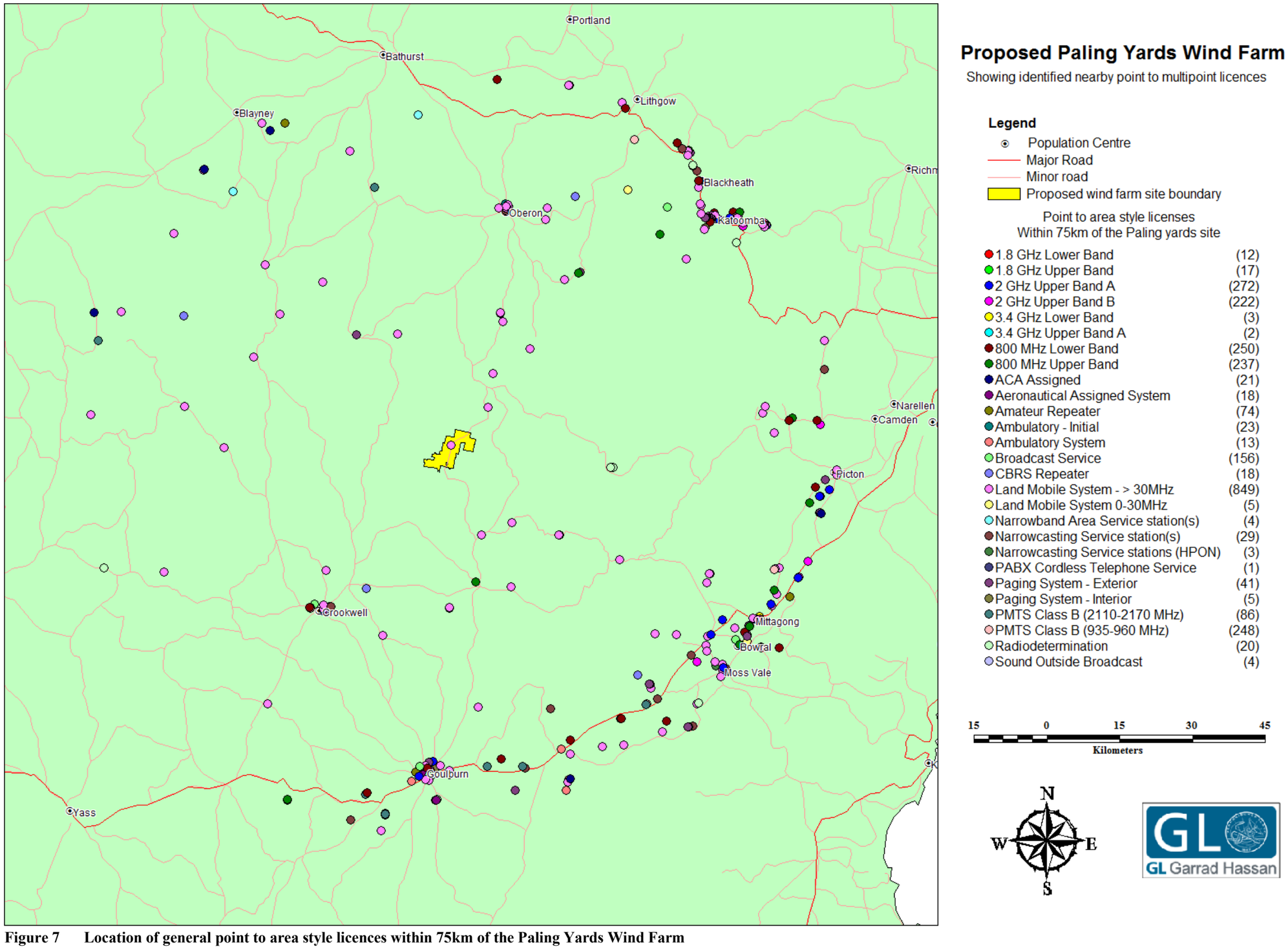


Figure 7 Location of general point to area style licences within 75km of the Paling Yards Wind Farm

Proposed Paling Yards Wind Farm

Showing nearby Beau of Meteorology
radar locations and major airports

Legend

- Major road
- Proposed wind farm site boundary
- 250 nautical mile (463km) buffer around site
- Major airport
- Bureau of Meteorology radar

100 0 100 200 300
Kilometers

N
W E
S

GL Garrad Hassan

Figure 8 Location of Major airports and Bureau of Meteorology weather watch radar sites within 250 nautical miles of the Paling Yards site

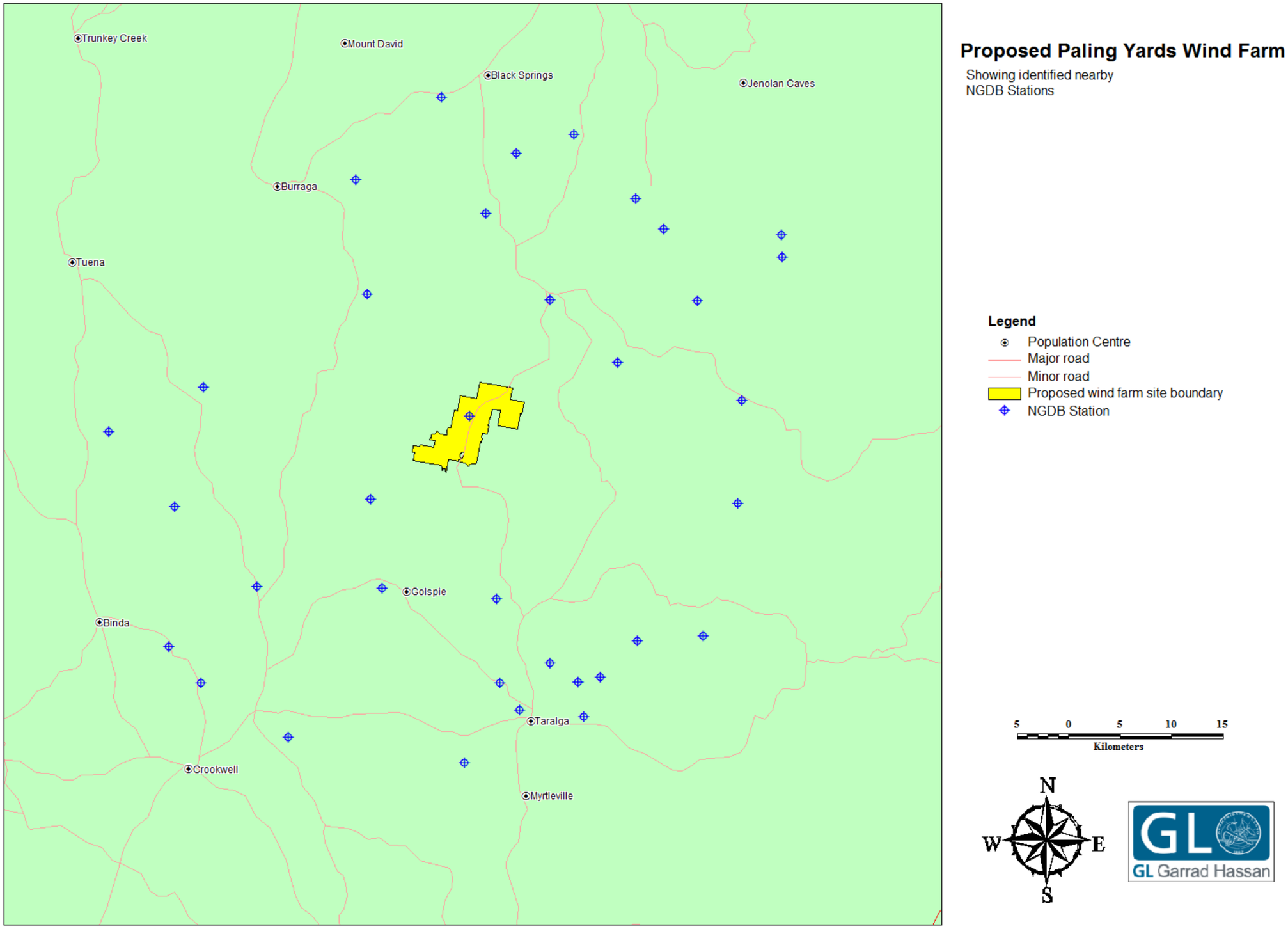


Figure 9 Location of Trig stations within 30 km of Paling Yards Wind Farm

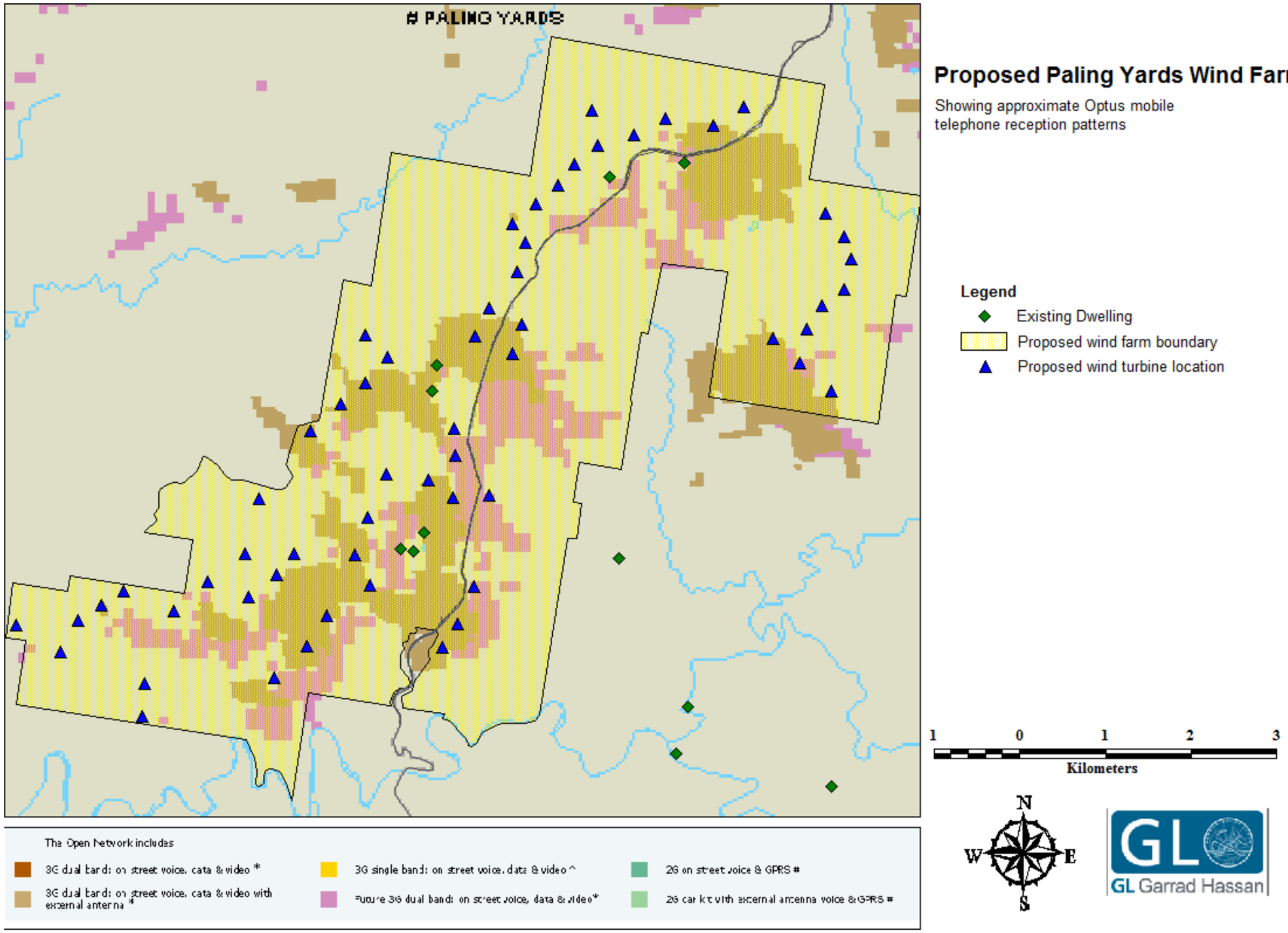


Figure 10 Optus GSM Mobile phone coverage for Paling Yards Wind Farm

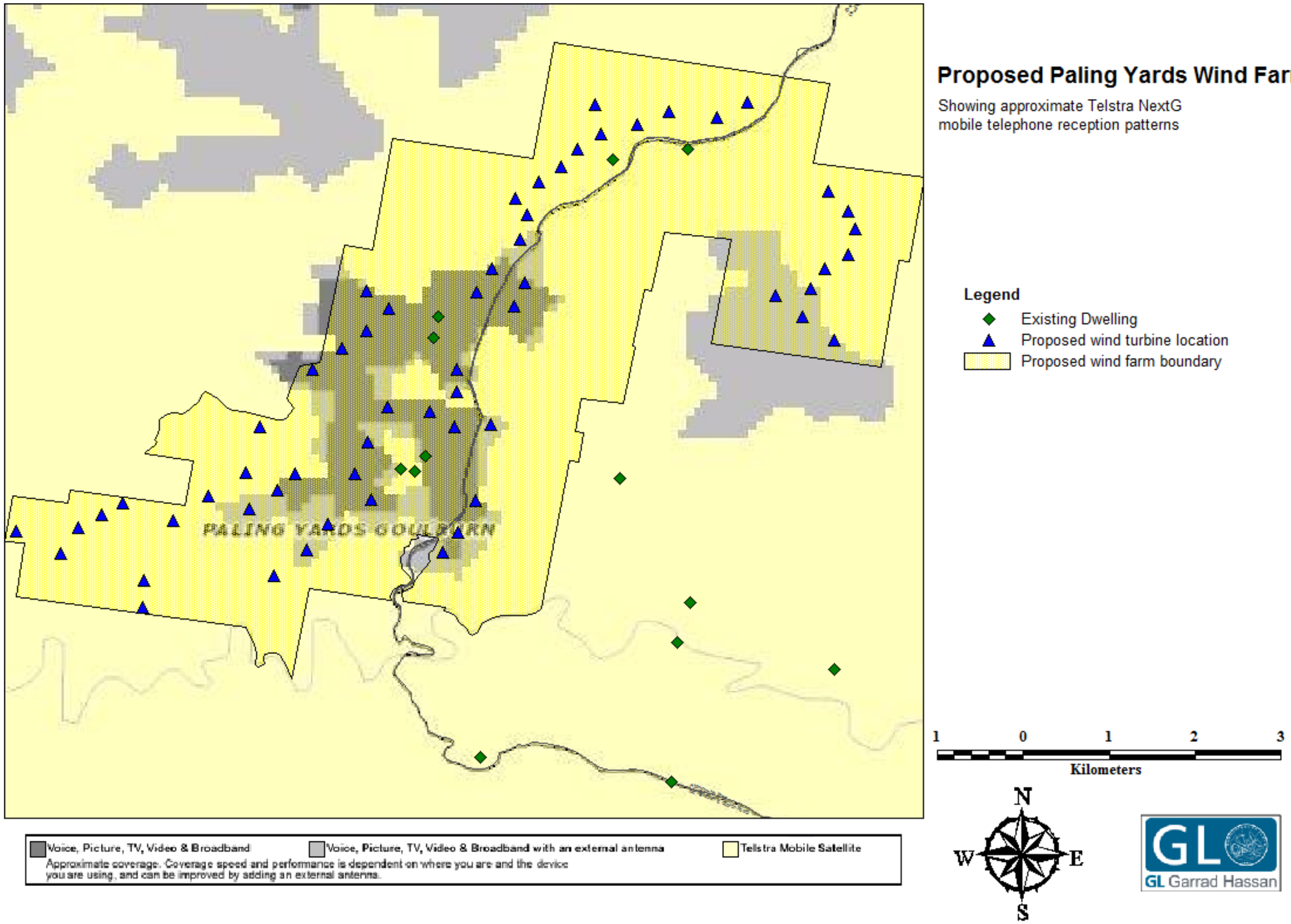
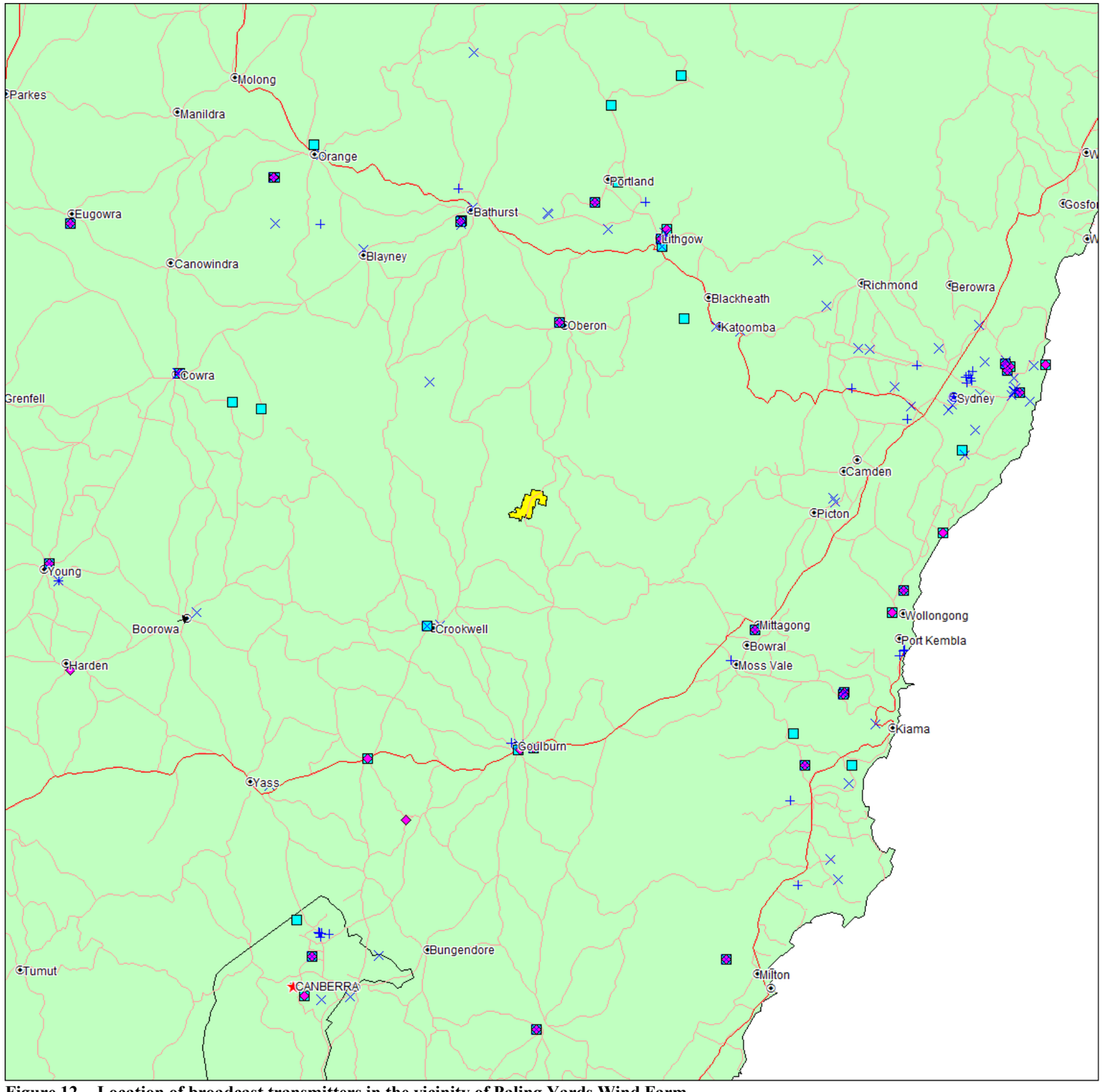


Figure 11 Telstra NextG network coverage map



Proposed Paling Yards Wind Farm

Showing site boundaries for proposed wind farm sites, and identified nearby broadcast towers

Legend

- Population centre
- Major road
- Minor road
- Proposed wind farm site boundary
- FM radio
- AM radio
- Digital television
- Analog television

20 0 20 40 60
Kilometers

N
W E
S

GL Garrad Hassan

Figure 12 Location of broadcast transmitters in the vicinity of Paling Yards Wind Farm

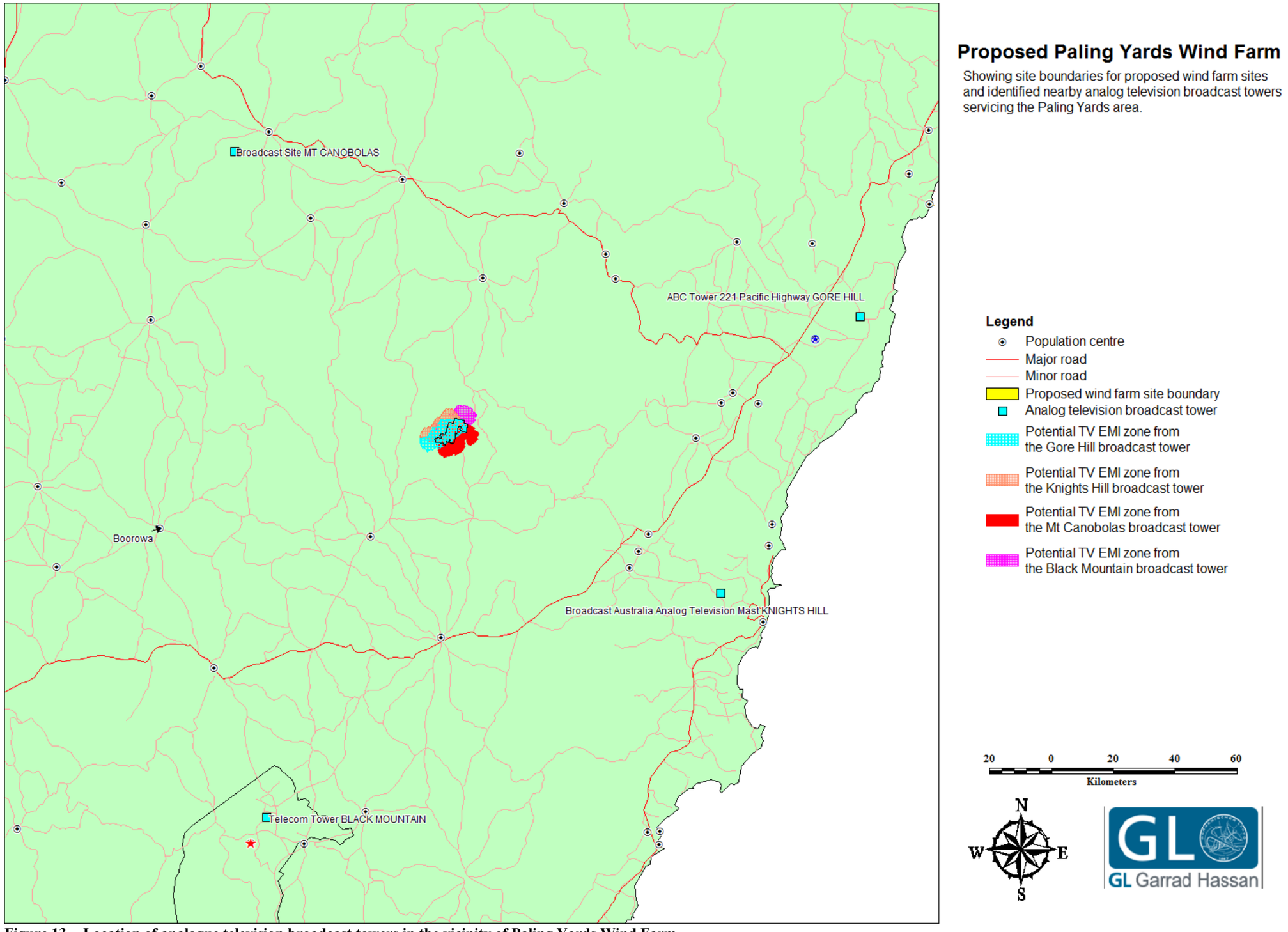
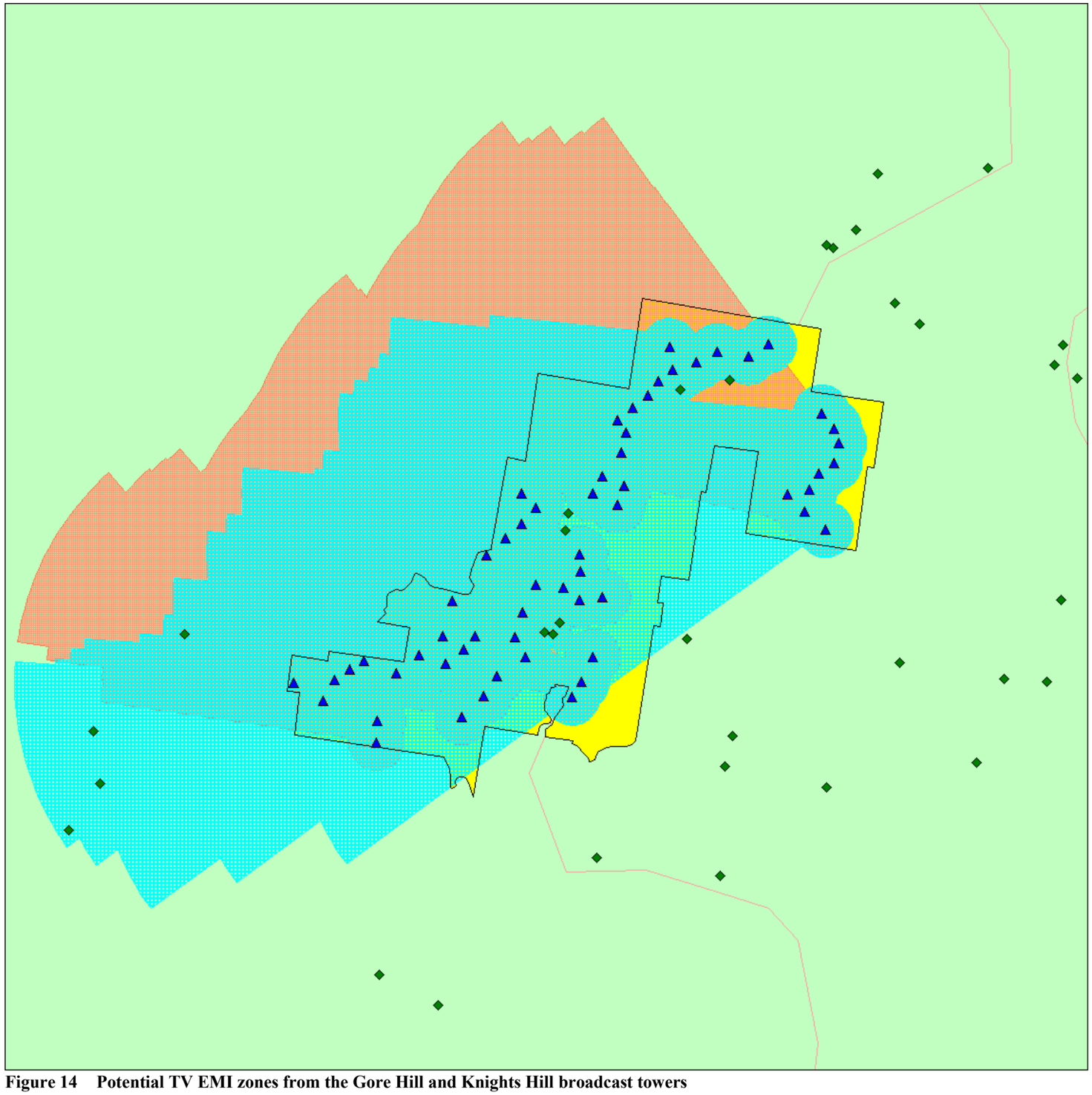


Figure 13 Location of analogue television broadcast towers in the vicinity of Paling Yards Wind Farm



Proposed Paling Yards Wind Farm

Showing potential analog television interference zones and dwellings within 5km of the proposed site

Legend

- Population centre
- Major road
- Minor road
- Proposed wind farm site boundary
- Potential TV EMI zone from the Gore Hill broadcast tower
- Potential TV EMI zone from the Knights Hill broadcast tower
- Potential wind turbine location

1 0 1 2 3

Kilometers

N W E S

GL Garrad Hassan

Figure 14 Potential TV EMI zones from the Gore Hill and Knights Hill broadcast towers

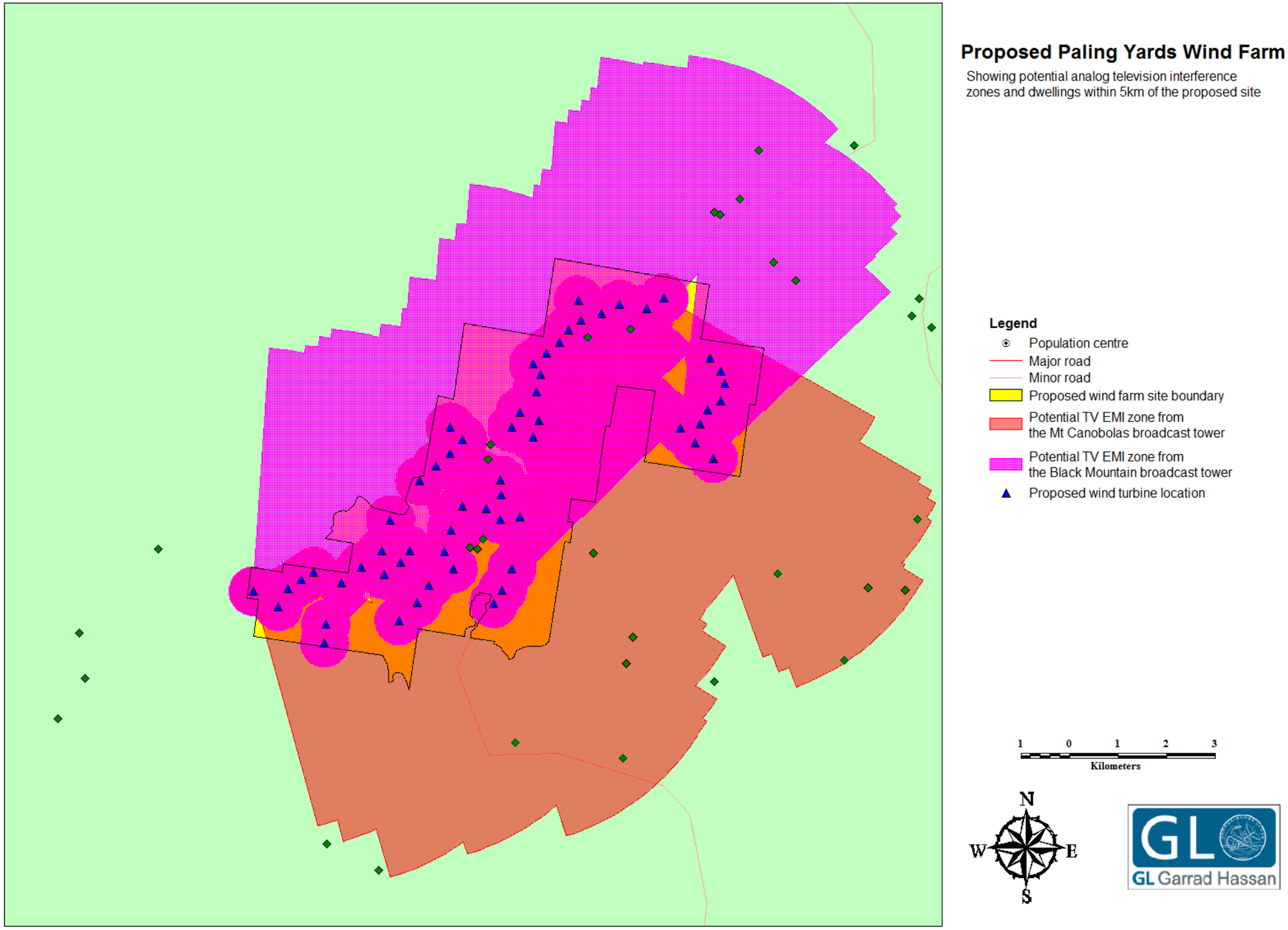


Figure 15 Potential TV EMI zones from the Mt Canobolas and Black Mountain broadcast towers