Hawkesdale Wind Farm and Ryan Corner Wind Farm
Expert Witness Statement of Trenton Gilbert
(Expert witness retained by Ryan Corner Development Pty Ltd)

Electromagnetic Interference

1 Name and address

Trenton Gilbert

Principal Engineer

DNV GL
Suite 25, Level 8
401 Docklands Drive
Docklands Victoria 3008

2 Area of expertise

- I hold the degrees of Bachelor of Engineering (Aerospace) and Doctor of Philosophy (Aerospace Engineering).
- My qualifications and experience are detailed in Annexure A.
- I have been involved with technical analyses for over 10 GW of proposed wind energy installations, including electromagnetic interference (EMI) assessments for over 3 GW of proposed wind energy installations.
- I have significant experience in assessing the potential electromagnetic interference impacts associated with wind farm projects.

3 Scope

3.1 Instructions

I have been commissioned by Herbert Smith Freehills on behalf of Ryan Corner Development Pty Ltd (**Ryan Corner Development**) to address the EMI impacts of the proposed Hawkesdale and Ryan Corner Wind Farms in relation to the Hawkesdale National Broadband Network (NBN) tower, and television and radio reception. I have also been commissioned to act as an independent expert in relation to concerns regarding the impacts of the proposed wind farms on television and radio reception, mobile phone reception, and the NBN service raised in Ryan Corner WF Submission (5), Ryan Corner WF Submission (8), and the submission from the Hawkesdale and District Development Action Committee (HADDAC). I have also reviewed the submission from the Moyne Shire Council.

I have received the following written instructions from Herbert Smith Freehills:

> *"Your report should address the matters relating to electromagnetic interference as it is relevant to the Amendment Applications. In particular, your report should consider the recently installed NBN tower that we are instructed services the Hawkesdale township… and consider the impact (if any) of the Amendment Applications on that NBN tower. It*

> *should also consider the potential for, and likely effectiveness of, any mitigation measures that may be available should nearby residents experience impacts to television and radio reception.*
>
> *A small number of submissions have been received in respect of the Amendment Applications… We request that you consider those submissions and respond to any relevant matters in your witness statement."*

My opinions as to the likely EMI impacts of the proposed Hawkesdale and Ryan Corner Wind Farms are based on my experience in predicting and assessing the EMI impacts for proposed wind farms.

I have been provided with a copy of Planning Panel Victoria's Guide to Expert Evidence, and I am aware of my obligations as set out in those Guidelines.

3.2 Process and methodology

EMI assessments for the Hawkesdale and Ryan Corner Wind Farm sites were initially conducted by Garrad Hassan Pacific Pty Ltd (now DNV GL) at the request of Environmental Resources Management Australia Pty Ltd on behalf of Union Fenosa Wind Australia Pty Ltd (now Ryan Corner Development) in August 2009. The findings of these analyses are contained in Garrad Hassan Pacific reports 45090/PR/002 Issue B [i] and 45090/PR/004 Issue C [ii] respectively.

DNV GL also conducted revised EMI assessments for the Hawkesdale and Ryan Corner Wind Farms at the request of Ryan Corner Development in February 2016 to account for proposed changes in the turbine layouts, hub heights, and rotor diameters. The findings of these analyses are contained in DNV GL reports 170492-AUME-R-01 Issue C [iii] and 170492-AUME-R-02 Issue C [iii] (together, the **EMI Assessments**), which were submitted by Ryan Corner Development as part of the Amendment Applications for the wind farms.

My role in the preparation of the EMI Assessments was to oversee and check the analyses and approve the final reports.

I have drawn on my experience with wind energy projects (as detailed in Annexure A) to review the EMI Assessments in order to address the issues discussed in this Statement. I have also attempted to consult with NBN Co to seek their feedback regarding the potential for the Hawkesdale Wind Farm to interfere with the wireless internet service provided from the Hawkesdale NBN tower.

3.3 Materials reviewed

In carrying out the work required to prepare this Statement, I have considered the following:

- DNV GL reports 170492-AUME-R-01 Issue C [iii] and 170492-AUME-R-02 Issue C [iii] (together, the **EMI Assessments**)
- planning permits no. 20060221 (**Hawkesdale Planning Permit**) [v] and no. 20060222 (**Ryan Corner Planning Permit**) [vi]
- submissions received in relation to the Amendment Applications
- locations of dwellings belonging to persons making submissions supplied by Herbert Smith Freehills
- information contained in the Australian Communications and Media Authority (ACMA) database [vii]
- information available on the Australian Government "mySwitch" website [viii].

3.4 Persons assisting with this work

In carrying out the work required to prepare this Statement, I have been assisted by Naomi Brammer, also an employee of DNV GL. Naomi Brammer's qualifications and experience are set out in Annexure B.

4 Findings

The EMI Assessments have been submitted by Ryan Corner Development as part of its Amendment Applications for the proposed Hawkesdale and Ryan Corner Wind Farms and I adopt them as the basis for my Statement and evidence. A summary of my findings, and any additional inquiries I have made, is contained within this Statement.

4.1 Overview

The results of the EMI Assessments show that, for most radiocommunication services near the Hawkesdale and Ryan Corner Wind Farms, the changes proposed in the Amendment Applications are unlikely to cause any increase in the potential for EMI impacts compared to the previous wind farm and turbine configurations. For the Hawkesdale Wind Farm, it is not expected that any of the turbines in either the previous or the amended layout will cause interference to the point-to-point links crossing the wind farm site. For the Ryan Corner Wind Farm, changes to the turbine layout proposed in the Amendment Application result in fewer turbines that could potentially cause interference to point-to-point links compared to the previous layout. Interference due to near-field effects or scattering of signals from nearby towers, or large-scale interference to television signals, is not expected for either wind farm. Feedback received from service operators via the consultation process undertaken in conjunction with the EMI Assessments also indicated that there would be no significant change in impact caused by the changes proposed in the Amendment Applications.

4.2 Television reception

For terrestrial television broadcasts, the EMI Assessments show regions in which the television signal received at a dwelling is more likely to be affected by forward or back scatter from wind turbines at the Hawkesdale and Ryan Corner Wind Farms. This approach was used to identify dwellings that have increased likelihood of experiencing interference to television reception. Based on this analysis, the changes in turbine layout proposed in the Amendment Applications increase the number of houses in the potential interference zones by up to three dwellings compared to the previous layout, depending on the wind farm and broadcast tower considered.

In addition, the potential for a wind turbine to cause interference to television signals is likely to be proportional to the radar cross section of the turbine, which is typically proportional to the turbine dimensions. Therefore, the increase in turbine size associated with the Amendment Applications may result in an increased potential for interference to television signals.

Mitigation

Although the changes proposed in the Application Amendments may result in increased potential for interference to television signals, a range of mitigation options are available to rectify issues if they arise. These options include adjusting the alignment or height of the television antenna at the affected dwelling, tuning the antenna into an alternative source of the signal, installing a more directional or higher-gain antenna, relocating the antenna, installing a cable or satellite television receiver at the dwelling, or installing a television repeater station to service the affected area.

4.3 Radio reception

The potential for interference to AM and FM radio signals is also likely to be proportional to the turbine dimensions, and may therefore be increased by the changes proposed in the Amendment Applications. Broadcast radio signals are generally not susceptible to interference from relatively small physical obstructions such as wind turbines. However, FM radio signals may be affected in the immediate vicinity of a wind turbine, or in low coverage areas if the direct line-of-sight between the transmission tower and a receiver is blocked by a turbine located within approximately 4 km of the transmitter. Figure 12 in each of the EMI Assessments indicates that there are no AM or FM radio transmitters within 4 km of turbines at either the Hawkesdale or Ryan Corner Wind Farm and so it is unlikely that the turbines will cause interference due to signal obstruction.

Mitigation

In most cases, radio interference problems can be easily resolved by installing a high-quality antenna or amplifier at the affected residence.

4.4 NBN fixed wireless service

I have been advised by Ryan Corner Development that the local community has raised concerns regarding the potential for the proposed Hawkesdale Wind Farm to interfere with wireless internet signals from the NBN tower that services Hawkesdale and the surrounding areas. Based on my review of the ACMA database, dated 19 July 2017, I believe that this tower is most likely to be the NBN Co Site located at 2621 Penshurst-Warrnambool Road, Hawkesdale (site ID 9018916).

The Hawkesdale NBN tower was identified in the EMI Assessments as the endpoint for a fixed point-to-point link operated by NBN Co that crosses the Hawkesdale Wind Farm site. The EMI Assessments also note that, at the time the assessments were conducted, the NBN service was stated to be available in Hawkesdale. However, it is likely that the point-to-area spectrum license for the Hawkesdale NBN service was not active at that time. DNV GL attempted to contact NBN Co as part of the consultation process undertaken in conjunction with the EMI Assessments to obtain feedback regarding the potential for impacts to their operations and services but no feedback was received.

The NBN fixed wireless service utilises LTE or 4G wireless technology, similar to that used in LTE or 4G mobile networks operated by mobile telecommunications providers such as Telstra or Optus. However, the NBN fixed wireless service is designed to provide services to a fixed number of premises within each defined service area.

The interference mechanisms that may influence the NBN fixed wireless service are therefore expected to be similar to those that may affect mobile phone networks. Signals at the frequencies used by the NBN fixed wireless service have the potential to be affected by obstructions such as wind turbines. However, the technology is designed to operate in an environment where there are signal reflections and other forms of interference, and in general interference in areas with good signal strength is not expected. However, locations where there is marginal existing coverage, or where signals need to pass through the wind farm to reach a customer, could have increased risk of experiencing interference from the wind farm. In addition, the potential for a wind turbine to cause interference to signals is likely to be proportional to the radar cross section of the turbine, which is typically proportional to the turbine dimensions. Therefore, the increase in turbine size associated with the Amendment Applications may result in an increased potential for interference to NBN fixed wireless signals.

Figure 1 shows the coverage area [ix] and tower locations [vii] for the NBN fixed wireless service in the vicinity of the Ryan Corner and Hawkesdale Wind Farms. A number of features are evident from this figure. Firstly, it is noted that the areas which are most likely to be affected by interference from the Hawkesdale Wind Farm (i.e., those areas to the southeast of the wind farm, where the wind farm is between the customer and the NBN tower) may be able to receive a signal from another NBN tower located to the southeast of the wind farm near Woolsthorpe. Secondly,

the extent of the coverage areas seems to be influenced by the presence of the wind farms, and may have already taken the presence of the wind farms into account. This is evident in the vicinity of both the Ryan Corner and Hawkesdale Wind Farms, where there is a coverage shadow behind the wind farms. However it is noted that there appears to be good coverage within the wind farm boundary, which may not accurately reflect the impact of the wind farm or the actual coverage in that area.

I have attempted to contact NBN Co to seek their feedback regarding the potential for the Hawkesdale Wind Farm to interfere with the wireless internet signal from the Hawkesdale NBN tower, and to confirm the observations above. NBN have responded and are currently investigating the issue, however no feedback on potential impacts has been received to date.

Therefore, based on the coverage maps [ix] presented in Figure 1, it is possible that NBN Co is currently offering the NBN fixed wireless service only to customers in locations that are not considered by NBN Co to be affected by the presence of the wind farm. If this is the case, the construction of the wind farm should not affect customers currently using the service, with the potential exception of any customers located within the wind farm boundary.

5 Response to key submissions

5.1 Ryan Corner WF Submission (5) and Ryan Corner WF Submission (8)

Ryan Corner WF Submission (5) and Submission (8) express concerns about the impact of the proposed Ryan Corner Wind Farm on television reception at the submitters' homes, and other dwellings in the Yambuk area.

I have been advised by Herbert Smith Freehills that the homes belonging to the persons making these submissions are located to the northeast of Yambuk. These dwellings were not included in the list of dwellings provided by Ryan Corner Developments and therefore were not explicitly considered in the EMI Assessments conducted by DNV GL. However, Figure 14 in the EMI assessment report for the proposed Ryan Corner Wind Farm [iii] indicates that dwellings in the Yambuk area have increased potential to experience interference to television signals from the Warrnambool Tower Hill broadcast tower caused by forward scatter from turbines at the wind farm.

Interference to television broadcasts due to signal scattering is generally more likely in areas where the existing signal is already weak or degraded. According to the Australian Government MySwitch website [viii], the areas around Yambuk currently experience good to variable signal coverage from the Warrnambool Tower Hill and Portland Mt Clay broadcast towers. Interference to the Warrnambool signal may therefore be experienced in the Yambuk area as a result of the Ryan Corner Wind Farm development. As noted above, the increased turbine dimensions proposed in the Amendment Applications may also increase the potential for interference to television signals.

The submissions also raise concerns about how any interference to television reception will be evaluated and dealt with if issues do arise, and cite the submitters' previous experience with interference to the television signal from the Portland Mt Clay broadcast tower caused by the Codrington Wind Farm.

The Planning Permits for the Ryan Corner and Hawkesdale Wind Farms include a number of conditions that are intended to protect television reception at dwellings in the vicinity of the wind farms.

Pre-construction surveys

Condition 24 in the Ryan Corner Planning Permit and Condition 27 in the Hawkesdale Planning Permit state that "a pre-construction survey must be carried out… to determine television and radio reception strength at selected locations up to 5 kms from all wind turbines" in the absence of the wind farm. It is my understanding that these conditions will not be changed by the Amendment

Applications, and the surveys will help to understand the existing television reception before construction commences. Pre-construction surveys for the Hawkesdale and Ryan Corner sites were conducted in 2010 [x,xi]. However, since these original surveys were performed prior to the completion of the switch to digital television, new surveys may need to be carried out before the wind turbines are erected. The town of Yambuk is located approximately 3 km from the nearest wind turbine location at the proposed Ryan Corner Wind Farm, and it is expected that reception survey results will be available at locations in vicinity of the submitters' homes prior to construction of the wind farm.

Mitigation and post-construction surveys

If interference to television signals from the Warrnambool broadcast tower is experienced at dwellings in the Yambuk area on account of the Ryan Corner Wind Farm, and no alternative broadcast signal is available, it may be possible to improve the reception at affected dwellings by adjusting the height or location of the existing antenna or installing a more directional or higher-gain antenna. Further mitigation options include installing cable or satellite television receivers at the affected dwellings, or installing a television repeater station to service the area.

Conditions 25 and 26 in the Ryan Corner Planning Permit and Conditions 28 and 29 in the Hawkesdale Planning Permit state that a post-construction survey must be carried out at any dwelling where a complaint has been made regarding television or radio reception, and appropriate measures must be undertaken by the wind farm operator to mitigate interference if the complaint is substantiated. Specifically, those measures must "return the affected reception to pre-construction quality at the cost of the wind energy facility operator and to the satisfaction of the Minister for Planning". It is my understanding that these conditions and obligations will not be changed by the Amendment Applications, and will help to ensure that television reception at dwellings is protected after construction of the wind farms.

5.2 HADDAC Submission

The submission made by the Hawkesdale and District Development Action Committee (HADDAC) raises concerns regarding impacts to television, mobile phone, and NBN reception.

Regarding impacts to television reception, reference is made to the information presented in the EMI Assessments, and in Sections 4.2 and 5.1 of this Statement.

Regarding mobile phone reception, reference is made to the findings presented in the EMI Assessments, namely that:

- Mobile phone signals are generally not susceptible to interference in areas with good coverage.
- There are some areas with marginal coverage which may be susceptible to interference from the wind farm.
- The operators of the mobile phone networks in the area were contacted to seek feedback on any potential impact that the wind farm could have on their services. Responses were received from Telstra and Optus and no concerns were raised regarding impacts to their services.

Regarding impact to NBN services, reference is made to the information presented in Section 4.4 of this Statement.

5.3 Moyne Shire Council Submission

The submission made by the Moyne Shire Council in relation to the Amendment Applications for the Hawkesdale and Ryan Corner Wind Farms notes that submissions received by the Council from the community and general public raised concerns regarding radio and television reception. The Council's submission also states that it incorporates the issues and concerns raised by the public submissions, and that it refers to the EMI Assessments for the wind farms. However, the

submission does not include any further detail about the nature of these concerns, or any other commentary specific to the potential EMI impacts of either wind farm.

6 Conclusion

DNV GL has previously conducted EMI Assessments to determine the potential impact of the Amendment Applications for the Hawkesdale and Ryan Corner Wind Farms. The EMI Assessments acknowledge that there is the potential for impacts to some services from both the Permitted and Amended Projects, and that for some services the impacts from the Amended Applications may be greater. However in many cases options are available to mitigate potential impacts from either the Permitted or Amended Projects, or service operators have not raised concerns about the potential impact of the Amended Applications.

Based on the EMI Assessments and any additional inquiries, it is my opinion that the changes to the Hawkesdale and Ryan Corner Wind Farms proposed in the Amendment Applications could result in increased potential for interference to television, radio, and NBN fixed wireless services, particularly in areas of marginal signal strength. In the case of television and radio signals a range of mitigation options are available to resolve any impacts that may arise. Regarding the NBN fixed wireless service, it is possible that NBN Co is currently taking the presence of the wind farms into account when defining their service areas. I have contacted NBN Co to determine if this observation is correct, however to date no formal response has been received. If this observation is correct, then NBN Co may only be offering the service to customers who are in locations that are not considered to be affected by the presence of the wind farm, meaning that the construction of the wind farm should not affect customers currently using the service, except for any customers located within the wind farm boundary.

Concerns have also been raised regarding the potential impacts of the Ryan Corner Wind Farm on television reception at dwellings in the Yambuk area, and how any issues will be dealt with if they arise. Dwellings in the Yambuk area have increased potential to experience interference to television signals from the Warrnambool broadcast tower. The Ryan Corner Planning Permit states that a pre-construction reception survey must be carried out at locations within 5 km of the wind turbines, which will ensure that the existing television reception in the vicinity of the wind farm is understood before construction commences. In addition, a post-construction survey must be conducted at any dwelling where a complaint has been made regarding television or radio reception. Under the permit, the wind farm operator is required to implement measures that will return the affected reception to pre-construction quality if the complaint is substantiated. If interference to television signals from the Warrnambool tower is experienced at dwellings in the Yambuk area, several mitigation options are available.

7 Opinion

The opinions that I have expressed in this Statement are based on my qualifications and experience. Subject to any limitations and exclusions outlined above, my opinions are complete and accurate in every respect.

I am satisfied through my inquiries that the opinions I have expressed are reasonable in regard to the impact of EMI in the vicinity of the proposed Hawkesdale and Ryan Corner Wind Farms.

8 Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Trenton Gilbert

Date: 1 August 2017

9 References

i. Garrad Hassan Pacific, "Assessment of Electromagnetic Interference Issues for the Hawkesdale Wind Farm", document no. 45090/PR/004 Issue C, 25 August 2009.

ii. Garrad Hassan Pacific, "Assessment of Electromagnetic Interference Issues for the Ryan Corner Windfarm", document no. 45090/PR/002 Issue B, 25 August 2009.

iii. DNV GL, "Ryan Corner Wind Farm EMI Assessment", document no. 170492-AUME-R-01 Issue C, 18 February 2016.

iv. DNV GL, "Hawkesdale Wind Farm EMI Assessment", document no. 170492-AUME-R-02 Issue C, 18 February 2016.

v. "Planning permit granted by the Minister under Division 6 of Part 4 of the Planning and Environment Act 1987", permit no. 2006021, August 2008.

vi. "Planning permit granted by the Minister under Division 6 of Part 4 of the Planning and Environment Act 1987", permit no. 2006022, August 2008.

vii. Australian Communications and Media Authority (ACMA), "Register of Radiocommunications Licences" [online], https://web.acma.gov.au/rrl/register_search.main_page, accessed 19 July 2017.

viii. Australian Government, "mySwitch" [online], https://myswitch.digitalready.gov.au/, accessed 24 July 2017.

ix. NBN Co Ltd, "NBN rollout map" [online], http://www.nbnco.com.au/learn-about-the-nbn/rollout-map.html, accessed 28 July 2017.

x. Lawrence Derrick & Associates, "Hawkesdale Wind Farm – Pre-construction TV/Radio Reception Survey", 15 January 2010.

xi. Lawrence Derrick & Associates, "Ryan Corner Wind Farm – Pre-construction TV/Radio Reception Survey", 20 January 2010.

Annexure A – Qualifications of Trenton Gilbert

Academic qualifications

Doctor of Philosophy (Aerospace Engineering), RMIT University, Melbourne, 2003

Bachelor of Engineering (Aerospace, Hons I), RMIT University, Melbourne, 1999

Membership of professional associations

Member, Engineers Australia (IEAust)

Associate, Royal Aeronautical Society (RAeS)

Detailed professional experience

Principal Engineer, Head of Section, Developer Support Services (Pacific)
DNV GL (formerly GL Garrad Hassan)
(2014 – Present)

Trenton is a Principal Engineer, and the Head of Section for Developer Support Services in the Pacific Region in the Renewables Advisory Division of DNV GL - Energy. He has a PhD in Aerospace Engineering and a BE in Aerospace.

Trenton has worked on a large number of wind farm projects throughout Australasia and Southeast Asia in support of developers and lenders, and is responsible for the delivery of a range of services including site identification, wind mapping, CFD, feasibility studies, wind monitoring programmes, layout development and optimisation, and technical inputs to environmental and planning assessments, including shadow flicker, electromagnetic interference (EMI) and visual impact assessments.

Trenton has presented evidence as an expert witness on shadow flicker and EMI at wind farm planning hearings, and has also been involved with site inspections, wind data analysis and energy production assessments for multiple wind farm projects.

Senior Engineer, Technical Lead, Development Services (Pacific)
DNV GL (formerly GL Garrad Hassan)
(2011 – 2014)

Senior Engineer
DNV GL (formerly GL Garrad Hassan)
(2008 – 2011)

Aerospace Engineer
DSTO (Defence Science & Technology Organisation)
(2003 – 2008)

DSTO is responsible for conducting and applying research in support of the Australian Department of Defence. Trenton played a key role in a number of projects, including:

- Development, validation and application of aerodynamic, inertial and propulsive models for predicting aircraft loads. These models were used to ensure the accuracy of loads measured on instrumented aircraft for the purpose for of performing aircraft life assessment.

- Involvement in flight testing of instrumented aircraft, and subsequent post-processing, analysis and visualisation of flight test data.
- Development of ground testing and numerical analysis techniques to assist with the prediction of aeroelastic instabilities in highly flexible aircraft.
- Involvement with ground vibration testing, flight flutter testing and subsequent data analysis for the purpose of aircraft envelope expansion.
- Development of parameter identification techniques based on numerical optimisation for use in developing databases for aircraft performance assessment.
- Management of long range research activities in aircraft loading and flight mechanics.

Postgraduate Researcher (PhD)
RMIT University
(2000 – 2003)

Trenton completed his PhD thesis titled “Non-linear Dynamic Modelling of Flexible Manoeuvring Structures”. This research involved the development of a technique based on a non-linear finite element method for modelling highly flexible robotic and aircraft structures in order to predict the loading experienced during manoeuvring.

Engineer (casual)
RMIT University
(2000 – 2003)

Trenton was employed on a casual basis by RMIT University whilst completing his PhD, and was involved in a number of activities, including:

- participation in development of numerical analysis and visualisation software
- assessment of structural flexibility of a trainer aircraft from deflection measurements
- use of data acquisition systems and data processing for aircraft fatigue life assessment
- conducting ground vibration testing and modal analysis of sporting equipment
- lecturing, tutoring, and student assessment in computer programming and dynamics.

Annexure B – Qualifications of Naomi Brammer

Academic qualifications

Doctor of Philosophy (Mechanical Engineering), Monash University, Melbourne, 2014

Bachelor of Engineering (Mechanical Engineering, Hons I), Monash University, Melbourne, 2004

Bachelor of Science, Monash University, Melbourne 2004.

Membership of professional associations

Member, Engineers Australia (IEAust)

Member, Australian Society for Technical Communication (ASTC)

Professional experience

Engineer,
DNV GL (formerly GL Garrad Hassan)
(Aug 2015 – Present)

Naomi has been involved in a range of tasks associated with providing technical inputs to environmental and planning assessments, including shadow flicker and electromagnetic interference assessments. She also has experience with wind data analysis, performing energy assessments for wind farm development, and the use of remote sensing data.

Postgraduate Researcher (PhD),
Monash University
(2005 – 2014)

Naomi completed her PhD thesis titled “Exergy-Based Indicators of Environmental Impact: Influence of Methodological Choices”. This research examined the use of exergy, a measure of deviation from the state of the environment, as an indicator to assess and compare the environmental impact of human activities. It showed that recommendations based on these comparisons can change depending on how the indicator or the environment is defined.

Assistant Lecturer and Teaching Associate,
Monash University
(2005 – 2012)

Naomi was employed as a lecturer and unit coordinator for several introductory units in thermodynamics, heat transfer, and power cycles for Mechanical, Aerospace, and Chemical Engineering students from 2008 to 2012. Prior to this, she worked as a demonstrator and tutor for laboratory and problem solving classes in thermodynamics, physics, and engineering drafting. During this time, Naomi also assisted in the training of demonstrators and tutors in the Faculty of Engineering, and jointly developed and implemented a new approach to teaching and assessing written communication skills in thermodynamics units.

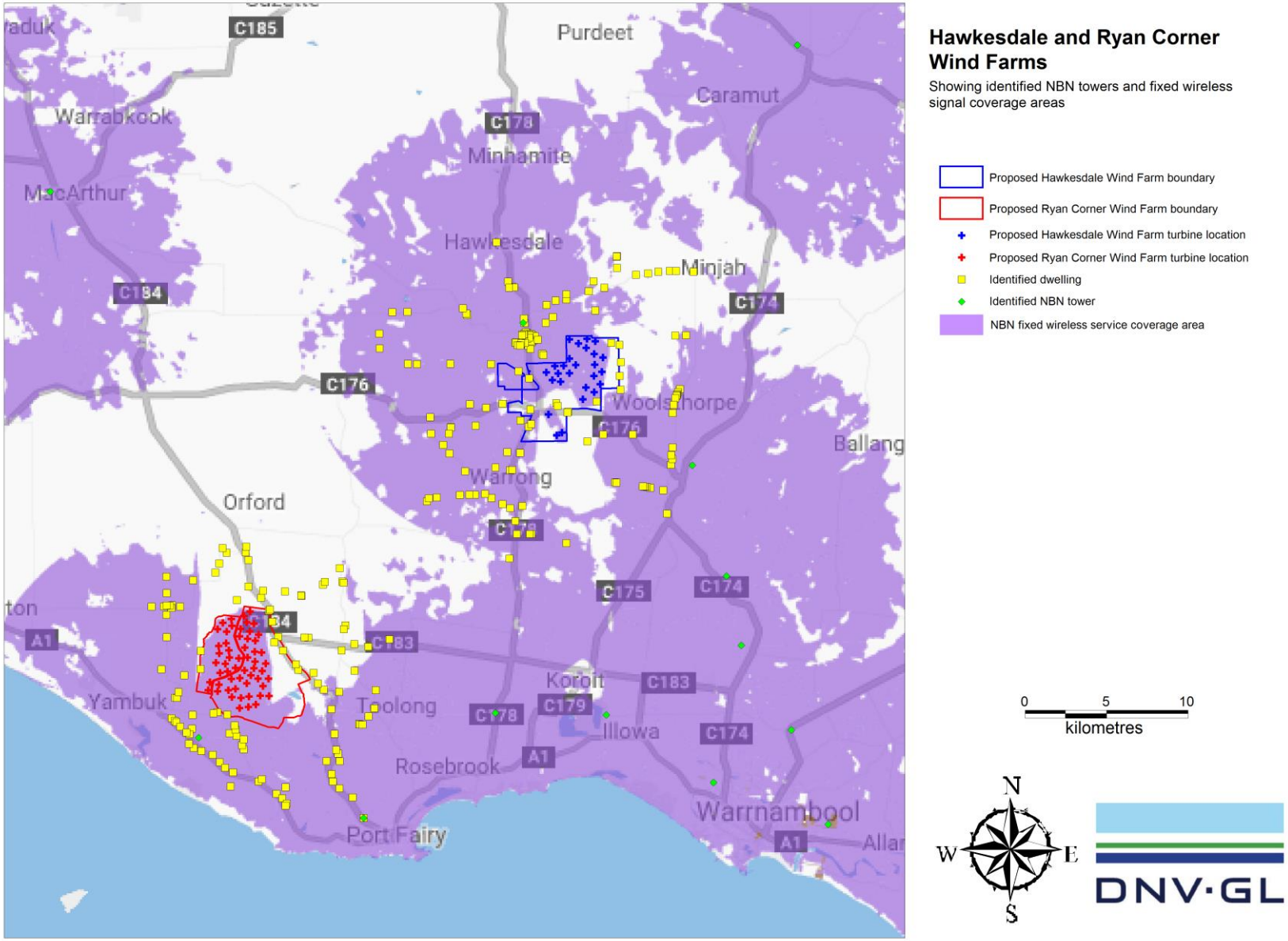

Figure 1 NBN towers and coverage areas