Flyers Creek Wind Farm Pty Ltd

Flyers Creek WIND FARM

Environmental Assessment

APPENDIX H
Telecommunications

Lawrence Derrick & Associates

FLYERS CREEK WIND FARM - INVESTIGATION OF POSSIBLE IMPACTS ON BROADCASTING AND RADIOCOMMUNICATION SERVICES

[Final]

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1. BACKGROUND

Flyers Creek Wind Farm Pty Ltd (FCWF) is proposing the development of the Flyers Creek Wind Farm at the Errowanbang locality within Blayney Shire. It is located northwest of Carcoar and about 20 km south of Orange in the Central Tablelands of New South Wales. The project is proposed to contain 44 turbines. Aurecon, working on behalf of FCWF, has sought advice on the Broadcasting and Radiocommunication constraints that occur in the Project Area and surrounds. The proposed wind turbines will consist of tapered cylindrical metal towers of up to 100 metre in height on which are the nacelle and turbine rotor of up to 100 metres diameter. The nacelle will house the generator, gearbox, motors for turning the turbine into the wind and for adjusting blade pitch. As part of the environmental study of the proposal, the potential for disruption to radiocommunications and broadcasting in the wind farm area is being assessed. Clearance distances between any near point to point microwave link paths and the turbines are also required to avoid any degradation to the performance of the links. Buffer zones from radio sites within or close to the boundaries of the wind farm are also to be specified where necessary.

2. INTRODUCTION

It is considered necessary to include an assessment of potential impacts of the wind turbines on TV and sound broadcasting reception in the general area of the wind farm from the transmitting stations utilised by residents and to determine if any of the turbines are close to radio link paths traversing the wind farm site. This report covers the outcomes of a desktop study to identify any potential issues and makes recommendations.

3. LEGISLATION AND GUIDELINES

3.1 Commonwealth legislation Under the Australian Radiocommunications Act 1992, “interference” is defined as:

• **In relation to radiocommunications**: Interference to, or with, radiocommunications that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device; or

• **In relation to the uses or functions of devices:** Interference to, or with, those uses or functions that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device.

In using these definitions, the Radiocommunications Act deals with the radiocommunications interference caused by electromagnetic fields and provides protection for users where such interference is caused. It does not, however, deal with radiocommunications interference caused by physical obstructions.

This report provides best practice guidance about the issues associated with the physical obstruction impacts, and details methods for assessing the potential of such impacts. It also advises which stakeholders should be consulted and what sort of information they may require. Mitigation strategies and post-construction monitoring methodologies are also presented. Some guidance has been taken

from Appendix F of the Environment Protection and Heritage Council's (EPHC) draft National Wind Farm Development Guidelines (Ref. 9).

3.2 NSW Planning Guidelines It is understood that the NSW Department of Planning and other agencies are developing the *NSW Planning and Assessment Guidelines for Wind Farms*. The guidelines will update the *Environmental Impact Assessment Guidelines for Wind farms* released by the Department of Planning in 2004. An assessment of potential telecommunications impacts is also included in the Flyers Creek Wind Farm Directors General's Requirements.

4. DESKTOP STUDY

A desk top study has been carried out on the likely impact of wind turbines and their supporting towers on broadcasting and radiocommunications in the area surrounding the wind farm. This study is based on relevant International Telecommunications Union (ITU) documents and on other professional reports on overseas and Australian experience of wind farm impacts on broadcasting services in the vicinity of any wind turbine structures. For Radiocommunication services sites up to at least 50 Km from the site need to be considered because of the length of point to point paths of up to 100 Km.

Using data from the Australian Communications & Media Authority's (ACMA) RADCOM Database, checks have been made on radiocommunication services within at least a 50 km radius of the wind farm to determine if any of the turbine towers could obstruct line-of-site paths or have any likely detrimental affect on these services. Clearance criteria for ray lines have been indicated for any point to point radio paths crossing or near the wind farm site.

5. BROADCASTING SERVICES IN THE AREA

From ACMA TV and Sound Broadcasting Station listings, and from a map survey of the area surrounding the Flyers Creek wind farm site, the following is a general summary of the broadcast transmitter site locations and radio frequency channels which provide cover of the area.

5.1 Analogue Television

It is expected that residents in the area surrounding the wind farm location currently generally view analogue TV from the Central Tablelands National and Commercial main stations located at Mt Canobolas which is approx. 20 km from the wind farm site centre. In addition coverage of some locations could be available from the National and Commercial Bathurst medium power stations located on Mount Panorama. These conclusions are based on the ABC's web site TV service area predictions for the towns surrounding the wind farm. The station utilised by individual residents for TV reception will depend on the least obstructed path to the transmitters and in some locations reception of channels from more than one station will be possible. In addition to analogue TV channels digital channels are also available from these transmitting locations as discussed in 5.2. A summary of possible channels available from the stations listed is shown in Attachment 2

5.2 Digital Television

Digital television signals are also currently being radiated from the same locations listed in 5.1 under the current programme of transition to digital television in Australia which commenced in 2001. According to the ABC's TV coverage predictions reception of digital TV may be possible in the area from the Central Tablelands and the Bathurst stations

The Government has announced that digital only transmission in Southern NSW will be achieved by 30th June 2012. It is therefore considered that any remedial action necessary for mitigation of interference to TV reception would likely only have to focus on digital transmission signals.

5.3 TV Retransmission Stations

There are at least 14 TV retransmission stations listed that may receive their input signal "off air" from the Central Tablelands main stations at Mt Canobolas. The potential interference issue is that the path to some of these stations may pass through the wind farm potentially causing interference to the signal which is retransmitted. This is discussed below.

5.4 FM Sound Broadcasting

Central Tablelands FM Services radiated from Mt Canobolas are predicted to service the general area. It is unlikely that these services will be affected by the proposed wind farm project. FM Stations covering this area have therefore not been listed.

5.5 MF Sound Broadcasting

Some Sydney and Cumnock Medium Frequency stations will be receivable in the general area. As indicated below, wind farm effects on MF radio are highly unlikely and therefore the stations serving the area have not been listed.

5.6 Satellite Pay Television

Some homesteads in the area may have satellite pay TV service antenna installations. Unless a particular subscribers antenna reception direction and elevation is closely aligned with a turbine, which is highly unlikely, no impacts on TV reception are expected.

6. RADIOCOMMUNICATIONS SERVICES

The wind turbine current grid coordinates are listed in Attachment 1. Maps generated from data in the ACMA database are shown in Attachments 3 & 4 Attachment 3 shows all radio sites and point to point links within at least 50 Km of the wind farm and with operational frequencies in the range 40 – 999 MHz (VHF & UHF). Attachment 4 is a similar map for links in frequency range above 1 GHz (microwave). It should be pointed out that due to the close spacing of adjacent link sites the site number displayed on the PDF maps may not be the appropriate one for a given point to point link due to overlaying of site labels. The wind farm site is shown as a rectangle.

6.1 Point to Point

A large number of point to point links are registered for operation within 50 km of the wind farm site. As shown in the map Attachment 3 there are 5 UHF/VHF links in 2 groups which traverse or are near to the boundaries of the wind farm.

Attachment 4 indicates that there are 6 microwave links (> 1GHz) with are near to or cross the wind farm site. Clearance requirements are required to ensure turbines are not located close to the ray lines of these links to avoid any impact on their performance. The ray lines passing near the wind turbines are shown in zoomed maps in Attachments 5, 6 & 7

6.2 Cellular Mobile Base Stations

Optus and Telstra cellular mobile base stations are registered at site 134718 on the wind farm site. The nearest turbine is 266 metres from the base station antennas. It is considered that the operation of the turbines should have no significant impact on the cellular mobile coverage; however, it is recommended that Optus and Telstra be advised of the situation. From the examination of recent photographs of the tower, it is believed that site 134718 and the associated radio link site 204434, which have different coordinates, are in fact the same tower. The different locations in the ACMA database may be due to the different grid reference systems (AMG versus MGA or WGS) used by the organizations reporting details to ACMA.

6.3 Two-Way Mobile

A number of private and Public Utility mobile bases exist in the area surrounding the wind farm site. These bases potentially provide cover to mobiles in a 360 degree arc from their bases. No significant impact from the wind farm on base coverage beyond normal mobile operational performance is predicted in view of the geographic separation between the base antennas and the turbine structures. Of course, a mobile transceiver unit communicating with a base station when the mobile is located within metres of the wind turbine structures (or indeed near any large building, silo, tower etc) may experience some very local performance change, however moving a short distance would restore performance to normal.

6.4 CB Radio

CB radios are not individually licensed, the equipment being subject to class licensing only. Therefore no records of location or operators of CB radios exist, and the channels are shared without any right of protection from interference. No impact from the wind farm is predicted except perhaps for very local effects to portable or mobile units in the immediate vicinity of the turbines which could be avoided by a small location change of the unit.

6.5 Aviation Services

There are no radar sites listed within the 50 km of the wind farm study area. Air Services, Orange City Council and others have registrations for ground – air VHF

services at Mt Canobolas, Orange Airport and Mt Panorama. Due to adequate separation distance to turbines no impact to these services is predicted.

6.6 Point to Multipoint (PMP) Systems

There are a number of PMP systems registered in the 50 km radius from the wind farm study area boundaries. The PMP base stations are registered in the ACMA data base however the customer/remote ends are generally not registered for PMP systems, so that it is not possible to check if any turbines are in the paths from the base station to the customer ends. These systems operate in the microwave frequency bands. Systems registrations include Telstra (3.4GHz), Chippawa Pty Ltd (2.3GHz) Murray Regional Telecommunications (3.8GHz), Vertical Telecoms (3.8GHZ), QEStel (3.8 GHz) Pty Ltd and Allegro Networks (3.8GHz). Most are located at Mt Canobolas or Mt Panorama. The operators of these systems may be in a position to assess if there are any impacts to their individual customers' services.

6.7 Met Bureau Radar and Other Services

No registrations for the Met Bureau were found in the area

7. EMI EFFECTS OF WIND TURBINES

The following is an extract from Ref. 1:

"It is well known that any large structure, whether stationary or moving, in the vicinity of a receiver or transmitter of electromagnetic signals may interfere with those signals and degrade the performance of the transmitter/receiver system. Under certain conditions, the rotor blades of an operating wind turbine may passively reflect a transmitted signal, so that both the transmitted signal and a delayed interference signal (varying periodically at the blade passage frequency) may exist simultaneously in a zone near the turbine. The nature and amount of electromagnetic interference (EMI) in this zone depend on a number of parameters, including location of the wind turbine relative to the transmitter and receiver, type of wind turbine, physical and electrical characteristics of the rotor blades, signal frequency and modulation scheme, receiver antenna characteristics, and the radio wave propagation in the local atmosphere. Other wind turbine components which have been considered to be potential causes of EMI are towers and electrical systems. However, neither of these has been found to be a significant source of interference. Thus, moving blades are the components of most importance in determining EMI levels.

Television Interference from wind turbines is characterised by video distortion that generally occurs in the form of a jittering of the picture that is synchronised with the blade passage frequency.

Effects on FM broadcast reception have been observed only in laboratory simulations."

Point to point links in microwave and lower frequency bands will be affected only if the turbine tower or turbine clearance to the line of site path to the other end of the link is within the second Fresnel zone which is dependent on the operating

frequency of the link, the distance of the tower/turbine from the link antenna and the total link distance. D. F. Bacon (Ref. 8) proposes 3 potential degradation mechanisms - near field effects, diffraction and reflection or scattering. The reflection or scattering treatment in the reference suggests greater clearance requirements at positions close to the link terminals than the usually applied to Fresnel Zone clearance for certain links with low antenna gain. This has been taken into account for this study.

8. DISCUSSION OF OVERSEAS EXPERIENCE

Observations and studies have been carried out for a number of years in both the USA and the UK on the effects of wind turbines on TV and other radiocommunication services. In 1976 the US Energy Research and Development Administration (ERDA) funded the RadLab at the University of Michigan for investigations into these effects and this continued for 7 years. Ref. 1 summarises the results of theoretical and field measurements.

The BBC's Research Department in the UK has also investigated this subject in some depth, and in 1983 a report was issued (Ref. 2). Another Report (Ref. 3) was issued in 1992 after the Research Department had carried out observations from test transmissions at existing wind farms in Denmark in 1991.

In 1992 the ITU issued a Recommendation (Ref. 4) on the assessment of impairment caused to television reception by a wind turbine.

In a recent exchange of emails, Mr Chris Gandy of the BBC Research Department summarised the conclusions they had come to on this subject as follows - "…..in the UK the only significant broadcast reception difficulties that have successfully been attributed to wind turbines so far have been associated with UHF analogue television, not FM radio and certainly not MF or LF radio. There may be some potential for effects on digital terrestrial television, but possibly only in cases where turbine blades are between the transmitter and the receiver - cases of reflection from the blades are much more common and in the majority of cases should do little damage to our DTT signals because of the guard interval present in each DVB signal. Of course, there will be the odd case where reception was right on the edge of the 'digital cliff' before the turbines were built. Also we have no record of interference with our Digital Radio transmissions in Band III."

Ref. 5 summarises the results of model measurements of the level of interference signals scattered by turbine blades and the supporting tower and confirms some of the backscatter estimates calculated in Ref. 4.

Metal blades were used for some earlier turbines unlike the modern ones where composite material - fibre glass, carbon fibre, plastics are used. In some cases metal exists in the composite material blades for strength reinforcing or for lightning protection. Some references indicate that the composite blades will have a reduced interference potential, however the BBC view is that at UHF TV frequencies the difference will be small.

It is also indicated in some of the reports that due to variable wind speeds and direction, the resulting changes to turbine blade pitch and turbine facing direction

will modify any interference levels at a given location in the service area ie interference effects would be time variant.

In relation to domestic TV reception in close proximity to wind turbines Ref. 7 issued by the BBC/Ofcom in the UK states that “In practice rarely does the tower or nacelle have any effect on reception; the impact on reception is solely on account of the rotating turbine blades. As the blades are moving objects, in terms of both their rotational speed and orientation, their effect is variable and hard to predict. When the combined effects of a number of turbines that comprise a wind farm are considered, the result is considerably more difficult to predict

From a study of the above references and others, the following general conclusions are drawn:

(a) No turbine interference effects are expected to MF radio reception.

(b) There is a very low probability of perceptible interference to FM radio reception

(c) Some interference may be experienced to analogue TV services and particularly where the path to the TV transmitter for a given receiver location is through the wind turbine blades or where there is a partly obstructed path to the transmitter and there is a clear path to a turbine. These effects may be restricted up to a distance of about 3 km from a single wind turbine in forward scatter directions (receiver on opposite side of the wind farm to the TV station). Backscatter may occur up to 0.5 km or so however as TV receiving antennas have a reasonable signal rejection to the rear it is unlikely that TV reception at dwellings in the back scatter zone will experience any impairment.

(d) Digital TV services are unlikely to suffer degraded picture quality, eg, ghosting, where signals have a margin above threshold levels, however a reduction in service area could occur due to time varying reflected signals.

9. FLYERS CREEK WIND FARM SITUATION

From overseas experience, calculations using the University of Michigan method and the topography of the area:

9.1 No interference from the wind farm is expected to the MF and FM sound broadcasting services in the area.

9.2 Theoretical estimates outlined in Attachment 12, of reflections of the typical analogue VHF and UHF TV transmissions from typical transmitting sites by the turbine blades indicate that some possibility of analogue TV picture degradation exists at times for dwellings located such that wind turbines exist within a +/- 20 degree sector (Ref. 6) from the TV antenna nominal direction of reception, and up to about 3 km from the turbines. Estimates of typical scattering from the blades are based on available data for three blades each have a one sided projected surface area of 67 sq. metres (44 metres long), that the turbine towers will be tapered steel columns about 100 metres high and on using the method outlined in Ref.1. The turbines proposed may have longer blades and so will have a nominal increase in reflected signal level. These measurements

overseas indicate that the calculations using the alternative ITU method (Ref.4) over estimate the scattering /reflection so this method has not been used. It is also difficult to estimate the additive effects of a number of turbines distributed over some distance and on the effect of the undulating terrain on the ratio of the reflected signal to the main wanted TV signal. Some neighbouring residences are predicted to have some probability of perceptible TV picture degradation for a percentage of time depending on the direction and speed of the wind.

9.3 Due to the undulating terrain around the wind farm and the possible individual choice of a few TV transmitting stations it is difficult to predict where interference may occur. In general, dwellings to the south of the wind farm and close to turbines are at increased risk of having some interference to analogue TV signals.

9.4 As indicated above, digital television is not subject to ghosting degradation in high signal strength areas, however some reduction of service area could result from reflected unwanted signals at the limits of the service area. There may be some isolated areas which are shadowed by local hills resulting in reduced signal levels; however, such effects are unlikely, but are also difficult to categorically exclude as a possibility.

9.5 There are at least 14 low power TV rebroadcast station locations listed in the ACMA database in the area the surrounding Mt Canobolas. These stations generally retransmit the TV signals transmitted from Mt Canobolas for local area fill-in coverage. These off air reception situations are not shown on the ACMA database as licensed links, and therefore do not appear on the link mapping. Rebroadcast stations for Darby Falls, Oberon and Wyangala are to the south of Mt Canobolas and if their input signals passed near to, or through, the wind farm, some interference to input signals and therefore to the TV service areas of each station could potentially occur. However a check of the three paths from Mt Canobolas to the retransmission sites indicates that they do not cross or come close to the wind farm boundaries. Any disturbance to the input to these TV rebroadcast stations as a result of the wind farm is therefore very unlikely.

9.6 For satellite pay TV services in the area of the wind farm no interference to these services is likely to occur unless the required pointing of their dish antennas to the serving satellite is also in line with a turbine.

9.7 The ACMA RADCOM database has been studied for services within at least 50 km of the wind farm to determine if any point to point services will have their paths obstructed by the wind turbine blades or the supporting towers. Maps derived from the ACMA database showing radio sites and links in the general area surrounding the site are shown in Attachments 3 & 4. Six microwave radio link paths and five VHF/UHF radio link paths have been identified as crossing or near the boundary of the wind farm site. Based on required clearances of the above links 3 of the microwave (2 operated by Optus and 1 by TransGrid) and 2 of the VHF/UHF link groups (operated by Dept of Environment Climate Change & Water, Forestry Commission, Country Energy, TT & CI Reece and Central Tablelands County Council) require consideration of turbine clearances. These are shown in zoomed map views in Attachments 5, 6 & 7. Attachment 11 provides calculations of the clearance required to achieve 2nd Fresnel clearance near the turbines for the microwave systems and 0.6 X 1ST Fresnel zone

clearance in the VHF/UHF cases. All the VHF/UHF links currently have sufficient horizontal clearance. To determine if any of the microwave radio path ray lines potentially have sufficient vertical clearance over the top of the turbines vertical path profiles were generated from digital elevation model data and are shown in Attachments 8, 9 and 10. These show the terrain profile including earth curvature along the radio ray lines. Representative structures are superimposed on these terrain profiles representing the turbine tower height plus blade length (150 metres) and have been positioned in the general locations of turbines on the paths. A check of the latest radio link maps in relation to the turbine layout and the vertical path profiles of links paths shown in Attachments 8, 9 & 10 indicate that all turbines have adequate clearance. Horizontal spacings of the distances calculated and shown in the tables of Attachment 11 are however required to be maintained in any micro-siting. The TransGrid link crossing the site has sufficient vertical clearance even after wind turbine #31 was shifted to the north by somewhat over 100 metres. Attachment 10 indicates that the ray line has sufficient vertical clearance over the top of the turbine blade at 150 metres above ground level.

9.8 The closest Airservices facilities at Mt Canobolas, Mt Panorama and Orange Airport are sufficiently separated from turbines and are of the type not to be interfered with by turbines as they are for ground – air communication or have localized coverage at the airport or other locations. There is no radar facility within line of sight of the turbines.

9.9 Microwave band PMP base stations at Mt Canobolas and Mt Panorama operated by Telstra (3.4GHz), Chippawa Pty Ltd (2.3GHz) Murray Regional Telecommunications (3.8GHz), Vertical Telecoms (3.8GHZ), QEStel (3.8 GHz) Pty Ltd and Allegro Networks (3.8GHz) are not able to be assessed for potential interference as the remote customer ends are not registered. It is recommended that these organisations be corresponded with to obtain their views of any potential turbine interference potential to their customers.

10. AVOIDANCE OF INTERFERENCE DURING CONSTRUCTION

10.1 There is a potential to cause interference to some microwave links during construction of the wind farm from the use of large construction cranes. These could be erected in locations where the crane tower or boom could traverse across the line of site paths of radio links particularly in proximity to the Optus tower within the wind farm site.

10.2 It is understood however that the cranes will normally work within the rotor diameter so that no special procedures will be necessary as the location of turbine towers allows for the operational rotor diameter in the clearances specified. If any movement of cranes is contemplated without dismantling avoidance of the operating radio link paths and Fresnel clearances will be needed.

11. FORTUITOUS RECEPTION OF BROADCAST SIGNALS

On some previous projects Responsible Authorities have imposed conditions such as:

"if the qualitative survey establishes any detrimental increase in interference to reception or transmission measures must be taken to mitigate the interference to return the affected reception or transmission to pre-construction quality" (Waubra Vic Planning Permit No PL-SP/05/0150),
This raises two issues primarily for analogue TV reception, the first being the criteria for interference assessment and the second being the protection of reception of some services outside their designed coverage area - termed fortuitous reception. For analogue television reception which is the most vulnerable service for turbine interference it is proposed to use the ITU grade 4, of a 5 grade impairment scale as the limit of acceptance, which is described as "perceptible but not annoying". On the second point, the ACMA's attitude to protection of reception outside designed service areas is understood to be that the reception is fortuitous and will not be protected. They will therefore plan for reuse of frequencies for new stations which in future may impair reception in areas where it is currently acceptable or useable, often for at least part of the time.

This is, of course, difficult for individuals to accept who, due to their particular location, cannot receive an acceptable service from their planned station. Others may use distant stations to avail themselves of diverse programs. It is not reasonable to attempt to protect these services which are likely to be of low signal level and may vary in quality of reception depending on time of day, weather patterns and season. It is therefore not recommended to mitigate any reception which may be impacted by turbine effects where the receivers are clearly outside the ACMA planned coverage area for the particular service being received.

12. MITIGATION TECHNIQUES

As indicated above, analogue TV will be switched off for Southern NSW by 30th June 2012. This will occur before the completion of the wind farm. Therefore, any mitigation of interference will involve digital television reception and issues like that discussed in Section 11 would not be applicable.

For individuals who experience any degraded FM or TV broadcasting service due to identified interference from the wind farm, possible techniques to reduce the interference to acceptable limits include:

1. Replacement of receiving antenna system with a higher gain more directive model,

2. Reposition antenna in height or horizontally on the dwelling,

3. Install an antenna elsewhere on the property and cable to dwelling,

4. Change the orientation of antennas to receive an alternative station if available, e.g. Bathurst instead of Central Tablelands.

5. Provision of an alternative satellite service eg, the proposed Viewer Access Satellite Television (VAST) (Ref. 10) or Austar Pay TV Service.

6. Where feasible, consideration could be given to the installation of a TV or FM Repeater station to provide service to groups of residents in a shadow zone.

Potential point to point system and mobile base coverage conflict is not predicted if turbines can be located with recommended clearance zones from radio sites or point to point ray lines. There are 3 identified microwave links passing close to turbines with none closer than the 2nd Fresnel.

Any minor affects to MF broadcasting would occur within 10's of metres of the turbines only and with a buffer zone of at least 500m to any dwelling, no corrective action will be required.

13. CONCLUSIONS

Interference to MF and FM sound broadcasting is not expected.

Potential conflicts between point to point radio systems and the wind turbines identified above will require clearance to be maintained between link ray lines and turbines as proposed in the attachments. The current wind turbine locations with grid references shown in Attachment 1 have acceptable clearances from currently registered point to point radio links and buffer zones from radio sites on or adjacent to the wind farm site are considered to be adequate.

Mobile radio and other radiocommunication services in the area are not expected to be significantly impacted by the wind farm or its operation.

Analogue TV reception at dwellings within about 3 km of the wind farm turbines and with antennas having turbines located with +/- 20 degrees angle of their reception direction will have some probability of noticeable ghosting at times. Any ghosting experienced may be time variant depending on wind direction and speed. However, as analogue TV transmission is scheduled to end prior to construction of the wind farm, this will not be an issue.

Digital TV is not susceptible to visible ghosting degradation where the signal level is above a minimum threshold The area surrounding the wind farm is expected to be a medium to high level signal area. However there may be a few individual houses located in shadow areas where other mitigating techniques may need to be applied.

Should any confirmed analogue interference problems occur during the wind farm construction period where TV receiving antenna system improvements are unsuccessful, the use of a set top box with reception of the available digital channels may be the best solution. Existing Digital TV services are expect to provide unimpaired picture to any houses near the turbines which may have experienced picture quality problems as a result of ghosting on analogue TV services as long as the signal levels have a margin above a threshold level. However as indicated above the NSW Central Tablelands TV stations covering the areas near the wind farm will be operating as digital only by June 2012 which presumably will be before the wind farm is operational. Provision of digital TV solutions to any degraded analogue reception would be simply advancing an inevitable transition to digital reception.

Alternatively a satellite service could be considered if digital TV reception is unsatisfactory in individual cases. In particular, the proposed Viewer Access

Satellite Television (VAST) Service announced by the Government recently would be available to provide a full complement of digital channels including a regional news channel.

Overseas experience indicates that EMI produced by the wind farm generators and controls is not a problem with reputable world class wind turbine manufacturers and therefore no electrical noise measurements from the electrical generators are warranted.

It is recommended that operators of point to point radio systems that cross the wind farm site, PMP operators identified in section 9.9 above, the Commercial Television Station operators in the area, Broadcast Australia for the ABC and SBS and Air Services be advised of the wind farm project to enable these organizations to confirm that there are no potential interference issues seen to be relevant to their operations.

REFERENCES

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2. J.L. Eaton, R.I. Black, G.H. Taylor, Interference to Television Reception from Large Wind Turbines, BBC Research Department Report 1983/2

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4. ITU, ITU-R Recommendation BT805 Assessment of Impairment Caused to Television Reception by a Wind Turbine 1992

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6. ITU, ITU-R, Recommendation BT 419-3 Directivity and Polarisation Discrimination of Antennas in the Reception of Television Broadcasting 1992

7. BBC, Ofcom, UK, The Impact of Large Buildings and Structures (Including Wind Farms) on Terrestrial Television Reception

8. D. F. Bacon, A Proposed Method for Establishing an Exclusion Zone around a Terrestrial Fixed Link outside of which a Wind Turbine will cause Negligible Degradation of the Radio Link, Ofcom UK Report Ver 1.1, 28 Oct 2002

9. Environment Protection and Heritage Council (EPHC) National Wind Farm Development Guidelines (Draft) - July 2010.

10. Media Release, Senator the Hon Stephen Conroy, “Digital Switchover Legislation Passed” 25th June 2010

ATTACHMENT 1 –FLYERS CREEK NSW WIND FARM TURBINE COORDINATES

Flyers Creek Turbine Locations MGA Zone 55			
Turbine No	X	Y	
1	692613	6292150	
2	691389	6291308	
3	692738	6290953	
4	693188	6290906	
5	692610	6290375	
6	692438	6289879	
7	692375	6289621	
8	691922	6289293	
9	691710	6288716	
10	690463	6289008	
11	690764	6288686	
12	690638	6288139	
13	693146	6288195	
14	693850	6287994	
15	694720	6287294	
16	693932	6287163	
17	692356	6286368	
18	693315	6284663	
19	693106	6284262	
20	693633	6283962	
21	691091	6283878	
22	691440	6283635	
23	691436	6283205	
24	690258	6283778	
25	690357	6283178	
26	690381	6282714	
27	689933	6282625	
28	689635	6282686	
29	689403	6282413	
30	689820	6282149	
31	690231	6282050	updated
32	692382	6282353	
33	692082	6282028	
34	692320	6281639	
35	692379	6281358	
36	692852	6280328	
37	692897	6279893	
38	694007	6282678	
39	695178	6283099	

40	695285	6282880
41	695383	6282655
42	695229	6282331
43	696494	6283966
44	696745	6283761
45	696940	6283488
46	697221	6283308

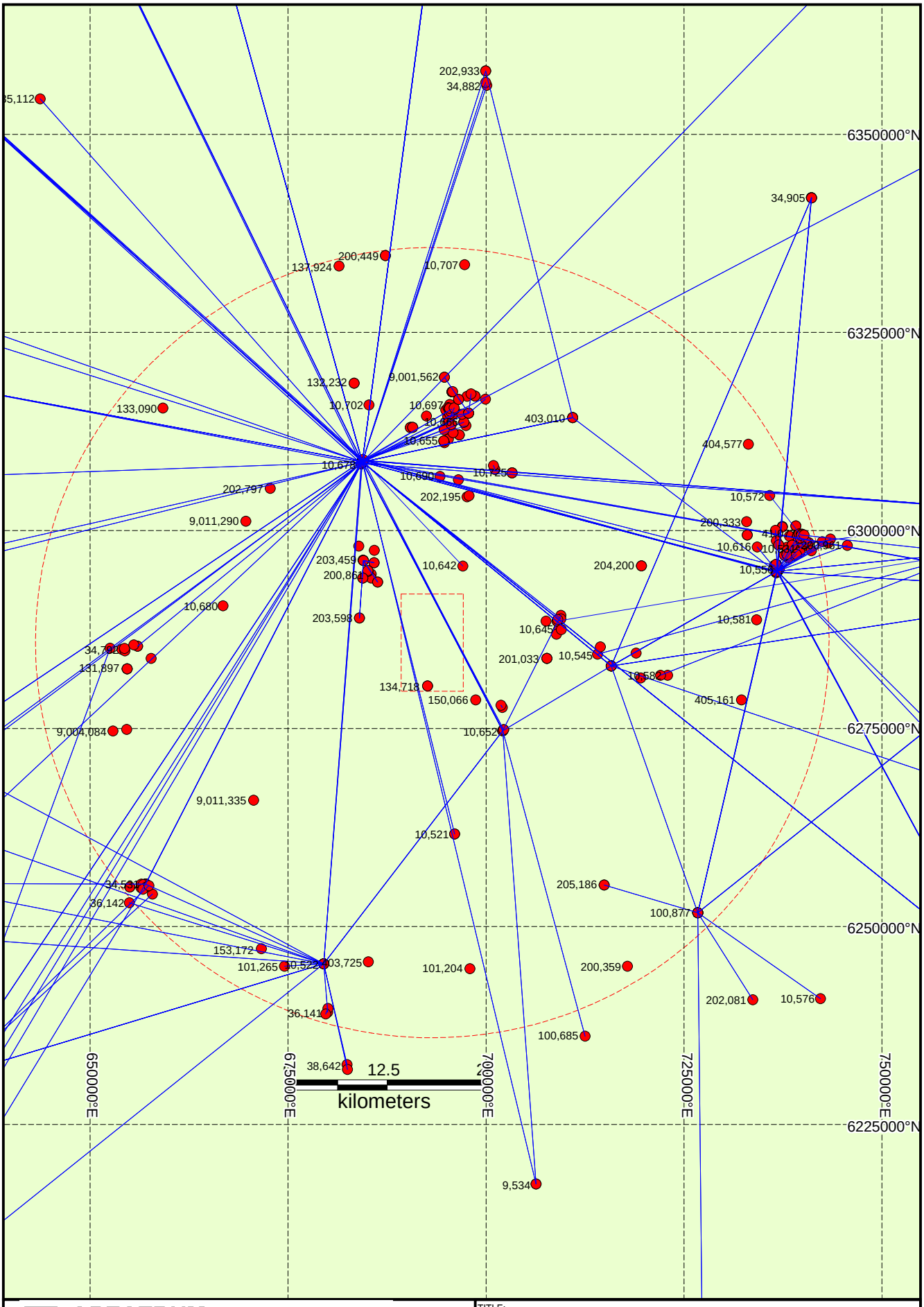
Note: T1, T2, have subsequently been removed from the project

ATTACHMENT 2 - TELEVISION STATIONS & CHANNELS - FLYERS CREEK WIND FARM AREA

Transmitter Location/service	Operator	Analog Channels	Digital Channels	Comment
Central Tablelands	SBS	30H	42H	UHF
	ABC	1V	38H	VHF/UHF
	CBN	8V	37H	VHF/UHF
	CTC	33H	43H	UHF
	WIN	39H	40H	UHF
Bathurst	SBS	46V	9V	UHF/VHF
	ABC	6V	7V	VHF
	CBN	11V	10V	VHF
	CTC	49V	9AV	UHF/VHF
	WIN	52V	12V	UHF/VHF
Darby Falls (retransmission)	SBS	55V		UHF
	ABC	58V		UHF
	CBN	61V		UHF
	CTC	64V		UHF
	WIN	67V		UHF
Oberon (retransmission)	SBS	54H		UHF
	ABC	57H	56H	UHF

	CBN	66H		UHF
	WIN	63H		UHF
Wyangala (retransmission)	SBS	59V		UHF
	ABC	62V		UHF
	CBN	65V		UHF
	CTC	53V		UHF
	WIN	56V		UHF

ATTACHMENT 3 - Radio Link Map 40- 999 MHz Frequencies



SPECTRUM ENGINEERING AUSTRALIA *Pty Limited A.C.N. 008 642 028*

Radiocommunications Planning and Design

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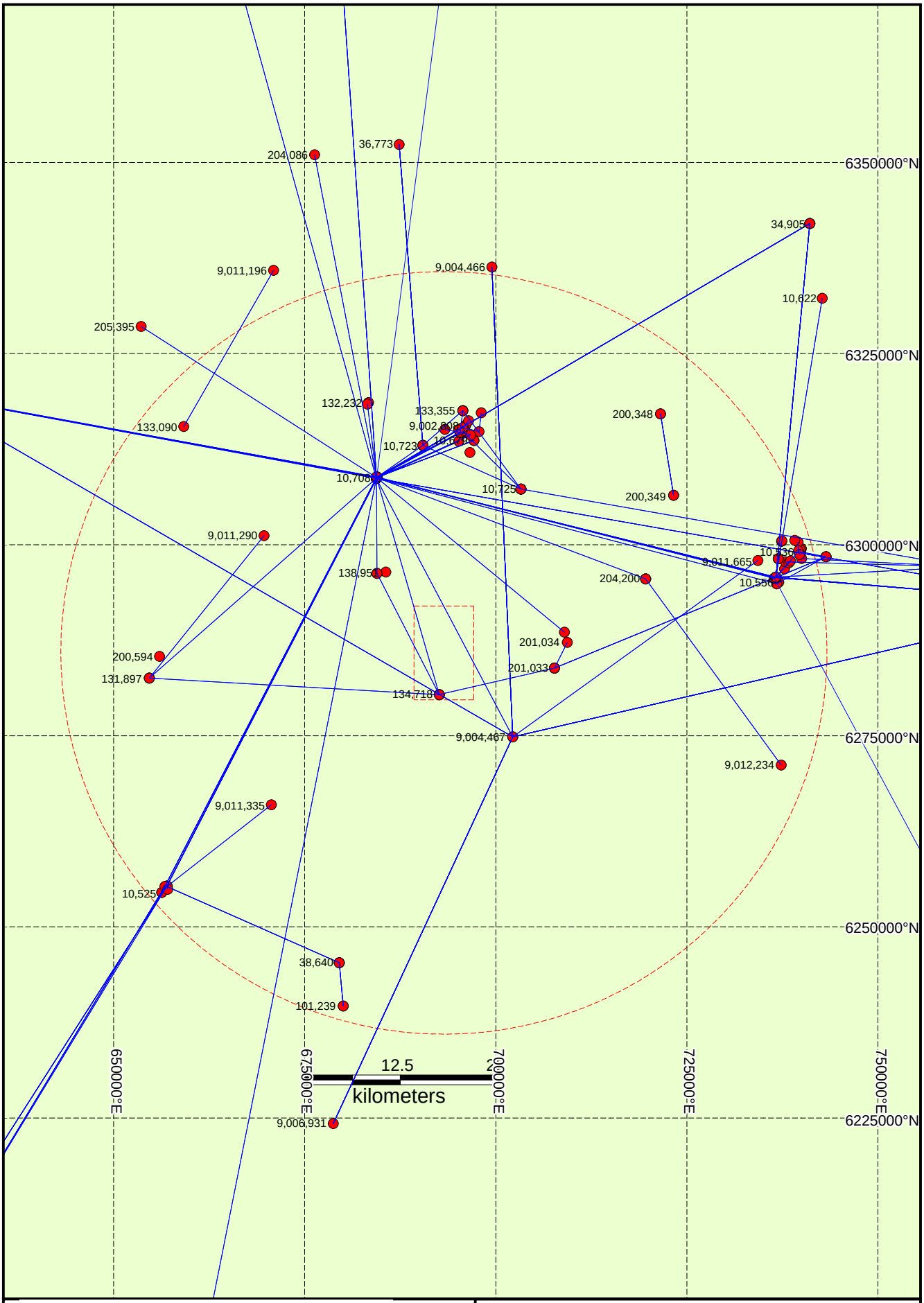
Facsimile: 02 6253 2800

TITLE: **40-999 MHz Assignment**
As Extracted from RRL Database

FILENAME:	Flyers Creek Addition 40-999 MHz	DATE:	4/11/2010
PROJECT:	Flyers Creek Addition	SCALE:	N/A
DRWG NO:	1 of 2	BY:	SEA

ATTACHMENT 4 - Radio Link Map above 1000 MHz Frequencies



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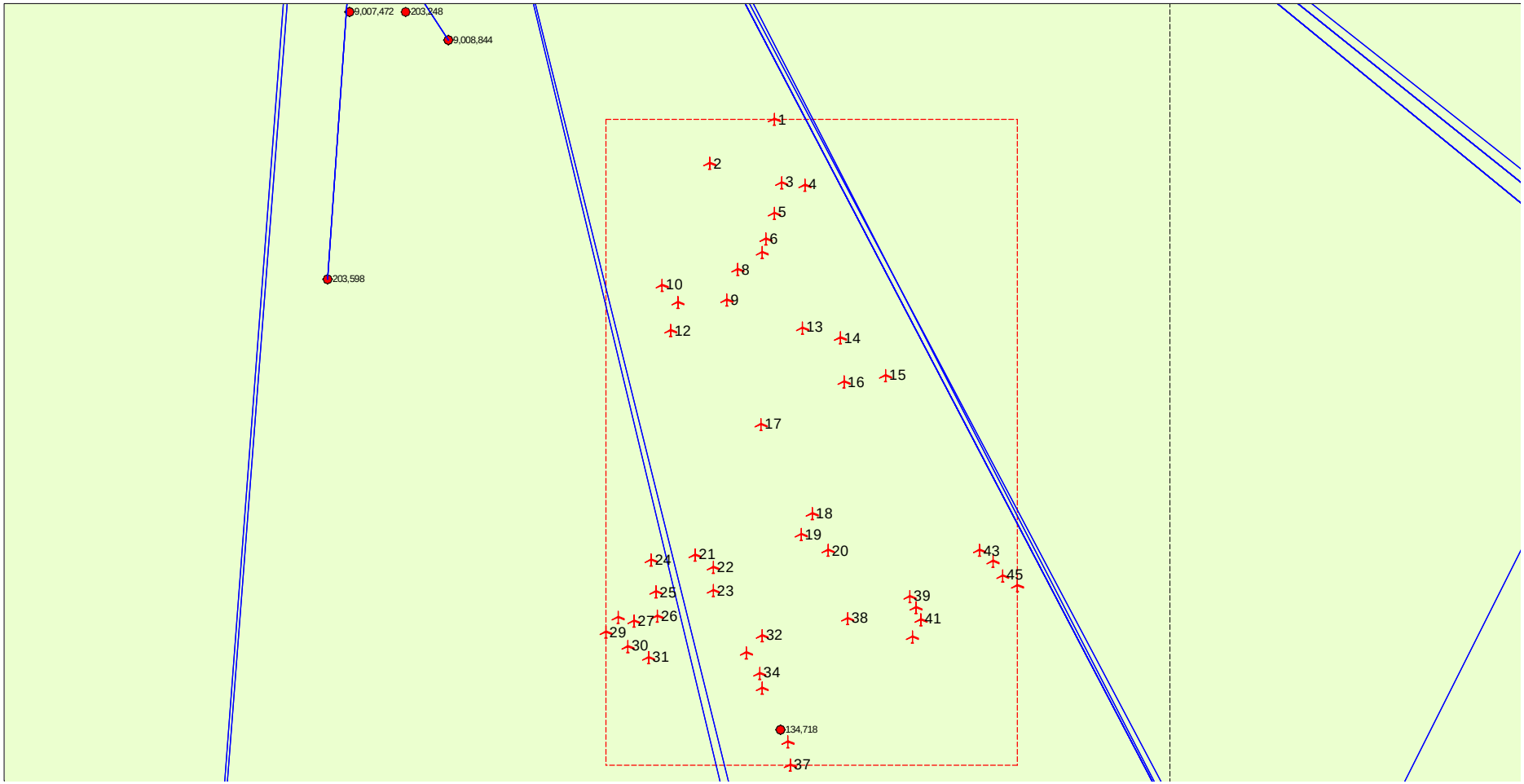
Radiocommunications Planning and Design

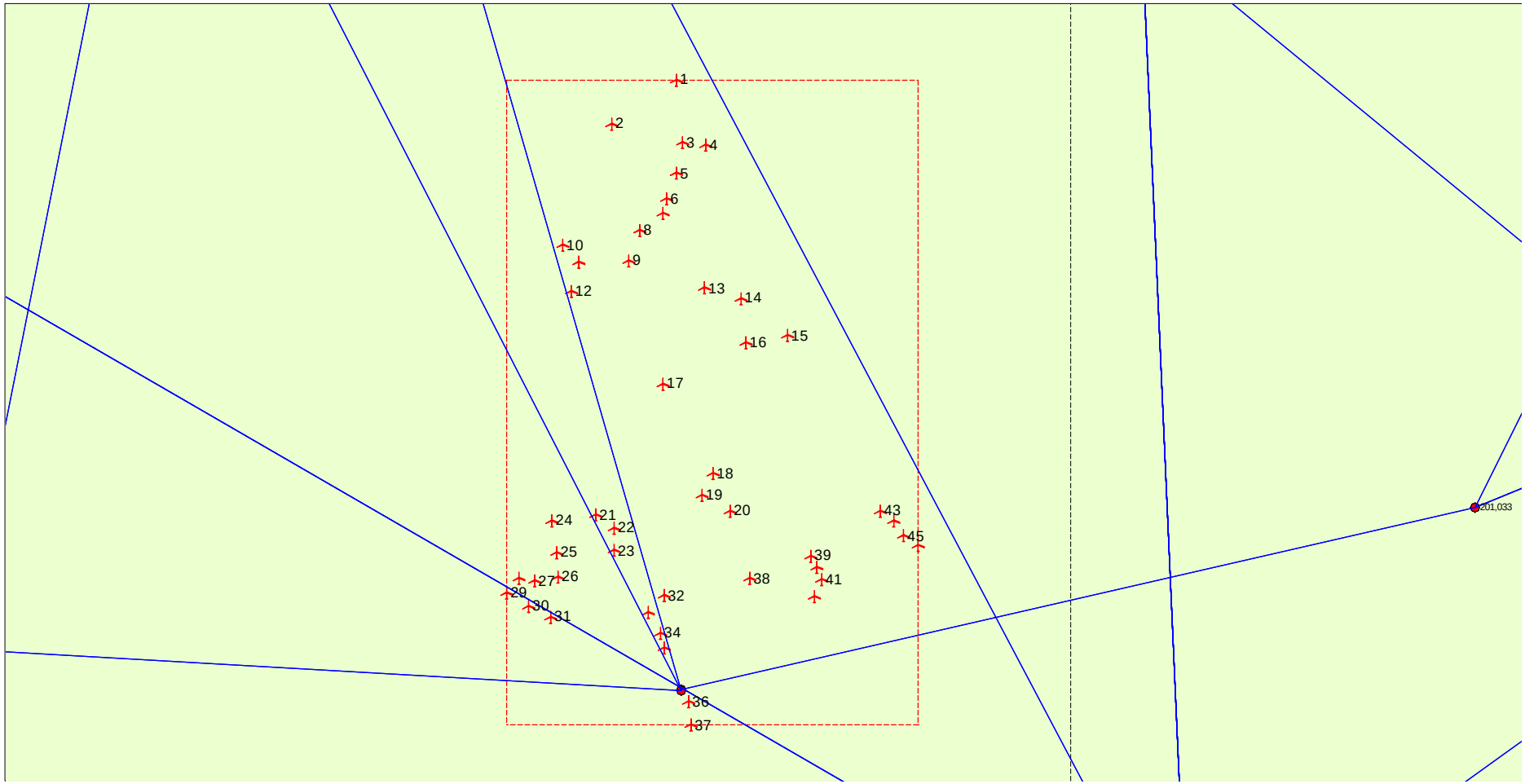
Postal: P.O. Box 3213, BELCONNEN ACT 2617
Telephone: 02 6253 2555
Facsimile: 02 6253 2800

TITLE:	**Above 1 GHz Assignment As Extracted from RRL Database**
FILENAME: Flyers Creek Addition Above 1 GHz	DATE: 4/11/2010
PROJECT: Flyers Creek Addition	SCALE: N/A
DRWG NO: 2 of 2	BY: SEA

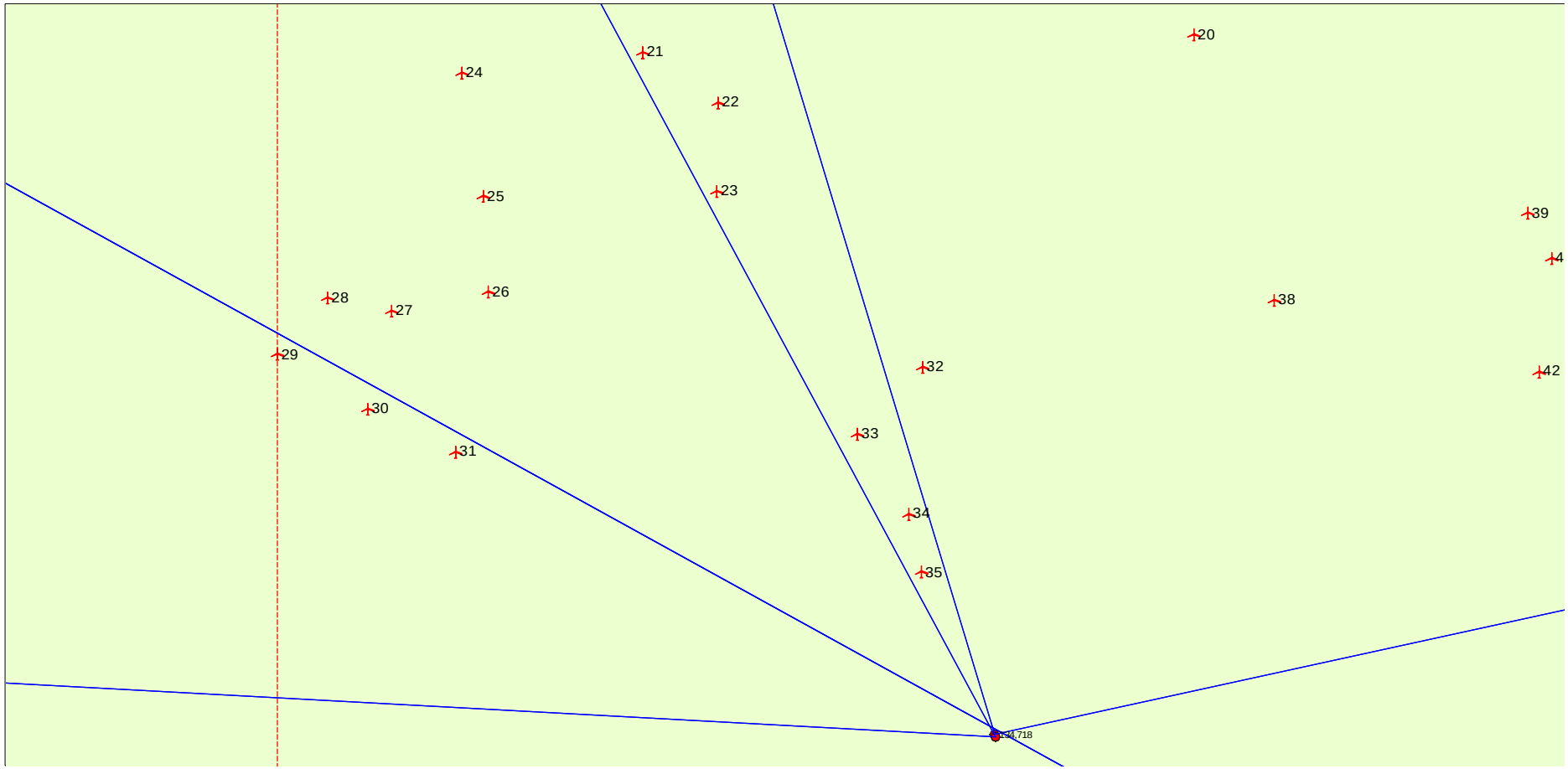
ATTACHMENT 5 – Map of VHF/UHF Radio Link Paths Near Wind Turbines



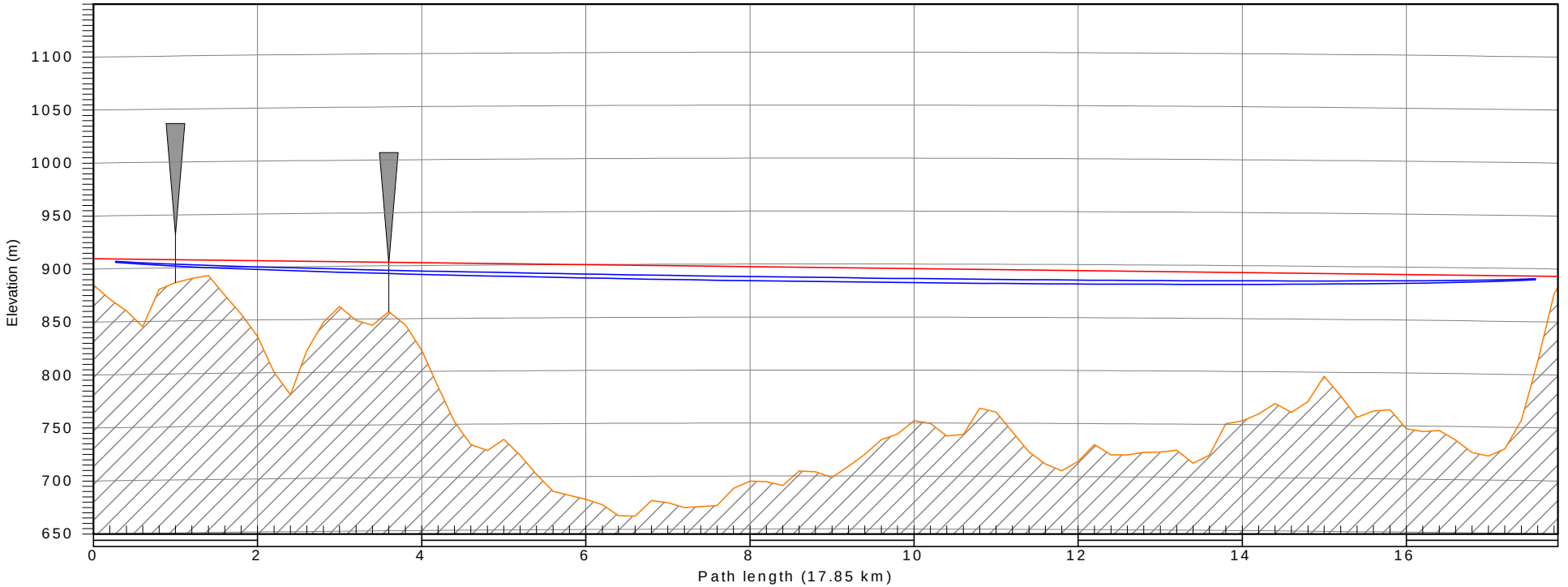
ATTACHMENT 6 – Map of Microwave Radio Link Paths Crossing Wind Farm



ATTACHMENT 7 – Map of Microwave Radio Link Paths Near Wind Turbines



ATTACHMENT 8 – PATH PROFILE OPTUS LINK BURNT YARDS TO SPRINGSIDE



204434	
Latitude	33 35 50.34 S
Longitude	149 04 37.11 E
Azimuth	331.71°
Elevation	885 m ASL
Antenna CL	25.0 m AGL

Frequency (MHz) = 15000.0
K = 1.33
Fn = 1.00, 2.00

9001068	
Latitude	33 27 20.17 S
Longitude	148 59 09.60 E
Azimuth	151.76°
Elevation	883 m ASL
Antenna CL	10.0 m AGL

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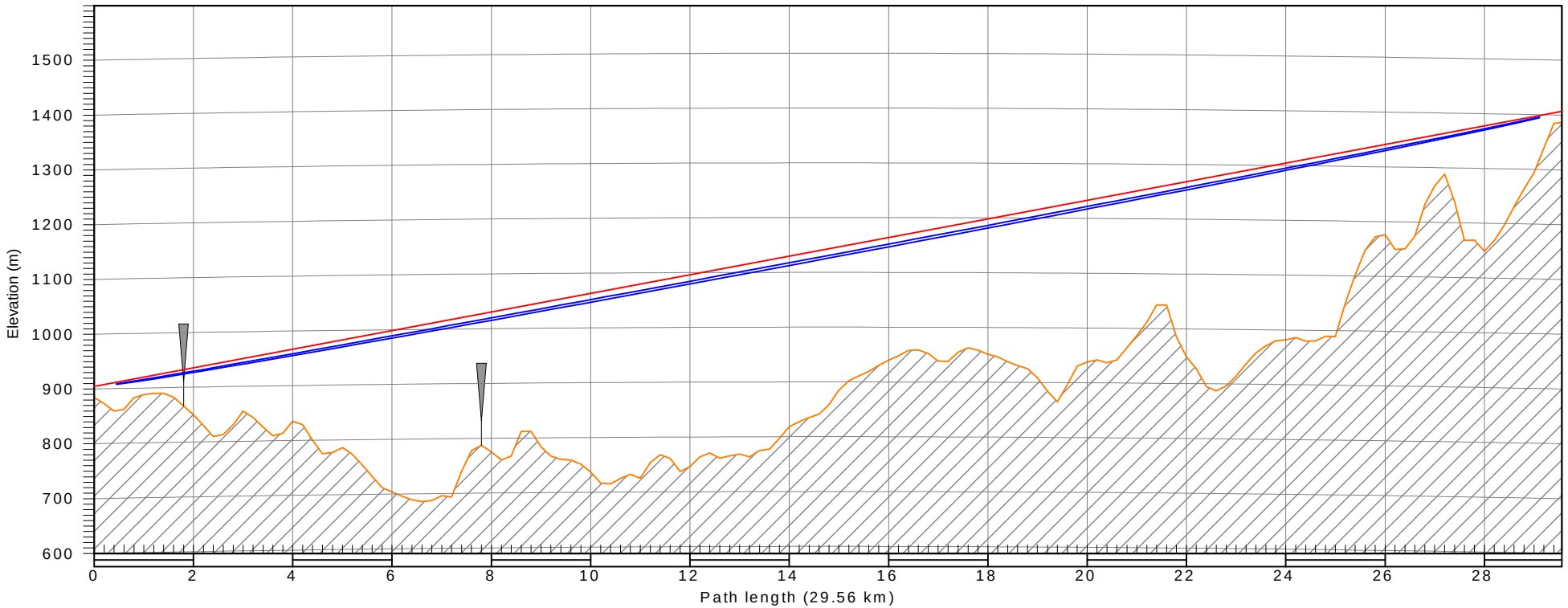
Optus Link	Nov 22 10	

ATTACHMENT 9 PATH - PROFILE OPTUS LINK BURNT YARDS TO MT CANOBOLAS



204434	
Latitude	33 35 50.34 S
Longitude	149 04 37.11 E
Azimuth	342.75°
Elevation	885 m ASL
Antenna CL	20.0 m AGL

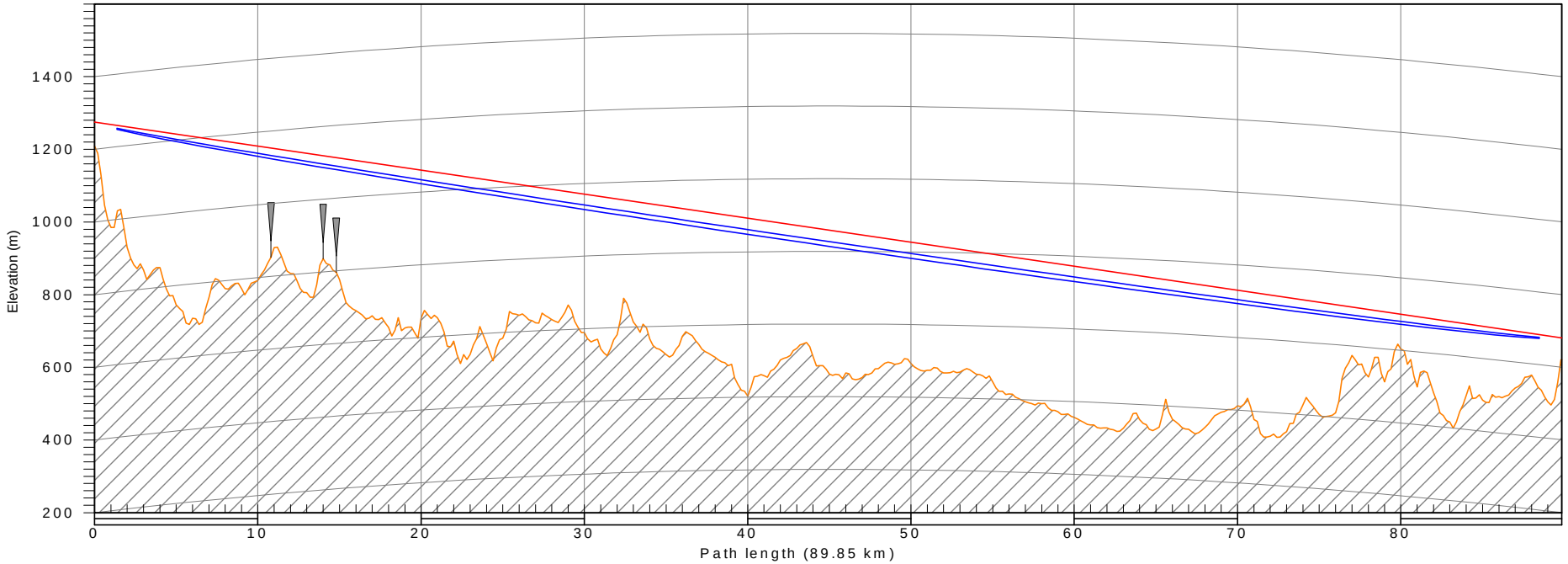
Frequency (MHz) = 15000.0
K = 1.33
Fn = 1.00, 2.00

10708	
Latitude	33 20 33.98 S
Longitude	148 58 58.12 E
Azimuth	162.80°
Elevation	1387 m ASL
Antenna CL	20.0 m AGL

Lawrence Derrick & Associates

Optus Link	Nov 22 10	

ATTACHMENT 10 – PATH PROFILE TRANSGRID LINK NEVILLE TO MT COONAMBRO



9004467		Frequency (MHz) = 6700.0 K = 1.33 Fn = 1.00, 2.00	9011668	
Latitude	33 38 43.19 S		Latitude	33 15 04.94 S
Longitude	149 10 54.32 E		Longitude	148 20 14.47 E
Azimuth	298.86°		Azimuth	119.33°
Elevation	1209 m ASL		Elevation	621 m ASL
Antenna CL	66.0 m AGL		Antenna CL	60.0 m AGL

Lawrence Derrick & Associates

TransGrid Link	Nov 22 10	

ATTACHMENT 11 – RADIO LINK DATA AND CLEARANCES

In the event of a microwave point to point system passing near a turbine the recommended clearance from link ray line to turbine blade tip is the Second Fresnel zone radius calculated using the following formula:

$$\text{Ymin} = \sqrt{2\lambda D1(1 - D1/D2)} \qquad \text{(Ref. 1)}$$

Example Only

1. Site 1 ID 204434 to Site 2 ID 9001068

   Operator: Optus
   Frequency Band 15000 MHz
   Calculated Path Length : 17.85 km
   Clearance to WTG at 3.7 km from near site.
   2nd Fresnel Clearance D1

   D1 = SQRT(2 x λ x d1 x (1 – d1/d2))
   =SQRT(2x (300/15000) x 3700(1- 3.7/17.85))
   = 10.83 metres

The required clearance from the ray line to a tower centreline is 50 + 10.83 = 60.83 metres (at 3.7 metres from the microwave tower)

For a VHF/UHF point to point system the recommended clearance from the link ray line to turbine blade tip can be relaxed to 0.6 X Ist Fresnel Zone clearance as there is less disturbance at the lower frequencies due to blade movements or obstructions generally.

Example only

2. Site 1 ID 10712 to Site 2 ID 10652

$$\text{Ymin} = 0.6\sqrt{\lambda D1(1 - D1/D2)}$$

   Operator: NSW Fire
   Frequency Band 450 MHz
   Calculated Path Length: 38.3 km
   Clearance at mid path
   0.6 x 1st Fresnel Clearance D1

   D1 = 0.6*SQRT (λ x d1 x (1 – d1/d2))
   = 0.6*SQRT ((300/450) x 19150(1-19.15/38.3))
   = 47.94 metres

The required clearance from the ray line to a tower centreline is 50 + 47.94 = 97.94 metres at mid path (19.15 km from either end of link path.)

SUMMARY OF CLEARANCE REQUIREMENTS

VHF & UHF LINKS - REQUIRED CLEARANCES AT MID PATH 0.6 X1st FRESNEL ZONE CRITERIA

								Site 1 Grid Ref		Site 2 Grid Ref	
Site 1 ACMA ID	Site 2 ACMA ID	Operator	Freq MHz	Path m	dist m	Corridor Width* m		GDA 94 Zone 54		GDA Zone 54	
10712	10521	Forestry C.	450	48.38	Mid path	108		684476	6308836	696133	6261874
55757	10652	Tt & Cl Reece	450	38.53	Mid path	96		684579	6309141	702233	6274903
10712	10652	NSW Fire	450	38.3	Mid path	96		684476	6308836	702233	6274903
10712	10652	Country Energy	900	38.3	Mid path	68		684476	6308836	702233	6274903
10712	10652	Country Energy	450	38.3	Mid path	102		684476	6308836	702233	6274903
10712	9004467	County Council	900	38.23	Mid path	68		684476	6308836	702333	6275033

MICROWAVE LINK CLEARANCES CALCULATED FOR LOCATIONS NEAR TURBINES

Site 1	Site 2	Operator	Freq	D1	D2	2nd Fresnel	Site 1 Grid Ref		Site 2 Grid Ref		Corridor
ACMA ID	ACMA ID		Mhz	Metres	Metres	Metres	GDA 94 Z54		GDA 94		Metres
204434	9001068	Optus	15000	3700	17850	10.8	696721	6280558	684579	6296439	21.6
204444	10708	Optus	8000	3700	29580	11.4	696721	6280558	684520	6308957	22.8
9004467	9011668	TransGrid	6700	15000	89850	33.4	581039	5853856	624579	6320048	66.8

*Corridor Width – total zone width around radio path where no intrusion of blade tip can occur

ATTACHMENT 12 – PREDICTED INTERFERENCE LEVELS TO TELEVISION RECEPTION

The estimates below of reflection of TV signals from generator blades use the formulas in Ref.1 and the details of a Suzlon S88 generator has been used. This is a three bladed 44 metre radius rotor on a tower of 80 metres in height. Information from Suzlon Energy Australia suggests that the blades have the following details:

Planform Area of each Blade approx 67 m² (calculated)
Coning Angle 4.3 degrees
Twist of Blade 9.9 degrees
Lightning Protection bus inside Blade 60mm² stainless steel

Signal Scattering Efficiency η_S

η_S = 0.8x0.41 x exp(- 2.3Δβ) for non-metallic blades

$\Delta\beta$ = total blade twist = 9.9/180 x π

η_S = 0.8 x 0.41 x 0.67206

= 0.2204

lightning protection 60mm² cable could increase efficiency by 20% so

η_S = 0.264

For VHF TV at on say Channels 7 & 9 (190 Mhz)

Effective Number of Blades for receiver in the back scattering zone

$$B_e = 1 + \sin c\left\{\frac{2\pi R}{\lambda}\sin(2\theta)\cos(k)\right\} \le B_e \max$$

$k = \phi_{RT} / 2$ for backward scatter zone

$k = 2\phi_{RT}$ for forward scatter zone

$$B_e = 1 + \sin c\left\{\frac{2\pi 44}{300/190}\sin 2x4.3\right\}$$

= 1.8672

where $B_e \max = 1 + \frac{\lambda R}{A_P}$ (Note 1.)

= 1 + 300/190x44/67 = 2.0369

therefore B_e = 1.8672 is applicable

$$Z_I = \eta_S \frac{B_e A_P}{\lambda D}\cos(k)$$

= 0.264x1.8672x67x190/(300x1000) for D = 1km for the maximum directions

= 0.020917

= -33.6db

= 0.264x1.8672 x67x190/(300x250) for D = 250m for the maximum directions
= .083668
= -21.5db

The required wanted to unwanted signal ratio for a just perceptibly degraded TV picture as a function of the time difference between the wanted and unwanted signals is shown in Fig. 2 of Ref. 4 and varies between 28db (<1μs delay) and 34db(>5μs delay). If it was assumed that the wanted signal strength at the residents' TV antennas was the same as at the generator centre, from the above signal scatter ratio estimates perceptible TV picture degradation would occur up to near 500 metres from generators in the forward scatter area. No TV receiving antenna discrimination is possible in the forward scatter case. As, in fact, the signals at the lower height TV antennas in the close in areas will be lower than at the 80m generator height by, for example 6 db, perceptible interference up to 1.0 Km is predicted.

Similar estimates have been made for other UHF channels. The signal scatter ratios for representative UHF channels are summarised below:
Channel 65 (765 MHz) at 1Km $Z_I = -26.8db$
Channel 34 (570 MHz) at 1Km $Z_I = -29.5db$

The calculations also show that at 250m
Channel 65, $Z_I = -14.8db$.
Channel 34, $Z_I = -17.5db$.

These figures indicate that there is a potential for interference for the UHF channels up to and beyond 1.5 Km from the generators in the forward scatter region.

Scatter from multiple generators would be additive to some degree at each receiver.

Note1. The formula for $B_{e,\max}$ was established for a 3 bladed generator in a recent exchange of emails with Prof. Sengupta, of the University of Michigan, USA, one of the Authors of Ref.1.

ATTACHMENT 13- GLOSSARY OF TECHNICAL TERMS

VHF	Very High Frequency
UHF	Ultra High frequency
EMI	Electromagnetic Interference
VHF Channels	TV Channels 0 to 12 (45 - 230 Mhz)
UHF Channels	TV Channels 28 - 46 (526 - 820 Mhz)
Band 111	VHF TV Channels 5A - 12
First Fresnel Clearance	Clearance to obstructions from the ray line on a radio Path which does not produce any additional loss above free space loss
FM	Frequency Modulation
MF	Medium Frequency
LF	Low Frequency (not used for sound broadcasting in Australia)
GSM	European Digital Cellular Mobile System
CDMA	Code Division Multiple Access Cellular Mobile System
ITU	International Telecommunications Union
ACMA	Australian Communications & Media Authority
CB Radio	Citizens Band Radio
VOR	VHF Omnidirectional Range (short range air Navigation aid)