

Lawrence Derrick & Associates

**ALBERTON VIC. WIND FARM - INVESTIGATION OF
POSSIBLE IMPACTS ON BROADCASTING AND
RADIOCOMMUNICATION SERVICES**

[draft 2]

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DISCLAIMER

This Report has been prepared on the basis of ACMA radiocommunications licensing data and broadcasting information and other reference material available in the public domain at the date of production of the report. The Report does not imply that any conclusions are not subject to change

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BACKGROUND

Synergy Wind Pty Ltd are developing a proposal for a wind farm in South Gippsland near the township of Alberton about 8 km south of the town of Yarram. The wind energy facility site will host up to 34 wind turbines, as well as have on-site infrastructure in the way of access tracks, substations and internal collection circuits involving high voltage (HV) underground or overhead power lines. The wind energy facility is to be connected to an existing HV power line. This Report considers the potential impacts of the wind facility on radiocommunications and broadcasting in the area.

A number of existing ACMA registered radiocommunication services are located in the general area. To ensure that the locations of turbines will not degrade the performance of any radio systems crossing the general site area, minimum separation distances and exclusion zones need to be established for the turbine structures. The residences in the area surrounding the wind facility are provided with TV, FM radio and other services from Latrobe Valley high power transmitters located at Mt Tassie. Fringe area reception may be available to some residences from the Melbourne stations at Mt Dandenong or the Bairnsdale stations at Mt Taylor however ABC service area predictions show this is unlikely. AM Radio broadcasting services transmitted from Melbourne, Sale and Warragul are expected to be received in the wind farm area. The TV/Sound broadcasting Licensees providing service to the area have been identified to facilitate correspondence with the organisations involved to invite their views on any impact foreseen on their services.

This Report provides an analysis of each of the radio facilities registered near the wind facility and if necessary establishes recommended clearances based on accepted industry criteria for radio links crossing the wind facility and any required buffer zones for other radiocommunications sites. A study of the signal paths from the main TV station to the area surrounding the wind facility has been carried out to identify any potential interference to reception at nearby residences.

2. INTRODUCTION

The Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria July 2015 require an investigation into potential impacts of the wind farm on TV and sound broadcasting reception in the general area of the proposed wind facility. This requires the identification of transmitting stations and nearby radio link paths. This report covers the outcomes of a desktop study to identify any potential issues that may arise from the proposed Alberton wind farm and makes recommendations on radio link path and radio site clearances.

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 of wind turbine structures, 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 (July 2010) (Ref. 9).

Radiated EMI can potentially be generated from wind turbine generators or HV power lines and substations on the site. These issues are also discussed in this report.

3.2 Victorian Planning Guidelines The Victorian Department of Environment, Land, Water and Planning re-issued the *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria*, in June 2015 (Ref.14). This document includes references to the need to consider electromagnetic interference issues in the design of wind farms. The *Model permit conditions to be applied as appropriate* at Attachment B of the Guidelines provides for a pre-construction survey of TV reception at selected locations within 5km of turbines. If any complaint regarding the wind energy facility having an adverse effect on television or radio reception at any pre existing dwelling a post construction survey at the dwelling is required. The operator of the wind energy facility is required to take measures to mitigate the interference if it is established to be as a result of wind energy facility.

3.3 Clean Energy Council (Auswind) Best Practice Guidelines. Appendix 11 of these Guidelines (Ref. 11) issued in December 2006 also provide guidance on the consideration of the potential impact of wind farms on radiocommunications and broadcasting.

4. DESKTOP STUDY

A desktop study was carried out to determine the likely impact, if any, of wind turbines and their supporting towers on broadcasting and radiocommunications in the area surrounding the proposed wind facility. This study is based on relevant International Telecommunications Union (ITU) documents and on other professional reports on overseas and Australian experience of wind facility impacts on broadcasting services in the vicinity of any wind turbine structures.

For Radiocommunication services sites up to at least 50km from the site need to be considered because of the length of point to point paths of up to and exceeding 100km.

Synergy Wind provided the Alberton wind farm development boundary, proposed turbine locations and turbine dimensions. Data was also obtained from the Australian Communications & Media Authority's (ACMA) RADCOM Database. This information allowed for an investigation into the potential impacts of the proposed wind facility on radiocommunication services within at least a 50km radius, as well as determining whether the wind turbine locations would obstruct line-of-sight paths or have any likely detrimental effect on these services. Clearance criteria for ray lines have been indicated for any point to point radio paths encroaching or traversing the Alberton site.

5. BROADCASTING SERVICES IN THE AREA OF PROPOSED ALBERTON WIND FARM

From ACMA TV and Sound Broadcasting Station listings, and from a map survey of the area surrounding the proposed 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. The proposed turbine layout map is provided in Attachment 2, depicting the proximity of turbine locations to the nearest houses in the area of the wind facility.

5.1 Analogue and Digital Television

Analogue television has been shut down throughout Australia so all television in the area is digital. It is expected that residents in the area surrounding the proposed wind facility generally view digital TV from the Latrobe Valley National and Commercial main stations located at Mt Tassie. Marginal TV reception from Melbourne and Bairnsdale Stations located at Mt Dandenong and Mt Taylor respectively may also be available at some dwellings. As a general indication Attachments 6 - 8 show ABC predictions for the 3 stations indicating primary for Latrobe Valley and basically no coverage from the other stations. These stations are approx. 24km, 143km and 130km respectively from the wind facility site centre. A summary of channels available from the listed stations is provided in Attachment 5.

5.2 TV Retransmission Stations

From ACMA TV Broadcasting Data there are no retransmission stations listed that may receive their input signal "off air" from the Latrobe Valley, main station at Mt Tassie. Wind farms may cause interference to a signal path that traverses any wind turbine location. The potential impact, if any, of the proposed Alberton wind farm on these nearby stations is discussed in Section 6.

5.3 FM Sound Broadcasting

Latrobe Valley National and Commercial Services are radiated from the Mt Tassie site. Based on overseas field and experimental evidence, discussed in

Section 8, the proposed wind farm is unlikely to negatively impact these services and therefore FM Stations covering this area have not been investigated in detail.

5.4 AM (Medium Frequency) Sound Broadcasting

Some Melbourne AM stations and a local AM stations at Horsham (ABC) and Ballarat (commercial) stations will be receivable in the general area. Based on overseas field and experimental evidence, discussed in Section 8, the proposed wind farm is unlikely to negatively impact Medium Frequency reception and therefore the stations serving the area have not been investigated in detail.

5.6 Satellite Television

Some homesteads in the area may have satellite pay TV or “Free to Air” TV service installations. The signal from the satellite to the subscriber’s antenna arrives at an elevation angle which typically passes well over the top of a turbine. The proposed Alberton wind farm is unlikely to cause signal obstruction/scattering to satellite TV reception, given that all homesteads are further than 1 km from proposed turbine locations and the satellite dish antenna have narrow reception beam width.

6. RADIOCOMMUNICATIONS SERVICES ANALYSIS

The proposed Alberton turbine location coordinates, as provided by Synergy Wind are listed in Attachment 1.

Maps generated from data in the ACMA database are shown in Attachment 3 and Attachment 4.

- Attachment 3 shows all radio sites and point to point links within at least 50km of the wind facility and with operational frequencies in the range 40 – 999 MHz (VHF & UHF),
- Attachment 4 shows all links in frequency range above 1 GHz (microwave).

6.1 Point to Point

A number of point to point links are registered for operation within 50km of the proposed wind farm. As shown in Attachment 3, there is one UHF/VHF links that approaches or traverses the boundaries of the wind facility.

Attachment 4 indicates that there are three microwave links (> 1GHz) that traverse the wind facility. There are specific clearance requirements from ray lines to mitigate any turbine interference on microwave links, however the proposed turbines are located outside these exclusion areas and therefore will not impact these links. The ray lines passing near the wind facility are shown in zoomed up maps in Attachment 9 and Attachment 10. The source ACMA database contains data for sites in Australian Geodetic Datum 1966 coordinate set (AMG 66). These maps are derived from MapInfo maps which are also displayed in AMG 66 coordinate set. Attachment 11 shows vertical profiles of the terrain for the radio link paths

6.2 Cellular Mobile Base Stations

The nearest Optus and Telstra cellular mobile base stations are registered at sites 305900, and 36662 which are 1.17km, and 5.36km respectively from the nearest proposed turbine location. These distances are remote enough from the proposed Alberton wind farm that operation of the wind facility would have no significant impact on antenna patterns and general service area coverage; however it is recommended that Optus and Telstra be advised of the wind facility proposal.

6.3 Two-Way Mobile

A number of private and Public Utility mobile bases exist in the wider area surrounding the proposed Alberton wind farm site. These bases likely provide cover to mobiles in a 360 degree arc from their location. The proposed Alberton wind farm is not expected to have any impact on base coverage beyond normal mobile operational performance. The base antennas are remote enough from the proposed turbine locations that an associated negative impact is highly unlikely. However, a mobile transceiver unit communicating with a base station may experience some local performance disruption when the mobile is located within metres of a wind turbine, this disruption is not limited to just wind farms and is experienced near any large building, silo, tower etc and moving a short distance would mitigate and restore performance to normal.

6.4 CFA Base Stations

There are a number of ACMA registrations for VHF base stations in the 50km radius around the proposed Alberton wind farm site. The closest of these are sites 301808 and 45598 approximately 4.2 and 5km respectively from the nearest proposed wind turbine. These services may experience some very local performance disruption when a portable unit is located in close proximity of a wind turbine, however moving a short distance away would mitigate any performance disruption. It is recommended that the CFA be contacted for their view on the potential impacts.

6.5 CB Radio

CB radios are not individually licensed as the equipment is 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 significant impact from the wind facility is expected, however like with two-way mobile and CFA Base Stations there may be local performance disruption when a portable unit is located in close proximity of a wind turbine structure, however moving a short distance away would mitigate any performance disruption.

6.6 Aviation Services

There is no radar but 4 navigational aid/ground-air sites are listed within the 50km radius from the proposed Alberton wind farm site. The VHF sites at Yarram Airport at 10.9km is not expected to be degraded in coverage by turbines. VHF sites at the Latrobe Valley Airport and the Yanakie Airfield at 42.5km and 39km

respectively are also too distant to be impacted. Airservices facilities at VHF and microwave frequencies at Mt Tassie are also considered to be distant enough to be not affected by turbines. It is expected that an aviation safety consultant will be engaged by Synergy Wind to examine any issues for aviation including any long distance radar issues.

6.7 Point to Multipoint (PMP) Systems

There are a number of PMP systems registered in the 50km radius from the proposed Alberton wind farm development boundary. The PMP base stations are registered in the ACMA data base, however the customer/remote ends are not registered. As a result the potential impact from turbines on the customer ends could not be investigated. Given that the base station location are generally remote from the proposed Alberton wind farm site there is low probability that any path to the remote (subscriber or device) would traverse the proposed wind facility. These systems operate in the VHF, UHF and microwave frequency bands and are listed in Table 1 below.

TABLE 1 - POINT TO MULTIPONT SYSTEMS IN THE AREA

Site/Service	Frequency Band MHz	Operator	Comment
Mt Hooghly, Mt Tassie	150	Latrobe City Council	VHF
Morwell	450	Loy Yang Power	UHF
Yallourn	450	Energy Australia	UHF
Foster, Fish Ck, Welshpool, Toora, Port Albert	450	South Gippsland Regional Water	UHF
Morwell, Mt Carrajong, Boolara, Maryvale	450	Central Gippsland Regional Water	UHF
Blackwarry, Jerralang Hill, Mt Fatigue, Hazlewood	450	Ausnet Electrical Services	UHF
Morwell, Loy Yang,	450	Australian Power Partners	UHF
Welshpool, Mt Carrajong	850	Gippsland Ports	UHF
Mt Tassie	850	Telstra	UHF
Welshpool	900	APA Gasnet	UHF
Mt Carrajong	900	Central Gippsland Regional Waterr	UHF
Toora, Morwell, Blackwarry, Foster N. Jerralang, Carrajong	3.4/3.6 GHz	Aussie Broadband	Microwave
Jeeralang	3.6 GHz	Kallistrate	Microwave

It is recommended that the operator of the PMP Services be advised of the wind facility proposal to confirm that no impacts to their services are foreseen

6.8 NBN Co Base Stations

NBN facilities are established in the wind farm area include 2.3 GHz Point to Multipoint (PMP) systems used to connect customers to the national broadband network via point to point microwave Point to Point (PTP) systems to the network exchanges. The PTP systems have been considered in the point to point section of this report. The nearest PMP sites include 9017997, 9017998 and 9017999 are 3.58 km, 7.75 km and 4.44 km from the nearest wind turbine. As indicated in 6.7 above PMP customer/remote ends are not registered in the ACMA data base so any assessment of wind turbines being in the path to customers cannot be carried out. It is recommended that NBN Co be advised of the wind facility proposal so that they can confirm that no impacts to their services are foreseen.

6.9 Radio Sites in Close Proximity to Wind Turbines

No radio sites are located inside the proposed Alberton wind farm development envelope. The proposed wind facility is located outside any radio buffer zones; the closest radio site 305900 is located 1.2 and 1.6 km from the nearest turbines T3 and T4 respectively and thus radio systems on these sites are unlikely to be impacted by turbines. There are no TV/Radio broadcasting or emergency services paging facilities near the proposed wind facility.

6.10 Met Bureau Radar and Other Services

No registrations of radar for the Met Bureau were found in the wider area and therefore the proposed Alberton wind farm is not expected to impact the operation of the Met Bureau.

7. PUBLISHED 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.

Digital television interference if severe would result in pixilation or freezing of the picture.

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 sight 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 an 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 i.e. 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.

In October 2015 a revised recommendation BT.1893-1 (Ref. 12) on impairment caused to digital television was issued by the ITU followed on by the issue of an updated ITU Report BT.2142-2 (Ref. 13) in October 2015 which provides an extensive analysis of the effect of the scattering of digital television signals from wind turbines and included field measurement comparisons in 3 Countries including Australia. From the field measurements in Australia Ref 13 indicated “In conclusion, in the backscatter region there is little effect from scattering from wind turbines on the performance of digital television, but in the forward scattering region, if there is significant blockage of the direct signal, significant interference to the reception of the digital television signal is possible. Further study is required to assess the performance of DVB-T receivers operating in the environment of time-varying interference from wind turbines”. The ITU recommendation BT.1893 in Annex 1 presents a simplified model of impairment caused to television reception by a wind turbine. It however requires measurement or prediction of TV signal levels at the centre of the turbine rotor and at the house locations as well as calculation of a scattering coefficient based on the blade area, signal wavelength and distance from the turbine to the house location.

From a study of the above references and others, the following general conclusions are drawn in regards to global wind farm operations:

- (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 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 3km 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 0.5km 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, e.g., ghosting, where signals have a margin above threshold levels, however a reduction in service area could occur due to time varying reflected signals.

9. ALBERTON WIND FARM SITUATION

Drawing from studies discussed in Section 8 and Section 9, as well as taking into account the topography of the surrounding area, the following conclusions regarding the proposed Alberton wind farm have been made:

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

9.2 Based on the latest ITU reports and recommendations on the effects of wind turbines on digital television reception some possibility of TV picture degradation could exist at times for dwellings located in the forward scatter region up to about 3-5 km from the turbines. Due to the directional characteristics of domestic TV receiving antennas (Ref. 6) reflections would be significantly reduced from turbines outside about a +/- 20 degree sector of the antenna pointing direction. The cumulative impact of a number of turbines and effect of undulating terrain on the ratio of the reflected signal to the main TV signal was not considered in detail due to the complexity of the calculations and expected minimal impact due to the small number of wind turbines.

9.3 Due to the predicted primary service area for the Latrobe Valley TV station in the wind farm area there is unlikely to be TV interference experienced at most dwellings. It is however difficult to predict where, if any, interference may occur. In general, at dwellings to the west of the proposed wind facility and in close proximity to turbine locations may have some risk of having interference to TV signals (which are digital) from transmission from Mt Tassie.

9.4 As indicated, digital television is not subject to ghosting degradation in high signal strength areas. However in the area around the wind farm where there are predicted marginal signal levels from the other two potential sources of TV signal, some reduction of service area could result from reflected unwanted signals. It is suggested that a TV pre construction survey be carried out at selected dwellings around the wind facility within 5 km from turbines to establish a baseline for comparison.

9.5 TV rebroadcast stations in the area have been considered. The off air TV reception links are not included on the ACMA database as licensed links, and therefore do not appear on the link mapping should they exist. If their input signals passed near or traverse the proposed Alberton wind farm, some interference to input signals and therefore to the TV service areas of each station could occur. However no TV rebroadcast stations are believed to exist in the area.

9.6 For satellite TV services in the area, no interference as a result of the operating wind facility is expected unless in the highly unlikely occurrence that the dish antennas to the serving satellite is also in line with a turbine. The probability

of this being the case is so remote that the predicted impact is considered to be negligible.

9.7 The ACMA RADCOM database has been studied for services within a radius of 50km from the proposed Alberton wind farm to determine if any point to point services will have their paths obstructed by the wind turbine blades or the supporting towers. As depicted in Attachment 3 and Attachment 4, no point to point services were found to traverse the project development envelope. The closest off site paths are depicted in Attachment 9 and Attachment 10. Analysis shown in Attachment 12 and 13 determines the required Fresnel clearance by turbines for typical microwave and VHF/UHF systems. This analysis established that the proposed turbine locations satisfies the required Fresnel Zone clearances of all microwave and VHF/UHF links in the area, therefore the Alberton wind farm is not expected to impact the performance of these links. One link however operated by Telstra, between Yarram town and the Wilsons Promontory Light House needs further consideration. This has been determined from a vertical path profile showing that the link appears to operate over-the-horizon and hence would have low and fading receiver signal levels. The profile is shown in Attachment 11(site 37908 – site 36436). This could result in the link performance being degraded due to scattered signals from the turbines even off path due to the height of the turbine towers and their visibility from each end of the link. Telstra were requested to provide their comments on this link performance issue however a response has not yet been received. Further consideration based on Ref 15. This reference provides analysis of wind turbine impacts on certain types of 450 MHz links which operate over-the-horizon. It recommends that an obstructed radio link with a path clearance of up to 1000 m from turbines need detailed analysis. The Alberton layout has the closest turbines at 330 m (T14) and 594 m (T2) from the link path.

9.8 Air navigational aids or ground – air communications base stations at Yarram Aerodrome, Latrobe Regional Airport, Yanakie Airfield and at Mt Tassie were the only identified Aviation service within 50km of the project boundaries. No Radar services exist. None of the facilities at the sites identified are expected to be impacted by moving turbine blades due to the minimum distance to the nearest turbine of 11km being in excess of 1 km where some influence on the radiation pattern of antennas is possible.

9.9 There are a number of registered Point to Multipoint (PMP) Systems within the study area, however the base stations are not located close to the proposed wind turbines and therefore are not expected to be negatively impacted. The operator of this system may be in a position to assess any impact based on their knowledge of the location of the remote sites. It is recommended that the licensees, shown in the table, be advised of the wind farm proposal.

9.10 There is no radio or broadcasting facility sites in close proximity to the proposed site. The closest FM Radio and TV being approximately 24km, far outside the usual required buffer zone therefore the project is unlikely to impact on radio signals. Normally a recommended buffer zone for the location of any wind turbine is a circle of radius 800 metres around a radio tower location.

10. AVOIDANCE OF INTERFERENCE DURING CONSTRUCTION

With no radio links crossing the project boundaries there is no potential impact or interference expected to radio links during construction of the proposed wind turbines as a result of the use of large construction cranes.

11. WIND MONITORING MAST LOCATIONS

The final location of any new meteorology masts would normally need to avoid the ray lines of any radio links, however due the radio path separation from the proposed wind turbines identified in this report no special requirements are required for masts within the current wind facility development.

12. POWER INFRASTRUCTURE ELECTRIC AND MAGNETIC FIELDS

The power generated by the wind turbines will be exported to the transmission grid via purpose built substation/s and high voltage transmission lines using conventional designs to meet standards applying to the State network at large. Substation/s will be designed and sited to reduce the electric and magnetic fields to acceptable levels at the boundary fence.

The internal wind farm reticulation will employ underground cables or overhead transmission lines of up to 33 kV in voltage. The wind farm substation will be constructed within 50m of the existing 66 kV line it will be connected into. Powerlines and substations are required to meet *Australian Standard AS/NZS 2344: 1997 Amendment 1:2007 Limits for EMI*, which protects broadcasting and radiocommunications reception from unacceptable interference.

13. MITIGATION TECHNIQUES

Any mitigation of interference will involve digital television reception as all analogue TV in Australia was switched off prior to 10th December 2013.

For individuals who experience any degraded FM (unlikely) or TV broadcasting service due to identified interference from the proposed wind facility, 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,
5. Provision of an alternative satellite service e.g. the Viewer Access Satellite Television (VAST) (Ref. 10) or Austar Pay TV Service,

6. In certain circumstances, consideration could be given to the installation of a TV repeater station to provide service to groups of residents in a shadow zone. However this is only likely to occur in higher density population areas.

Potential point to point system and mobile base coverage conflict is not expected if turbines are located with recommended clearance zones from radio sites or point to point ray lines. There are no identified radio links passing close to turbines requiring clearance calculations.

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.

14. CONCLUSIONS

In relation to the proposed Alberton wind farm the following conclusions have been drawn:

- Interference to MF and FM sound broadcasting is not expected.
- From a horizontal clearance point of view there are no potential conflicts between radio system paths and wind turbines due to adequate separation. The current proposed turbine locations with grid references shown in Attachment 1 have acceptable horizontal clearances from currently registered point to point radio links. However the Telstra UHF Link from Yarram to Mt Oberon Lighthouse which appears to operate over-the-horizon may need further consideration for any impact on that links performance.
- There are no radio sites close enough to the proposed turbine locations to require buffer zones to be specified.
- Mobile radio and other radiocommunication services in the area are not expected to be impacted by the wind facility or its operation. Cellular mobile coverage at some individual locations may be affected but the with the robust nature of the transmission system and with alternative base stations available, acceptable grade of service should be maintained
- TV reception at some dwellings within about 5 km of the wind turbines and with antennas having turbines located with +/- 20 degrees angle of their reception direction could have some probability of noticeable effects at times. This may apply to a few dwellings on the eastern side of the wind farm. Any degradation of reception experienced may be time variant depending on wind direction and speed.
- Digital TV is not susceptible to visible ghosting degradation where the signal level is above a minimum threshold. The area surrounding the wind facility is predicted as a good signal area. There may however be individual houses located in shadow areas where other mitigating techniques may need to be applied.

- Alternatively a satellite service could be considered if digital TV reception is unsatisfactory in individual cases. In particular, the Viewer Access Satellite Television (VAST) Service provided by the Government would be available to provide a full complement of digital channels including a regional news channel.
- During wind farm construction as indicated above there is no impact on point to point radio links expected due to their remoteness from the site. Should any confirmed TV interference problems occur and TV receiving antenna system improvements are unsuccessful, an alternative terrestrial station or satellite service should be considered.
- Overseas experience from operating wind farms indicates that EMI produced by the wind turbines and controls is negligible with reputable world class wind turbine manufacturers, similar to ones proposed for Alberton wind farm, and therefore no electrical noise measurements from the electrical generators are warranted.
- It is recommended that, PMP operators, Commercial Television Station operators in the area and Broadcast Australia for the ABC and SBS, be advised of the proposed wind facility to enable these organizations to confirm that there are no potential interference issues seen to be relevant to their operations.

It would be prudent to carry out a pre-construction TV reception survey for this project at selected dwellings within 5km to establish a reception baseline of the digital TV environment now existing in the region for comparison with any post construction reception complaints in the area.

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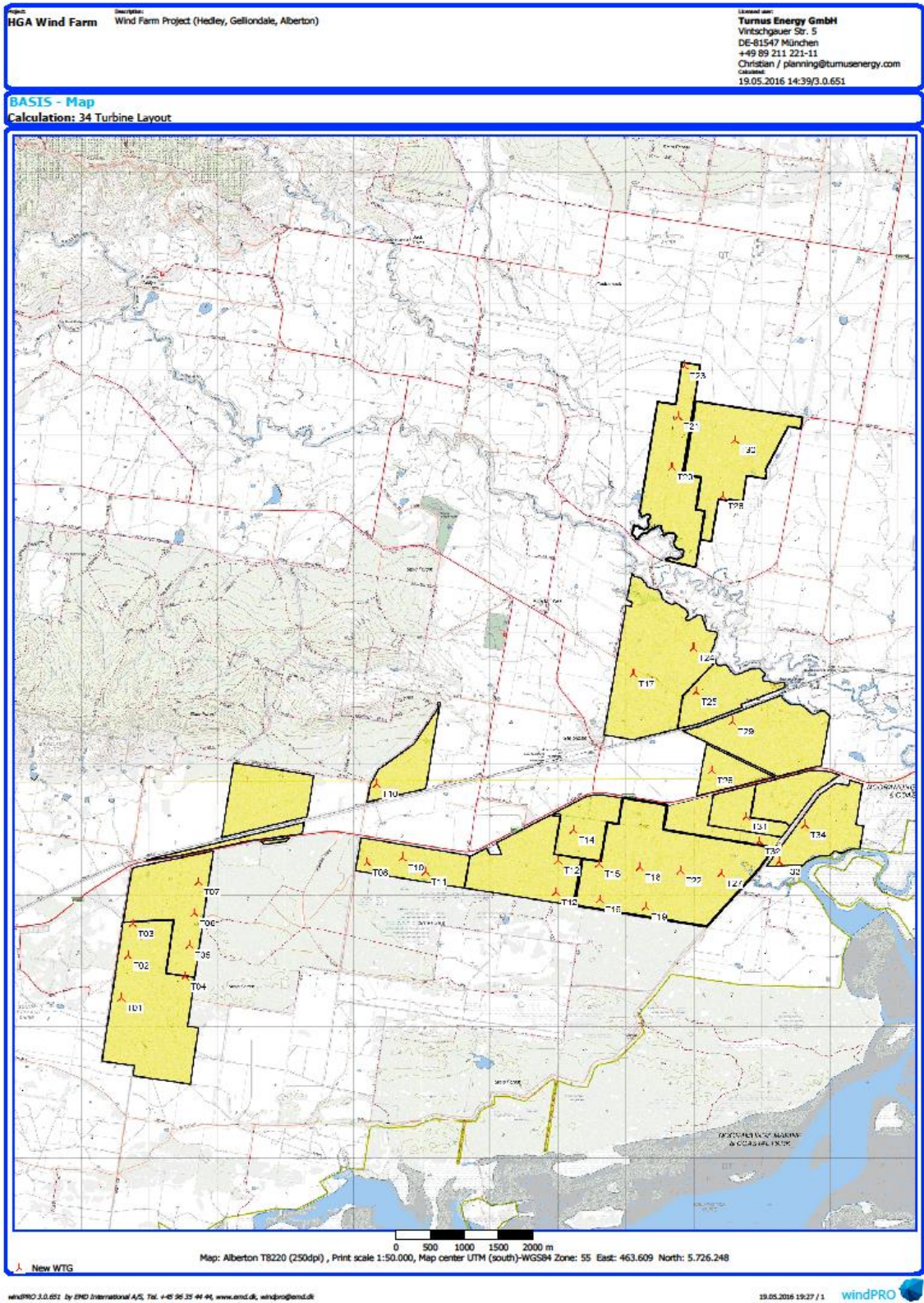
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ATTACHMENT 1 – ALBERTON FARM TURBINE COORDINATES

Coordinate System:	UTM (south) WGS84
Zone:	55

Turbine No.	Easting	Northings
T1	458587	5721442
T2	458685	5722082
T3	458756	5722567
T4	459525	5721764
T5	459588	5722240
T6	459657	5722726
T7	459724	5723203
T8	462198	5723499
T9	462340	5724695
T10	462721	5723573
T11	463061	5723359
T12	465008	5723529
T13	464976	5723043
T14	465227	5723996
T15	465606	5723479
T16	465616	5722934
T17	466111	5726369
T18	466207	5723430
T19	466293	5722824
T20	466674	5729517
T21	466771	5730287
T22	466804	5723380
T23	466861	5731055
T24	466994	5726762
T25	467034	5726096
T26	467264	5724898
T27	467403	5723331
T28	467418	5729078
T29	467567	5725644
T30	467597	5729928
T31	467774	5724250
T32	467964	5723825
T33	468258	5723514
T34	468632	5724068

ATTACHMENT 2 –ALBERTON WIND FARM LAYOUT MAP



ATTACHMENT 3- Radio Link Map 40- 999 MHz Frequencies

It should be noted that due to the close spacing of adjacent link sites the site number displayed on the map may not be the appropriate one for a given point to point link due to overlaying of site labels. The wind facility nominal envelope is shown as a rectangle and wind turbine locations are also shown.

See map on next page

ATTACHMENT 4 - Radio Link Map above 1000 MHz Frequencies

It should be noted that due to the close spacing of adjacent link sites the site number displayed on the map may not be the appropriate one for a given point to point link due to overlaying of site labels. The wind facility nominal envelope is shown as a rectangle and wind turbine locations are also shown.

See map on next page

**ATTACHMENT 5 - TELEVISION STATIONS & CHANNELS – ALBERTON
WIND FARM AREA**






Transmitter Location/service	Operator	Analogue Channels	Digital Channels	Comment
Mt Tassie/Latrobe Valley	SBS		30H	UHF
	ABC		29H	UHF
	AMV		33H	UHF
	VTV		31H	UHF
	GLV		28H	UHF
Mt Dandenong/Melbourne	SBS		7H	VHF
	ABC		12H	VHF
	HSV		6H	VHF
	GTV		8H	VHF
	ATV		11H	VHF
Mt Taylor/Bairnsdale	SBS		34H	UHF
	ABC		35 H	UHF
	AMV		36 H	UHF
	VTV		37 H	UHF
	GLV		38 H	UHF


ATTACHMENT 6 Latrobe Valley TV Coverage – ABC Predicted

Orange Marker – Approx wind facility Site. Blue Marker – Transmitter Site

Find your ABC Service by entering your location here →

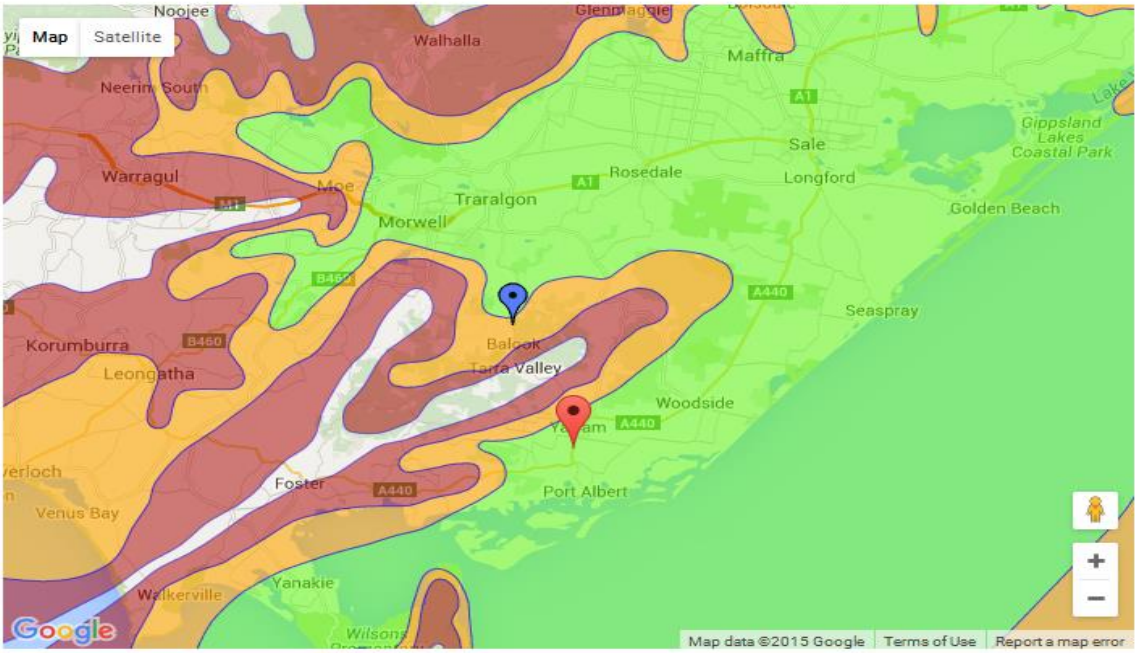
Search Results
Select the ABC service to view coverage by clicking the button on the left of the service

- ▶ ABC Local Radio
- ▶ ABC Classic FM
- ▶ ABC Digital Radio
- ▼ ABC Digital TV
 - Latrobe Valley 
 - Churchill 
 - Foster 
 - Bairnsdale 
 - Warburton 

For further information, click on the transmitter icon 

<<view next 5 returns>>

- ▶ ABC News Radio
- ▶ ABC Radio National
- ▶ triple j



Map Keys

- + Primary Coverage: (+ expand for details)
- + Secondary Coverage: (+ expand for details)
- + Tertiary Coverage: (+ expand for details)

ATTACHMENT 7 Bairnsdale TV Coverage- ABC Predicted


Orange Marker – Approx wind facility Site. Blue Marker – Transmitter Site

ABC Radio TV Shop News Sport Local Children Science Environment more Topics help Keywords ABC Search

Find your ABC Service by entering your location here → Search

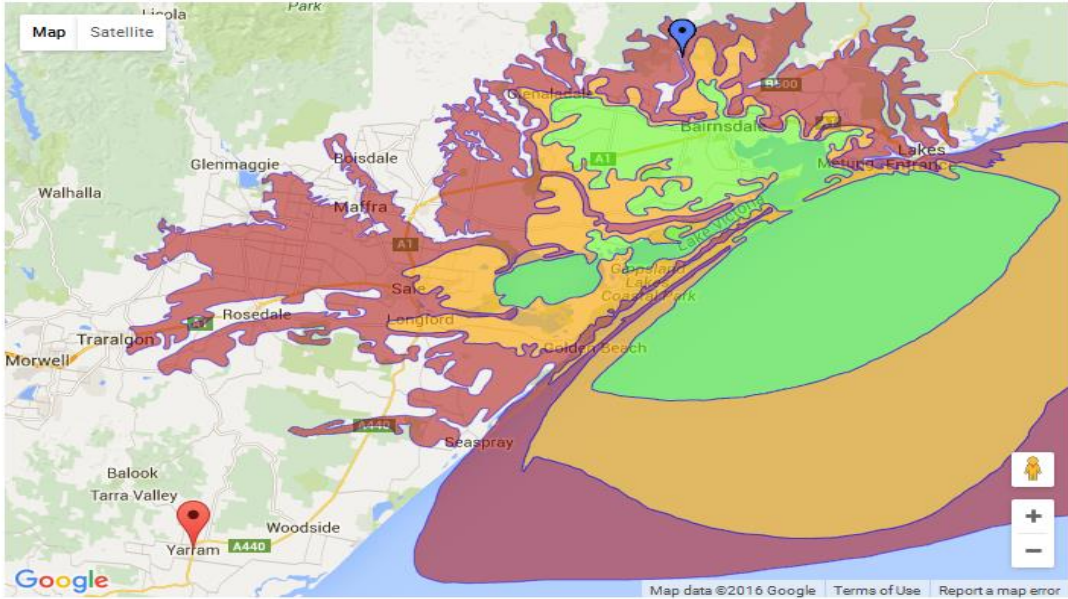
Search Results
Select the ABC service to view coverage by clicking the button on the left of the service

- ▶ ABC Local Radio
- ▶ ABC Classic FM
- ▶ ABC Digital Radio
- ▼ ABC Digital TV
 - Latrobe Valley
 - Churchill
 - Foster
 - Bairnsdale
 - Warburton

For further information, click on the transmitter icon 

<<view next 5 returns>>

- ▶ ABC News Radio
- ▶ ABC Radio National
- ▶ triple j



Map Keys

- + Primary Coverage: (+ expand for details)
- + Secondary Coverage: (+ expand for details)
- + Tertiary Coverage: (+ expand for details)

Map data ©2016 Google Terms of Use Report a map error

ATTACHMENT 8 Melbourne TV Coverage – ABC Predicted

Orange Marker – Approx wind facility Site. Blue Marker – Transmitter Site

ABC Radio TV Shop News Sport Local Children Science Environment more Topics help Keywords ABC Search

Find your ABC Service by entering your location here → Search

Search Results
 Select the ABC service to view coverage by clicking the button on the left of the service

- ▶ ABC Local Radio
- ▶ ABC Classic FM
- ▶ ABC Digital Radio
- ▼ ABC Digital TV
 - Marysville
 - Bruthen
 - Selby
 - Upwey
 - Melbourne

For further information, click on the transmitter icon

If you require further assistance please contact the Reception Advice Line on 1300 13 9994

<<view previous 5 returns>>

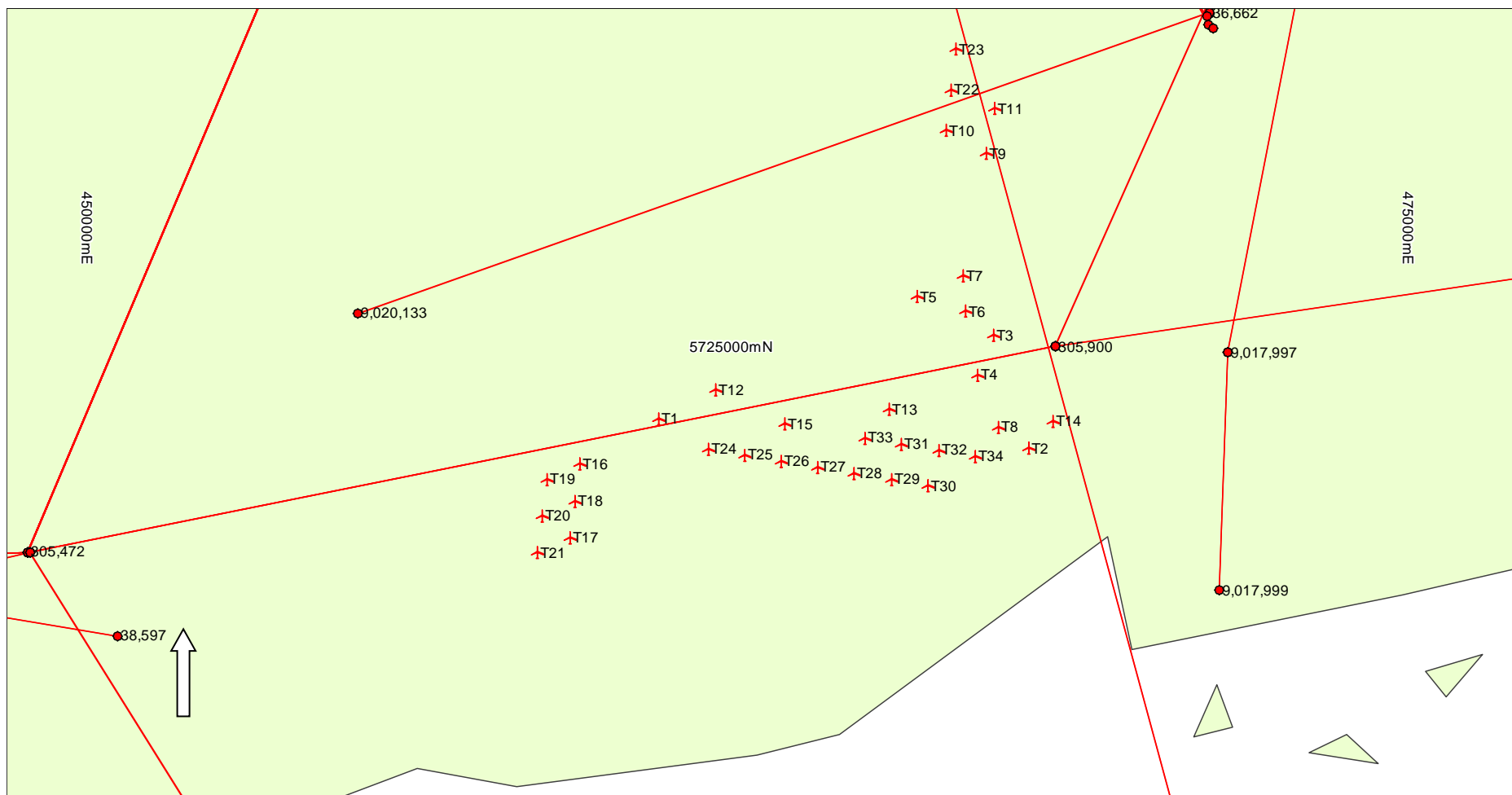
- ▶ ABC News Radio
- ▶ ABC Radio National
- ▶ triple j

Map Keys

- + Primary Coverage: (+ expand for details)
- + Secondary Coverage: (+ expand for details)
- + Tertiary Coverage: (+ expand for details)

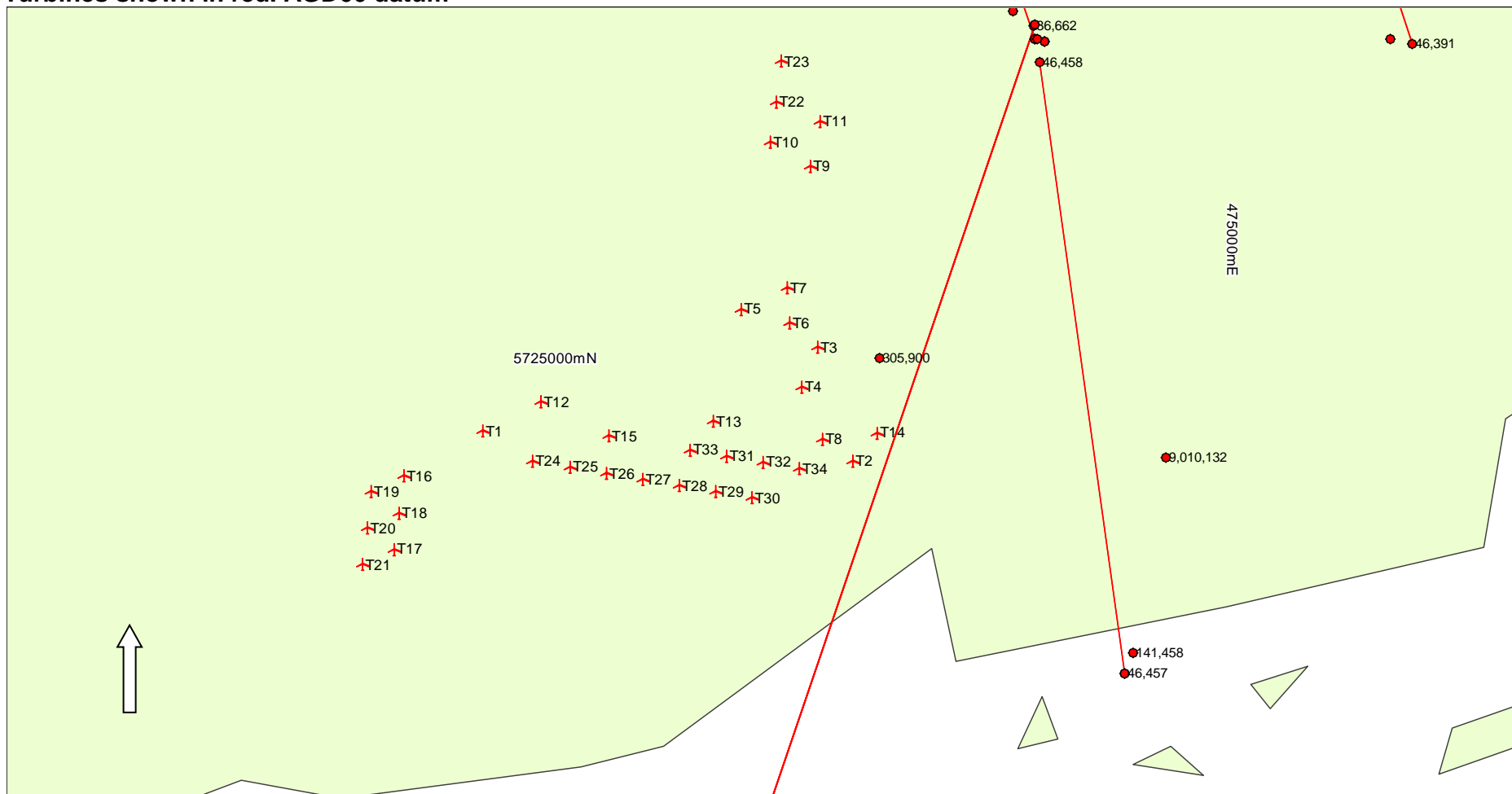
Map data ©2016 Google Terms of Use Report a map error

ATTACHMENT 9 – Map of Microwave Radio Link Paths Near Alberton Wind Farm
Turbines shown in red. AGD66 datum

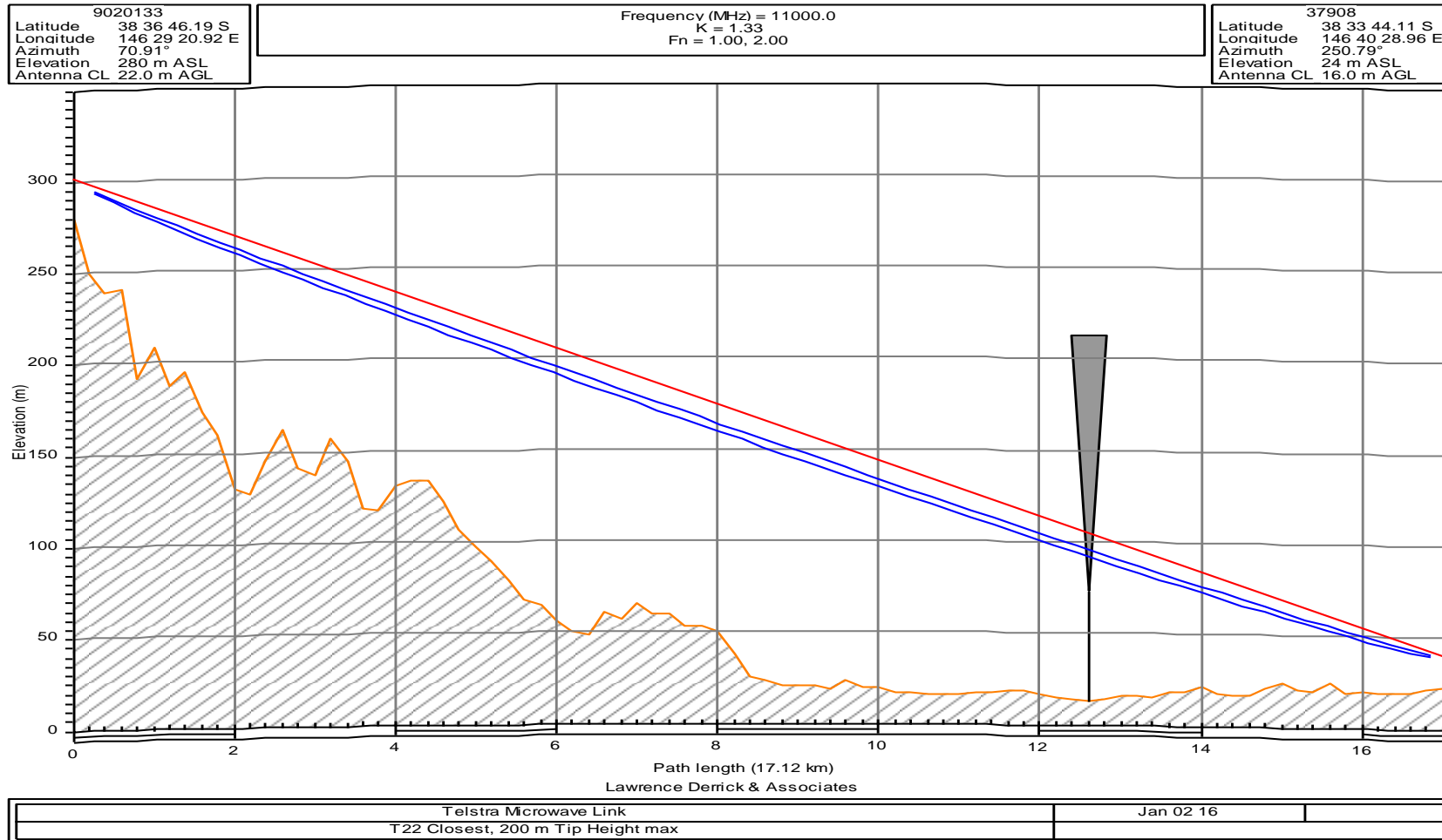


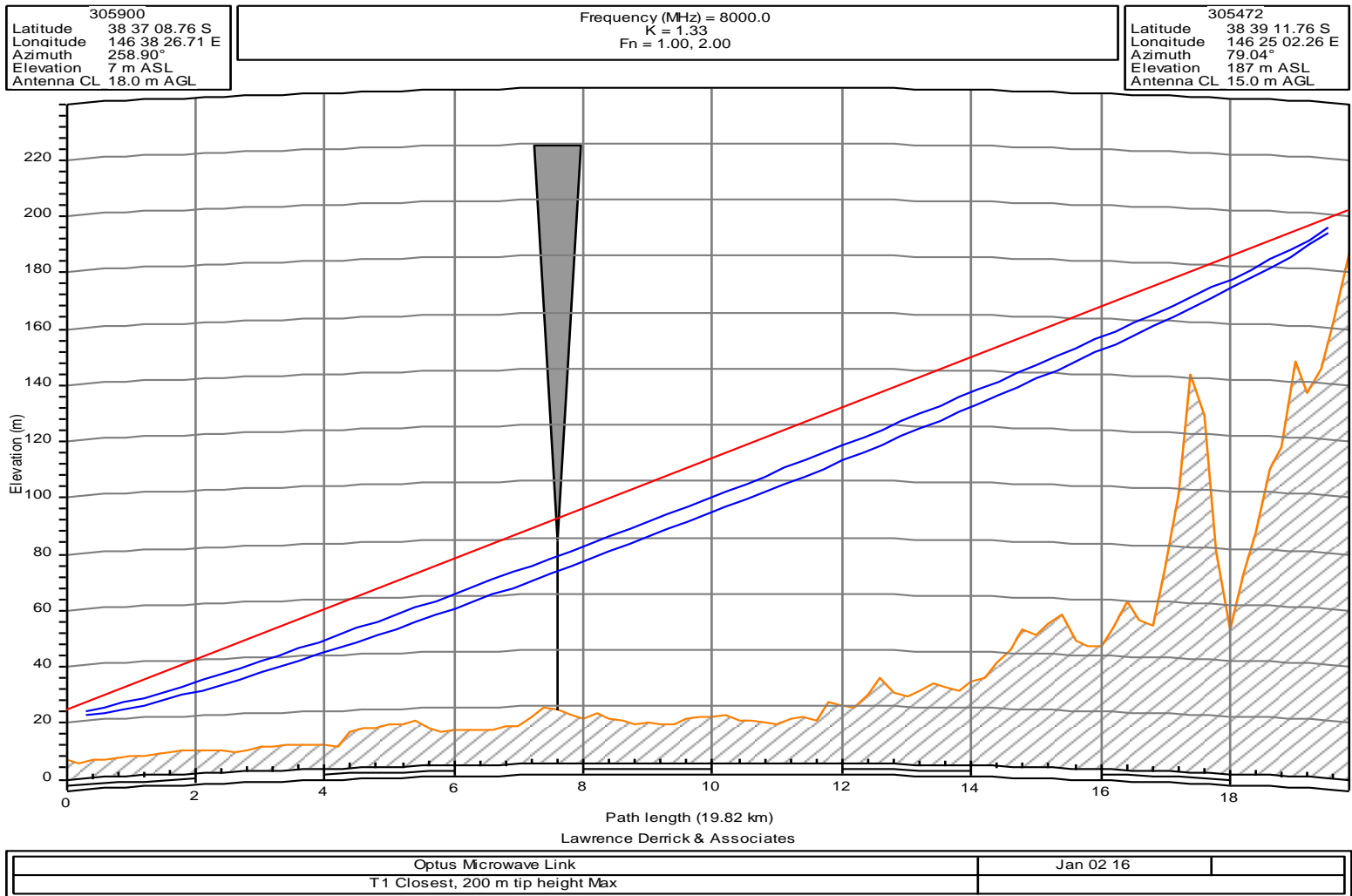
Alberton Wind Farm – Possible Impacts on Broadcasting & Radiocommunications Services

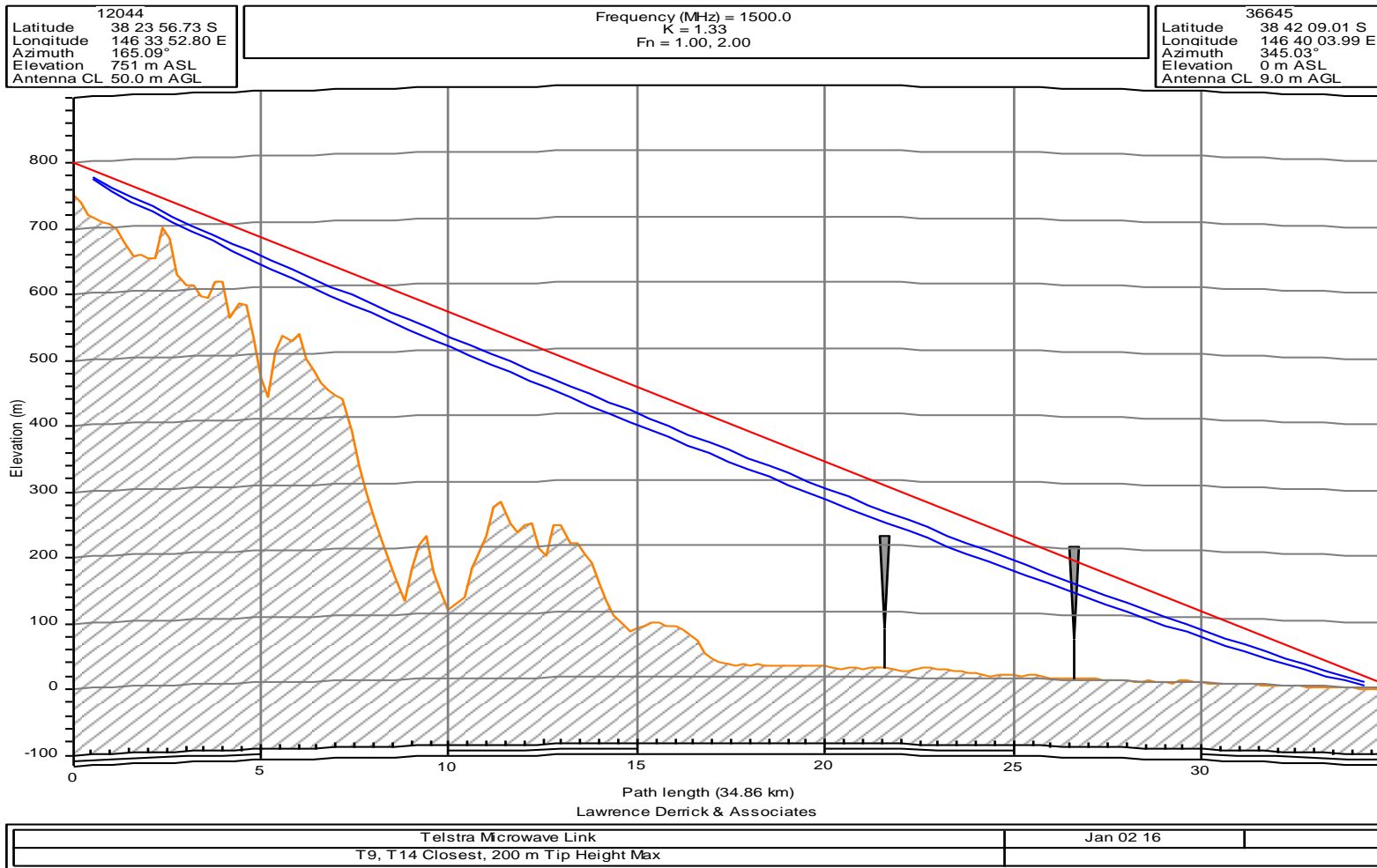
**ATTACHMENT 10 – Map of VHF/UHF Radio Link near Alberton Wind Farm
Turbines shown in red. AGD66 datum**

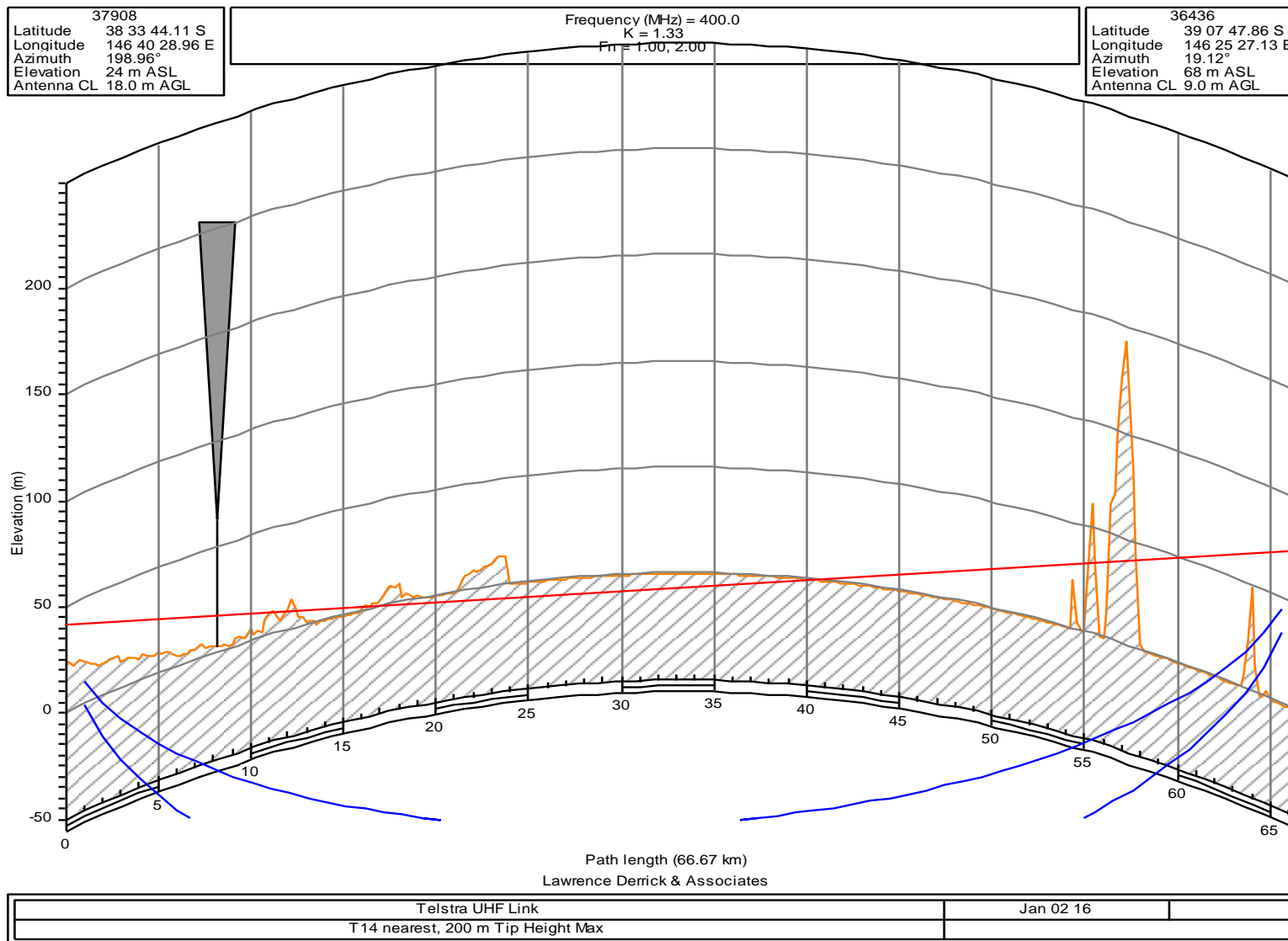


ATTACHMENT 11 – Radio Link Vertical Path Profiles









Alberton Wind Farm – Possible Impacts on Broadcasting & Radiocommunications Services

ATTACHMENT 12 – CALCULATION OF RADIO PATH 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:

$$Y_{\min} = \sqrt{2\lambda D_1(1 - D_1/D_2)} \quad (\text{Ref. 1})$$

Example Only

1. Site 1 ID 204434 to Site 2 ID 9001068

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

$$\begin{aligned} D_1 &= \text{SQRT}(2 \times \lambda \times d_1 \times (1 - d_1/d_2)) \\ &= \text{SQRT}(2 \times (300/15000) \times 3700(1 - 3.7/17.85)) \\ &= 10.83 \text{ metres} \end{aligned}$$

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 1st Fresnel Zone clearance as there is less disturbance at the lower frequencies due to blade movements or obstructions generally.

Example only

1. Site 1 ID 10712 to Site 2 ID 10652

$$Y_{\min} = 0.6 \sqrt{\lambda D_1(1 - D_1/D_2)}$$

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

$$\begin{aligned} D_1 &= 0.6 * \text{SQRT}(\lambda \times d_1 \times (1 - d_1/d_2)) \\ &= 0.6 * \text{SQRT}((300/450) \times 19150(1 - 19.15/38.3)) \\ &= 47.94 \text{ metres} \end{aligned}$$

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

ATTACHMENT 13 –RADIO PATH HORIZONTAL CLEARANCES REQUIRED

UHF SYSTEM

Site 1	Site 2	Operator	Freq MHz	Path m	dist m	2nd fresnel m	0.6 x 1st fresnel m	Site 1 GDA94 Lat	Site 1 Long	Site 2 GDA94 Lat	Site 2 Long
37908	36436	Telstra	400	66770	8110	103.38	43.86	-38.56225217	146.6747118	-39.129961240	146.4242020

MICROWAVE SYSTEMS

Site 1	Site 2	Freq	D1	D2	2nd Fresnel	Operator	Site 1 Lat	Long	Site 2 Lat	Long
ACMA ID	ACMA ID	Mhz	Metres	Metres	Metres		GDA94		GDA94	
9020133	37908	11000	12650	17070	13.36654	Telstra	-38.61283131	146.48914471	-38.56225217	146.67471175
12044	36645	1500	8260	34900	50.21973	Telstra	-38.39909039	146.56466643	-38.70250196	146.66777428
305900	305472	8000	7620	19700	18.72011	Optus	-38.6190994	146.64075236	-38.65326543	146.41729358

No wind turbines blade tips should protrude into the high lighted distances from the link paths

For the UHF Telstra link due to its apparent over-the-horizon operation further consideration should be given to whether current setbacks which meet the Fresnel zone criteria are sufficient.

ATTACHMENT 14- 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
AM	Amplitude 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)
Terrestrial	Earth based i.e. not space based e.g. satellite