

Beatrice Offshore Wind Farm: TV & Radio Impact Report

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| Project Title | Beatrice Offshore Wind Farm |
| Date: | 26th July 2017 |

Beatrice Offshore Wind Farm TV & Radio Impact Report

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1 INTRODUCTION

1.1 Scope of Document

This report outlines the findings of a comprehensive desk and field survey undertaken to determine the viewing preference of residents located around the proposed Beatrice Offshore Wind Farm and identifies the possible effects the development may have on television and radio broadcast services. Figure 2 provides a map of the area with an illustration of the layout of the wind farm superimposed.

This TV and Radio Impact Report has been prepared in accordance with the Television and Radio Reception Mitigation Plan ("TRRMP") (Revision 4, issued 28/10/2015) submitted by Beatrice Offshore Windfarm Limited (BOWL) to discharge consent condition 24 of the Section 36 consent. The TRRMP commits BOWL to undertake baseline reception surveys at locations agreed with Marine Scotland Licensing Operations Team (MS-LOT), on behalf of the Scottish Ministers and in consultation with The Highland Council (THC). The survey results must be submitted to THC, as detailed in the TRRMP, section 6.3.

1.2 Location Information

The Beatrice Offshore Wind Farm is located in the north of Scotland, in the outer Moray Firth, approximately 13.5km from the Caithness coastline. The wind farm is situated in a remote area surrounded by a small local population.

Areas of highest population within the vicinity of BOWL are Wick, Lybster, Berridale, Buckie, MacDuff, Rosehearty, Brora and Helmsdale.

Wireless services can be impacted when a building or structure is constructed which is significantly taller than those around it. A clear path between the transmitter and the receiver is important for optimal reception. Large structures within, or near to, this path may affect signal quality and result in performance degradation or complete loss of a wireless service.

Two potential mechanisms that cause problems to wireless services are:

- Physical blocking of the signal by the structure

When dealing with wireless signals it is desirable to have a clear line of sight path between the transmitter and receiving aerial in order to achieve a quality signal and reliable reception. The presence of a tall structure between the transmitter and receiver may cause a 'shadow' to be cast behind the structure on the side opposite the transmitter.

- Reflection from the sides of the structure.

Ofcom (2009) outline potential distances of impact of reflection as being “limited to less than a few tens of metres, perhaps extending to a few hundred metres for a very tall and reflective structures. The ‘slot’ part of the keyhole (figure 1 refers) may extend for some kilometres, but typically for no more than 5km”. Reports have been received of reflection effects affecting broadcast television up to 20km from the structure, although this has only occurred in exceptional circumstances.

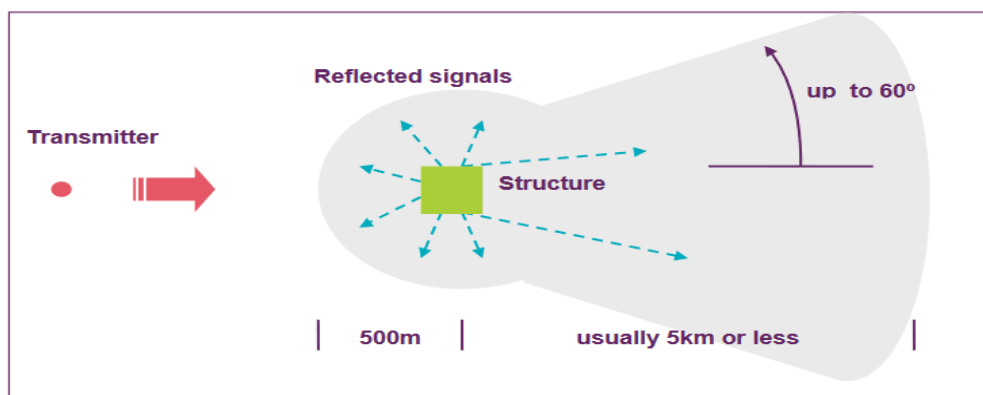


Figure 1

Distances affected by Reflected Signals

Figure 2 below provides a BOWL area map with illustration of the proposed Wind Farm and WTG's superimposed.

The dotted black line within the blue square (see Figure 2), represents the area where signal strength degradation is possible as a small area lies within the 20km area highlighted by Ofcom to be affected in “exceptional circumstances”. This includes the coastal areas to the north and west of the wind farm.

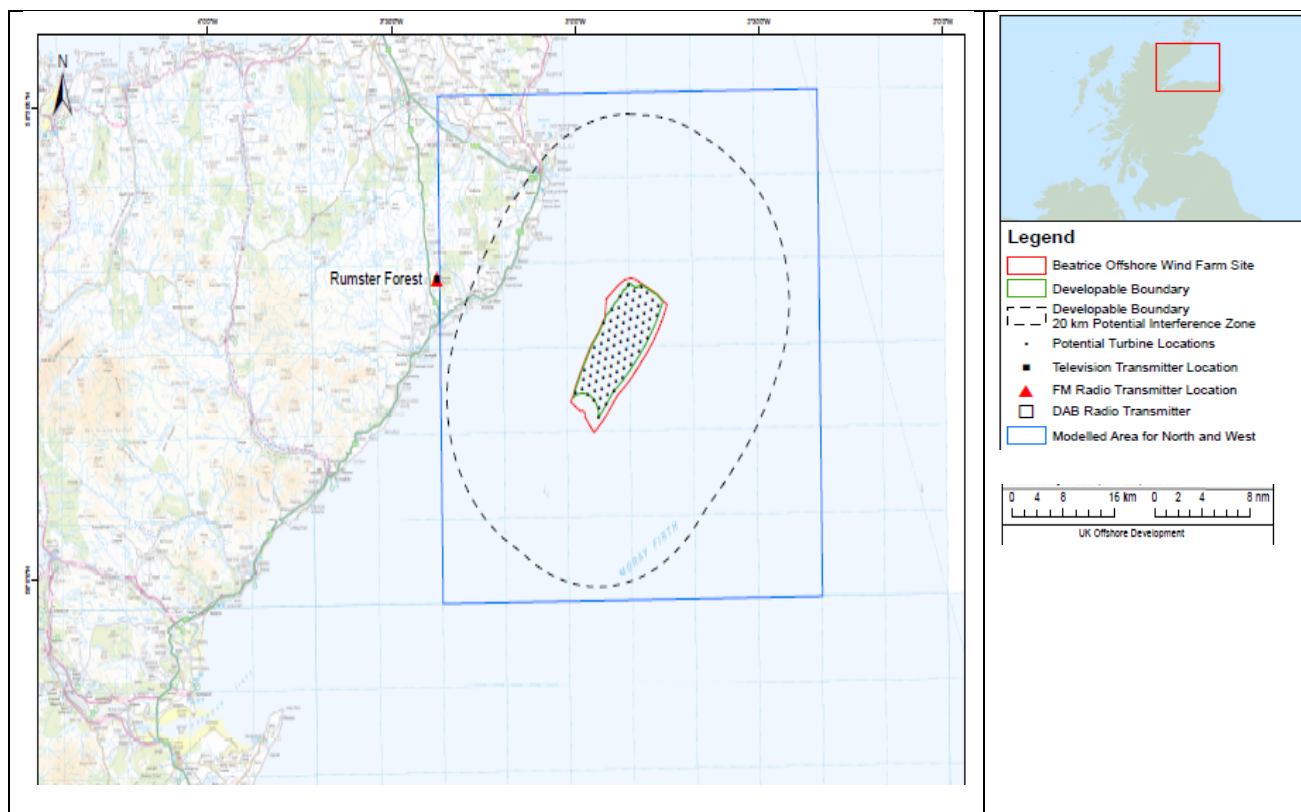


Figure 2 BOWL: Area map with illustration of the proposed Wind Farm and WTGs superimposed.

2 TECHNICAL DESCRIPTION

2.1 Digital Transmitters

Currently there are three main transmitters that provide a service to the area surrounding BOWL Wind Farm. These are Rumster Forest, Rosemarkie and Knockmore Transmitters which are highlighted in Figure 3.



Figure 3 Transmitters around the proposed wind farm

Digital television services are broadcast on a multiplexes (or Mux) where many stations occupy a single broadcast frequency, as shown in Tables 2.1, 2.2 and 2.3. Generally speaking radio signals are less susceptible to wind farm interference than TV signals. The interference mechanisms are largely the same for radio signals and TV signals.

2.1.1 Table 2.1 - The current digital multiplex information for Rumster Forest:

| | BBC A | | D3&4 | | BBC B | | SDN | | Arqiva A | | Arqiva B | |
|----|-------|------|------|------|-------|------|-----|------|----------|------|----------|------|
| Gp | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP |
| wv | 27 | 20kW | 24 | 20kW | 21 | 20kW | 30 | 20kW | 59 | 10kW | 55 | 10kW |

2.1.2 Table 2.2 - The current digital multiplex information for Knockmore:

| | BBC A | | D3&4 | | BBC B | | SDN | | Arqiva A | | Arqiva B | |
|----|-------|------|------|------|-------|------|-----|------|----------|------|----------|------|
| Gp | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP |
| wv | 26 | 20kW | 23 | 20kW | 29 | 20kW | 53 | 20kW | 57 | 10kW | 60 | 10kW |

2.1.3 Table 2.3 - The current digital multiplex information for Rosemarkie:

| | BBC A | | D3&4 | | BBC B | | SDN | | Arqiva A | | Arqiva B | |
|----|-------|------|------|------|-------|------|-----|------|----------|------|----------|------|
| Gp | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP | Ch | ERP |
| wv | 45 | 20kW | 49 | 20kW | 42 | 20kW | 43 | 10kW | 46 | 10kW | 50 | 10kW |

Digital signals are less susceptible to interference as there are only two states to a TV picture, meaning that there is either a visible picture, or there is no picture visible on the TV screen. The probability of a wind farm affecting the TV signal is dramatically reduced unless the receiving aerial is in the RF shadow of the wind farm. The shadow refers to an area where chopping of the signal can occur if the path of the signal from transmitter to receiver passes through the spinning rotor resulting in the received power level fluctuating significantly. Figure 4 provides a visual representation of a shadow scenario. As the proposed wind farm is not located between transmitters and receivers in all areas surveyed there will be no shadow effect.

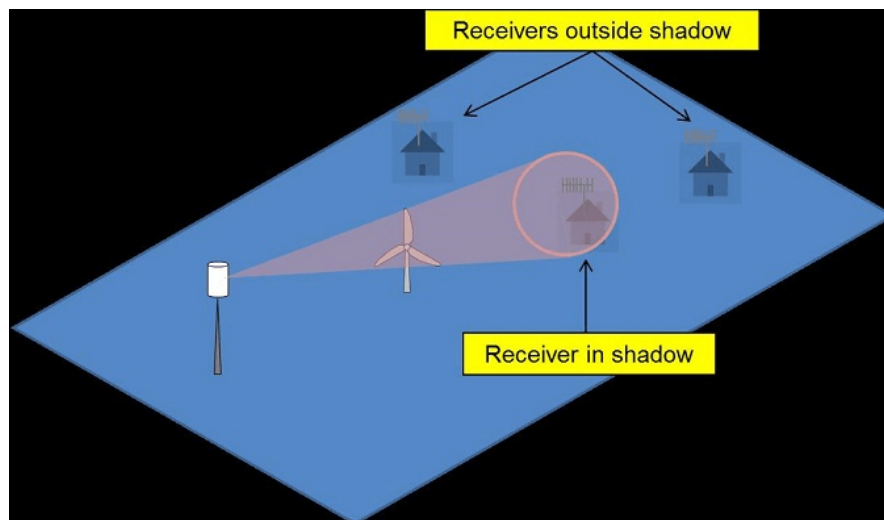


Figure 4 Receiver Shadow

2.1.4 *The following channels are transmitted within each multiplex:*

BBC A

| | |
|--|-----|
| BBC One | 1 |
| BBC Two | 2 |
| BBC Three | 7 |
| BBC Four (Border region only) | 9 |
| CBBC Channel | 70 |
| CBeebies (Border region only) | 71 |
| BBC News | 80 |
| BBC Parliament (Border region only) | 81 |
| BBC Red Button (text) | 105 |
| BBC Radio Scotland (Scotland and Border region only) | 719 |
| BBC Radio Ulster (Northern Ireland only) | 719 |
| BBC Radio Wales (Wales only) | 719 |
| BBC Radio nan Gàidheal (Scotland and Border region only) | 720 |
| BBC Radio Foyle (Northern Ireland only) | 720 |
| BBC Radio Cymru (Wales only) | 720 |

D3&4

| | |
|--------------------------|----|
| ITV1 | 3 |
| Channel 4 (except Wales) | 4 |
| ITV2 | 6 |
| Channel 4 (Wales only) | 8 |
| ITV3 | 10 |

| | |
|---|-----|
| Channel 4 +1 | 13 |
| More 4 | 14 |
| ITV4 | 24 |
| E4 | 28 |
| Teletext | 100 |
| Teletext Holidays (Wales only) | 101 |
| Rabbit (text) | 102 |
| DirectGov (text) | 106 |
| U105 (radio, Northern Ireland only) | 726 |
| Heart (radio, not Scotland or Northern Ireland) | 728 |

SDN

| | |
|--|----|
| S4C (Wales only) | 4 |
| Five (not Border region) | 5 |
| Tele G (Scotland and Border region only) | 8 |
| QVC | 16 |
| G.O.L.D.* | 17 |
| Bid TV | 23 |
| UKTV Style* | 26 |
| British Eurosport* | 33 |
| Setanta Sports* | 34 |
| Five USA | 35 |
| Fiver | 36 |
| Top Up TV Anytime 1* | 38 |

| | |
|--|-----|
| Top Up TV Anytime 2* | 39 |
| Top Up TV Anytime 3* | 40 |
| GemsTV1 | 44 |
| Smile TV (not Wales) | 46 |
| Quest | 47 |
| Super Casino (not Wales or Northern Ireland) | 48 |
| Rocks & Co (not Wales or Northern Ireland) | 49 |
| CITV (not Wales) | 72 |
| CNN | 84 |
| S4C2 (Wales only) | 86 |
| Teachers' TV | 88 |
| TVX/Red Hot* | 97 |
| Teletext Holidays (not Wales) | 101 |
| Teletext Casino (not Wales) | 103 |
| 1-2-1 Dating (text) (not Wales) | 104 |
| Smash Hits! (not Wales) | 712 |

BBC B

| | |
|------------------------------------|-----|
| Five (Border region only) | 5 |
| BBC Four (not Border region) | 9 |
| CBeebies (not Border region) | 71 |
| BBC Parliament (not Border region) | 81 |
| Community Channel | 87 |
| BBC Red Button (extra video) | 301 |

| | |
|------------------------------|-----|
| BBC Red Button (extra video) | 302 |
| BBC Red Button (extra video) | 303 |
| BBC Red Button (extra video) | 305 |
| BBC Radio 1 | 700 |
| BBC 1Xtra | 701 |
| BBC Radio 2 | 702 |
| BBC Radio 3 | 703 |
| BBC Radio 4 | 704 |
| BBC Radio 5 Live | 705 |
| BBC 5 Live Sports Extra | 706 |
| BBC 6 Music | 707 |
| BBC Radio 7 | 708 |
| BBC Asian Network | 709 |
| BBC World Service | 710 |

Arqiva A

| | |
|-------------------|-----|
| Sky Three | 11 |
| Dave | 19 |
| E4 +1 | 29 |
| SmileTV | 37 |
| Sky News | 82 |
| Sky Sports News | 83 |
| SkyText | 108 |
| TalkSPORT (radio) | 723 |

| | |
|-------------------------|-----|
| Premier Christian Radio | 725 |
| Absolute Radio | 727 |

Arqiva B

| | |
|--------------------------|-----|
| Yesterday | 12 |
| Film Four | 15 |
| 4Music | 18 |
| Virgin 1 | 20 |
| TMF The Music Factory | 21 |
| Ideal World | 22 |
| Dave ja vu | 25 |
| ITV2 +1 | 27 |
| Top Up TV Anytime 4* | 41 |
| GemsTV | 43 |
| National Lottery Xtra | 45 |
| Russia Today | 85 |
| 4TV Interactive Services | 300 |
| The Hits Radio | 711 |
| Kiss (radio) | 713 |
| Heat (radio) | 714 |
| Magic (radio) | 715 |
| Q (radio) | 716 |
| Smooth Radio | 718 |
| Kerrang! (radio) | 722 |

2.1.5

The main masts relevant to the specific areas outlined above are Rumster Forst, Knockmore and Rosemarkie. The geographical as per longitude / latitude is shown in Table 2.4.

Table 2.4 Transmitted signals which have the potential to be impacted by the windfarm:

| Mast | Lat | Long | Alt (AMSL) |
|----------------|------------|-----------|------------|
| Rumster Forest | 58°19'39"N | 3°22'22"W | 323 |
| Knockmore | 57°31'56"N | 3°8'8"W | |
| Rosemarkie | 57°38'02"N | 4°04'26"W | |

Table 2.4 Transmitter co-ordinates

To ensure reliable service is received, the signal level at the receiver should be maintained at between 45 and 65 dBμV. This level should not be allowed to drop below 45 dBμV at any point throughout a TV system as signal consistency would be negatively impacted resulting in poor TV reception.

The Carrier to noise ratio (C/N) should be 26dB or better to be classed as a reliable signal (marginal reception 23-25dB; unreliable 22dB). This will ensure a satisfactory ratio so that if the signal is amplified, the noise won't be amplified along with it, to an unworkable level.

The Bit Error Ratio (BER) is the ratio of bits that the detector in the demodulator is unable to detect against the number of bits transmitted. An acceptable level is 2E-4 (2 bits in every 10,000).

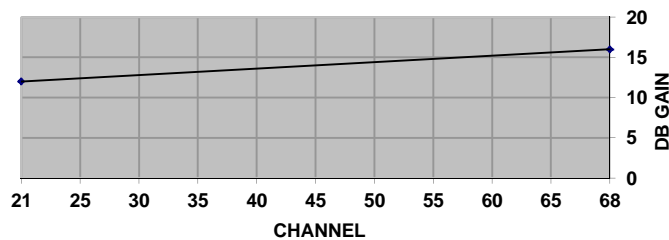
3 SURVEY

3.1 *Equipment*

This survey was carried out using the following equipment:

- 76 element high gain WB aerial with a gain of 12 – 16 dBs
- 3m of WF100 double screened coax with a total loss of 1.025dB @ 860MHz
- Promax TV Explorer 2+
- X2 F Type connectors
- GPS system

The chart below shows the gain of the 76 element wideband aerial used:



The Antenna was positioned 3m above the ground to ensure accurate representation of the signal would be obtained.

3.2 *Surveyed Areas*

Deemed the most highly populated areas within a 20km radius of the wind farm, and in accordance with the survey locations agreed with The Highland Council in an email dated 15th March 2017, the areas specified below were plotted on the map, measurements were recorded and findings analysed to establish TV signal strength.

| AREA | Lat | Long |
|------------|------------|-----------|
| Wick | 58.4389° N | 3.0937° W |
| Lybster | 58.3042° N | 3.2852° W |
| Berriedale | 58.1843° N | 3.5009° W |
| Buckie | 57.6774° N | 2.9673° W |
| MacDuff | 57.6706° N | 2.4978° W |
| Rosehearty | 57.6955° N | 2.1181° W |
| Brora | 58.0122° N | 3.8525° W |
| Helmsdale | 58.1173° N | 3.6535° W |

Table 2 **Plotted test areas**

3.3 Method

Using GIS tools, transmitter locations were plotted on to a map. This facilitated identification of the transmitter or transmitters that had the potential to disturb the signal within each area specified above. Test sites were plotted and prediction of signal direction identified.

The following testing methods were employed:

- In order to highlight areas of potential impact, built-up areas around the perimeter of the wind farm were located and their transmitters identified.
- Equipment was erected and a GPS reading taken.
- An initial 360° horizontal, analogue search for the main transmitters was carried out and findings recorded.
- When a signal was located, the transmitting antenna was identified then verified using a map and compass.
- A further 360° search for digital was carried out.
- The aerial was then rotated from the horizontal plane through to the vertical plane.
- A further 360° search was repeated for digital.

3.4 **Results - TV**

3.4.1 *Brora*



Brora is located approximately 61km South-West from the site. The area receives its signal from the Rosemarkie transmitter which is located 100km south of the site. The aerials in Brora are positioned in a south facing direction pointing in the opposite direction from the wind farm. A strong signal was detected at this location. A local resident confirmed that this area received good reception. Due to the distance from the wind farm and the position of the transmitter and receiving location, no impact on signal reception is anticipated.

3.4.2 Helmsdale



Helmsdale is situated 48.5km South-West from the site. The area receives its signal from the Rosemarkie Transmitter. As the signal strength in the area was found to be weak a high gain aerial would be required to ensure reception. The current signal is of poor quality and would not be further degraded as a consequence of the wind farm. It is predicted that the wind farm will have no impact on the TV signal in Helmsdale due to distance from the wind farm and the position of the transmitter and receiving location, therefore no impact on signal reception is anticipated.

3.4.3 *Berriedale*



Berriedale is the least populated area surveyed and is situated 37km South-West from the site. The area receives no TV signal from any transmitters. The wind farm will therefore have no impact. Currently residents in the area use satellite receivers to access television services.

3.4.4 *Lybster*



Lybster is approximately 22km west of the site. The area receives its signal from the Rumster Forest transmitter which is located 28km west from the site. Signal strength detected in the area was strong. As the transmitted signal and the town which receives the signal are both located more than 20km to the west of the site, it is expected that there will be no impact from the turbines on the local TV signal strength.

3.4.5 Wick



Wick is the most populated area surveyed and is situated 17km North-West of the site. The area receives its signal from the Rumster forest Transmitter which is located approximately 28km South-west of the site. The signal strength in the area was found to be very strong.

As the transmitted signal and the town which receives the signal lies north west of the nearest turbine location and receiving aerials face in the opposite direction from the windfarm, it is anticipated that there will be no impact from the turbines on the local TV signal strength.

3.4.6 *Buckie*



Buckie is situated approximately 68km south of the site. The area receives its signal from the Knockmore Transmitter which is located 87km south of the site. Signal strength in the area was found to be strong. As the transmitted signal and the town which receives the signal are both located more than 20km to the south of the site, it is anticipated that there will be no impact from the turbines on the local TV signal strength.

3.4.7 *MacDuff*



MacDuff is situated 74km south of the site. The area receives its signal from the Rumster Forest Transmitter. As signal strength in the area was found to be weak a high gain aerial would be required in order to ensure a satisfactory service is received. The current poor quality signal would not be further degraded as a consequence of the wind farm because the geographical location of the wind farm in relation to MacDuff takes it beyond the limits capable of negatively impacting signal reception.

3.4.8 *Rosehearty*



Rosehearty is situated 81km south of the site. The area receives its signal from the Knockmore Transmitter which is situated approximately 85km from the site. The signal strength in the area was found to be good. As the transmitted signal and the town which receives the signal lie south of the wind farm and aerials are positioned in the opposite direction from the wind farm, it is anticipated that there will be no impact from the turbines on the local TV signal strength.

3.5 Report findings - Radio

Interference to terrestrial radio services due to wind turbine developments is considered unlikely as such services are more robust to interference than TV signals. This analysis has considered transmissions from Rumster Forest and Knockmore DAB radio transmitters for

the same area as per TV interference. If interference was to occur it would be most likely for mobile radios in the intermediate vicinity of the turbines.

4 CONCLUSION

In order to predict the potential impact Beatrice Offshore Wind Farm may have on the surrounding TV and Radio signals when the wind turbines are erected, the area around BOWL Wind Farm was surveyed.

Locations were agreed in consultation with MS-LOT and THC. The Eight test sites were plotted using GIS tools and each test location around the wind farm site was surveyed. TV and radio signals in the area were measured and recorded. Three main transmitters serve the areas around the wind farm. These are Rosemarkie, Knockmore and Rumster Forest Transmitters, which have already gone through the digital switchover. Five of the areas surveyed received a strong signal from their transmitters; two received poor signals which required the use of high gain aerials to boost signal strength; and one area that required satellite equipment in order to receive TV services.

Subsequent to analysis of test data obtained during this survey it is predicted that the wind farm will have no impact on the TV or Radio signal strength in the areas surveyed around the wind farm due to the directional characteristics of the individual sites relationships between location and mast. It is therefore considered that further survey activity, as set out in section 6.3 of the TRRMP is no longer required.

5 REFERENCES

Calaz, R A. (2002). An Introduction To Domestic Radio TV And Satellite Reception.

Ofcom (2009) Tall structures and their impact on broadcast and other wireless services

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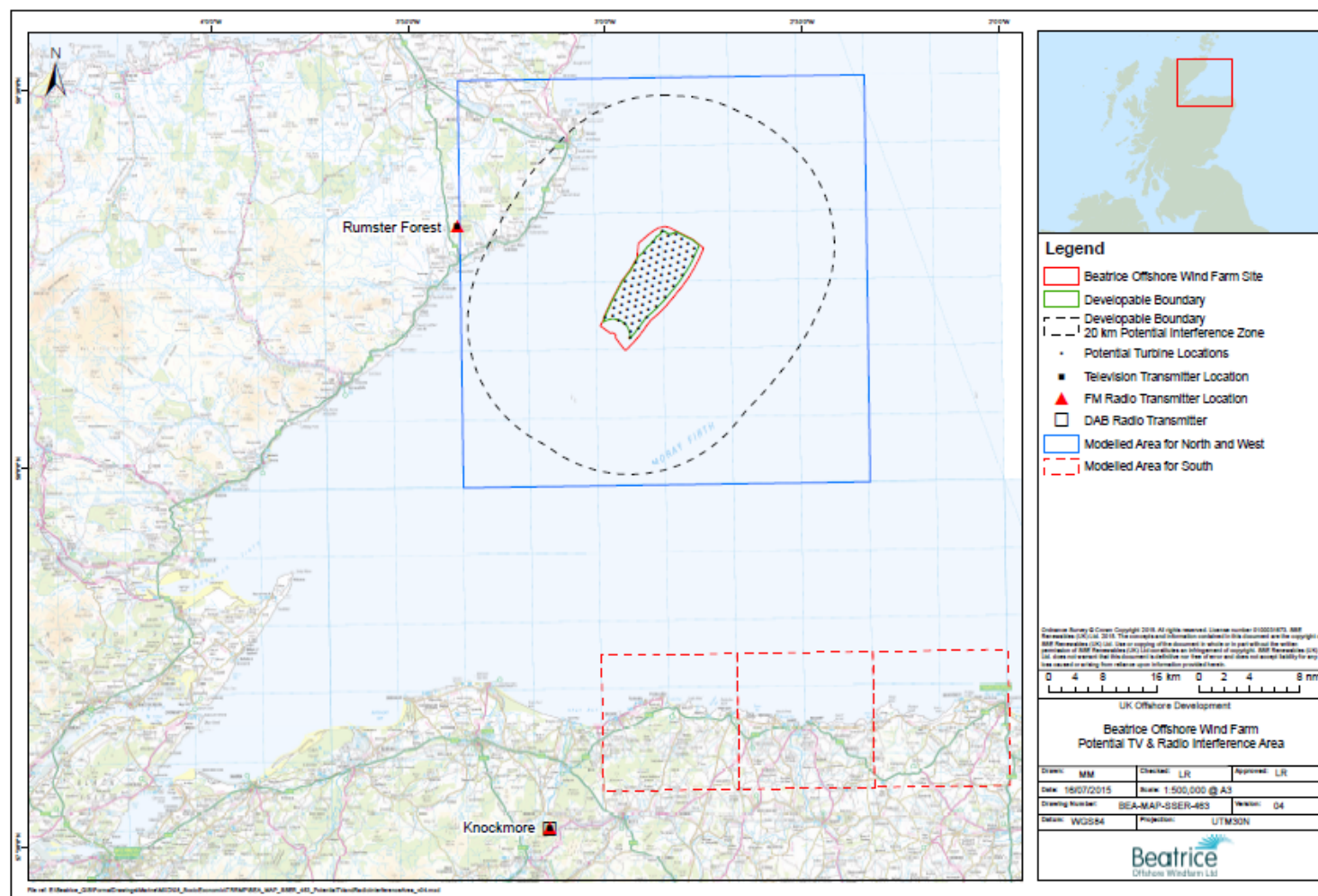
<http://www.ofcom.org.uk/tv/>

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Beatrice Offshore Wind Farm: TV & Radio Impact Report

APPENDIX 1 – Potential TV and Radio Interference Area



APPENDIX 2 – Survey Results

| AREA | | | | BBC A | | | | D3&4 | | | | BBC B | | | | SDN | | | |
|------------|-----|------|----------------|-------|------|------|------|------|------|------|------|-------|------|------|--------|--------|----|-----|-----|
| SITE | LAT | LONG | Main Tx | CH | dB | C/N | BER | CH | dB | C/N | BER | CH | dB | C/N | BER | C H | dB | C/N | BER |
| Wick | | | Rosemarkie | 45 | 51.5 | 36 | 1E-7 | 49 | 53.7 | 34.2 | 1E-7 | 42 | 50.2 | 37.3 | 1E-7 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Lybster | | | Rumster Forest | 27 | 60.2 | 37.5 | 1E-7 | 24 | 58.6 | 36.2 | 1E-7 | 21 | 55.9 | 36 | 1E-7 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Berriedale | | | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Buckie | | | Knockmore | 26 | 59.6 | 38 | 1E-7 | 23 | 55.4 | 36.2 | 1E-7 | 29 | 49.8 | 35.6 | 1E-7 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| MacDuff | | | Rumster Forest | 27 | 37.5 | 26 | 3E-3 | 24 | 37.3 | 27.2 | 2E-3 | 21 | 38.6 | 25 | 2.5E-3 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Rosehearty | | | Kockmore | 26 | 50.7 | 39 | 1E-7 | 23 | 52.3 | 38.5 | 1E-7 | 29 | 51.4 | 36.8 | 1E-7 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Brora | | | Rosemarkie | 45 | 46.1 | 36 | 1E-7 | 49 | 44.9 | 35.1 | 1E-7 | 42 | 45.1 | 37.8 | 1E-7 | | | | |
| | | | | | | | | | | | | | | | | | | | |
| Helmsdale | | | Rosemarkie | 45 | 35.2 | 24 | 9E-3 | 49 | 36 | 20 | 2E-2 | 42 | 37 | 22 | 9E-3 | | | | |
| | | | | | | | | | | | | | | | | | | | |

| Argiva A | | | | Argiva B | | | |
|----------|----|-----|-----|----------|----|-----|-----|
| CH | dB | C/N | BER | CH | dB | C/N | BER |
| | | | | | | | |
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