Appendix 16.2 – 2012 Aviation Impact Assessment

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WSP

Sandy Knowe

Aviation Impact Assessment

August, 2012

ADMINISTRATION PAGE

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EXECUTIVE SUMMARY

Burcote Wind Ltd (the Applicant) is proposing the development of a 30 turbine wind farm (the Proposed Development) with a maximum tip height of up to 125 m above ground level (agl). The Proposed Development, located between New Cumnock and Kirkconnel, is approximately 10.5 km south east of Cumnock, Scotland.

Pager Power has been appointed by the Applicant to assess the effects upon aviation in the vicinity of the Proposed Developer. In summary, the analysis in this report has shown:

- At 125 m tip height, eight wind turbines within the Proposed Development would be in line of sight (LOS) to the Prestwick Airport Primary Surveillance Radar (PSR).
- All 30 turbines are in full line of sight to the Lowther Hill PSR and Secondary Surveillance Radar (SSR).
- None of the turbines within the Proposed Developmentwill be in line of sight to Glasgow Airport's PSR and SSR and Edinburgh Airport's PSR and SSR.
- None of the turbines will be in LOS to the MOD's PSR and SSR at Spadeadam Deadwater Fell and the Spadeadam Berry Hill PSR.
- Detectability analysis has shown that turbine 7 is likely to be detectable to the PSR at Prestwick Airport. Turbines 4, 5, 6 & 11 are all expected to produce a return to the radar of between approximately -15 dBm and 0 dBm as detailed in the report. At this margin the certainty of remaining undetected decreases and therefore it cannot be guaranteed that these turbines will be undetectable. All other turbines are expected to be undetectable.
- Detectability analysis, based on the first addition of CAP764, was not initially designed for analysis on L-Band en-route radar however, due to the distance and full visibility of all turbines, it is likely that all the turbines will be detectable to the Lowther Hill PSR and should be considered as such.
- None of the turbines will be detectable to the Military PSR at Deadwater Fell and Berry Hill.
- No additional shielding along the LOS is available for the wind turbines from the Lowther Hill PSR.
- Marginal additional shielding is available along the Prestwick Airport's LOS for turbines 4,5,6,7 and 11 however it is unsure whether the buildings at Mossblown Farm will provide enough shielding to fully obscure the turbines from view. A field survey may be beneficial to determine this.
- The Proposed Development lies in a high priority low flying zone and tactical training area (LFA 20T) where aircraft can fly as low as 100 feet for training purposes. Early consultation with the MOD is strongly advised to determine their position towards the Proposed Development.
- Altering the layout is likely to be the only form of technical mitigation for alleviating the issues concerning the presence of the Proposed Development in a High Priority Military Low Flying Zone.
- The most suitable form of mitigation to alleviate the impacts upon the Prestwick PSR is considered to be layout and height optimisation to reduce impacts upon the PSR. In-fill radar or Local In-fill could be used if layout optimisation is unviable.
- The most suitable mitigation solution for the NATS Lowther Hill PSR issue is likely to be the Raytheon Solution or In-fill radar. For In-fill, the feed from the other radar would need to be able to see between approximately 1,000 ft and 5,000 ft below the base of controlled airspace due to the potential for the presence of high speed low flying jets in the Military Low Fly Zone.

- Prestwick Airport could object initially, however, because the effects upon the PSR are marginal, mitigation can be easily implemented. If layout and height optimisation can alleviate the issues, Prestwick Airport's PSR may be a viable In-fill radar solution.
- It is likely that the effect upon the NATS and MOD installations will be the biggest aviation threat to the Proposed Development. It is likely that both stakeholders will object due to the expected operational effect caused by the Proposed Development. Mitigation options are available but may be costly.
- Consultation with Prestwick Airport, NATS and the MOD will be required to determine their position and to suggest the possibility of implementing the mitigation options presented in this report.

Conclusion summary

It is likely that some aviation stakeholders in the area will have significant concerns to the Proposed Development however mitigation is available to alleviate the issues identified. The main issues and stakeholders concerned are:

- presence of the Proposed Development in a High Priority Low Flying Zone (MOD);
- the likelihood of detectability of all of the turbines to the Lowther Hill PSR (NATS/NERL); and
- detectability of up to five wind turbines to the PSR at Prestwick (Prestwick Airport).

Mitigation options have been presented and recommendations have been made. Based on Pager Power's experience it is advised that the next steps should be to initiate consultation with the MOD and Prestwick Airport followed by NATS. The aims of these consultations should be to determine their position towards the Proposed Development and discuss the viability of mitigation where necessary.

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1 INTRODUCTION

Burcote Wind Ltd (he Applicant) is proposing the development of a 30 turbine wind farm with a maximum tip height of up to 125 m above ground level (agl) (the Proposed Development). The Proposed Development, located between New Cumnock and Kirkconnel, is approximately 10.5 km south east of Cumnock, Scotland.

Pager Power has been appointed by the Applicant to assess the effects upon aviation in the vicinity of the Proposed Development. This report will assess and summarise the effects upon aviation by presenting the following analysis:

- Line of Sight (LOS) assessments from:
  - Lowther Hill's NATS primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR);
  - Prestwick Airport's PSR;
  - Glasgow Airport's PSR and SSR;
  - Edinburgh Airport's PSR and SSR;
  - Spadeadam (Berry Hill) PSR and SSR;
  - Spadeadam (Deadwater Fell) PSR and SSR;
- detectability analysis from all of the relevant PSRs;
- desk top shielding analysis of the relevant installations where potential shielding could be significant;
- assessment of air traffic and airspace usage in the vicinity of the proposed development site;
- assessment of Military Low Flying Zones in the vicinity of the proposed development site;
- a high level assessment of the operational impact on the relevant installations; and
- assessment of potential radar mitigation options and associated costs (as required).

The analysis will be complemented with discussions of the findings throughout to determine the severity of the effect. Finally, Pager Power's conclusions and recommendations will be presented.

Information regarding the detectability assessment methodology is attached in the Appendix of this report.

Unless otherwise stated all coordinates used within this report are in British National Grid (OSGB36 datum).

2 WIND DEVELOPMENT DETAILS

The turbine details and British National Grid co-ordinates are shown below:

2.1 Turbine Layout and Map:

Turbine	Easting (m)	Northing (m)	Hub height (m)	Rotor Diameter (m)	Tip Height (m)
1	269539	611439	80	90	125
2	269201	611337	80	90	125
3	269055	611108	80	90	125
4	268892	610887	80	90	125
5	269074	610564	80	90	125
6	268865	610367	80	90	125
7	268720	610143	80	90	125
8	268627	609893	80	90	125
9	269488	611065	80	90	125
10	269408	610668	80	90	125
11	269198	610102	80	90	125
12	269050	609876	80	90	125
13	269913	610787	80	90	125
14	269962	610498	80	90	125
15	269724	610136	80	90	125
16	269685	609866	80	90	125
17	270428	610753	80	90	125
18	270382	610471	80	90	125
19	270402	610182	80	90	125
20	270151	610007	80	90	125

Turbine	Easting (m)	Northing (m)	Hub height (m)	Rotor Diameter (m)	Tip Height (m)
21	270151	609728	80	90	125
22	270579	609876	80	90	125
23	270830	610051	80	90	125
24	271136	610275	80	90	125
25	270764	610503	80	90	125
26	271017	610676	80	90	125
27	271381	610445	80	90	125
28	271342	610785	80	90	125
29	270757	610950	80	90	125
30	271039	611094	80	90	125

Table 1 *Turbine details*

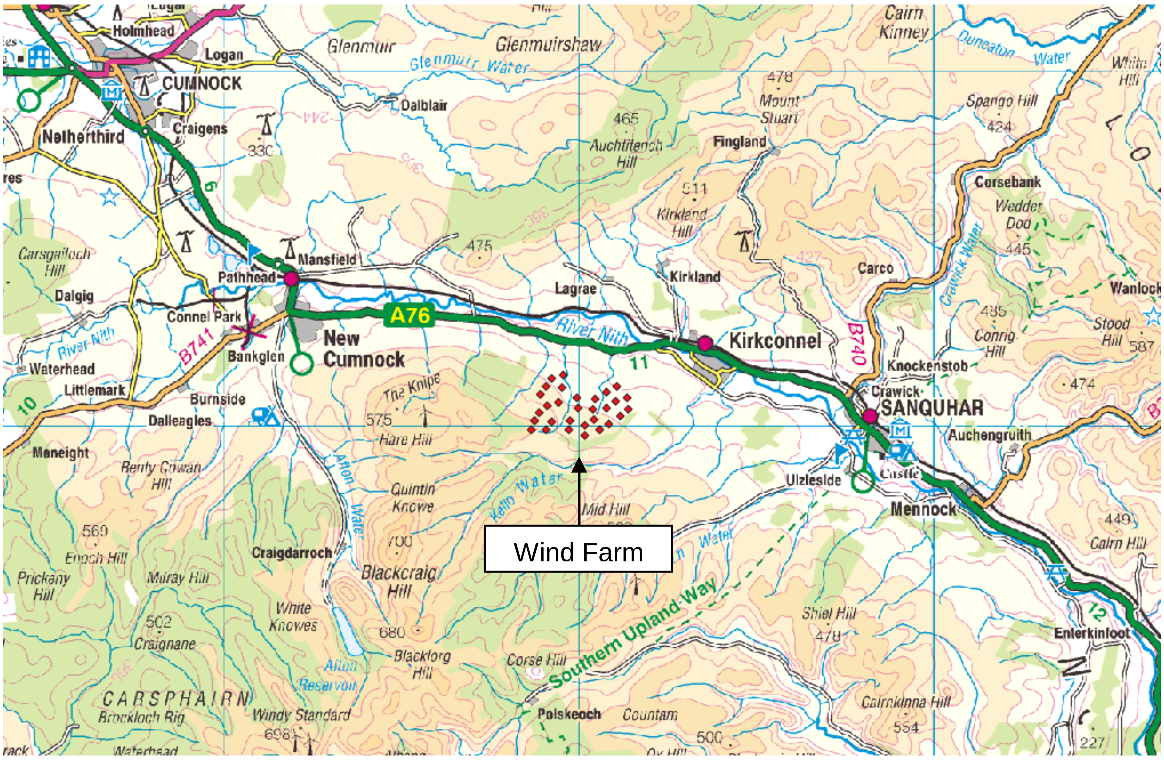

Figure 1 *Wind turbine Locations*

3 RADAR DETAILS

The following tables present information regarding the relevant PSR and SSR. Tables are organised in ascending distance from the wind farm:

3.1 Lowther Hill Radar Details

Radar	NATS PSR
Height of Ground at the radar above OS Datum (m)	722.1
Height of radar above ground level (agl) (m)	15.9
Overall Radar Height above OS Datum (m)	738.0
Average Distance between the wind farm and radar (km)	19.1
Average grid bearing from the radar to the wind farm (°)	269.3

Table 2 *Lowther Hill PSR details*

Radar	NATS SSR
Height of Ground at the radar above OS Datum (m)	722.1
Height of radar above ground level (agl) (m)	20.9
Overall Radar Height above OS Datum (m)	743.0
Average Distance between the wind farm and radar (km)	19.1
Average grid bearing from the radar to the wind farm (°)	269.3

Table 3 Lowther Hill SSR *details*

3.2 Prestwick Airport radar details

Radar	Civil Airfield PSR
Height of Ground at the radar above OS Datum (m)	18.0
Height of radar above ground level (agl) (m)	17.3
Overall Radar Height above OS Datum (m)	35.3
Average Distance between the wind farm and radar (km)	36.5
Average grid bearing from the radar to the wind farm (°)	115.3

Table 4 *Prestwick PSR details*

3.3 Glasgow Airport Radar Details

Radar	Civil Airfield PSR
Height of Ground at the radar above OS Datum (m)	6.0
Height of radar above ground level (agl) (m)	19.1
Overall Radar Height above OS Datum (m)	25.1
Average Distance between the wind farm and radar (km)	61.0
Average grid bearing from the radar to the wind farm (°)	158.6

Table 5 *Glasgow PSR details*

Radar	Civil Airfield SSR
Height of Ground at the radar above OS Datum (m)	6.0
Height of radar above ground level (agl) (m)	22.1
Overall Radar Height above OS Datum (m)	28.0
Average Distance between the wind farm and radar (km)	61.0
Average grid bearing from the radar to the wind farm (°)	158.6

Table 6 *Glasgow SSR details*

3.4 Edinburgh Airport Radar Details

Radar	Civil Airfield PSR
Height of Ground at the radar above OS Datum (m)	28.5
Height of radar above ground level (agl) (m)	23.4
Overall Radar Height above OS Datum (m)	51.9
Average Distance between the wind farm and radar (km)	77.3
Average grid bearing from the radar to the wind farm (°)	214.7

Table 7 *Edinburgh PSR details*

Radar	Civil Airfield SSR
Height of Ground at the radar above OS Datum (m)	28.5
Height of radar above ground level (agl) (m)	26.5
Overall Radar Height above OS Datum (m)	55.0
Average Distance between the wind farm and radar (km)	77.3
Average grid bearing from the radar to the wind farm (°)	214.7

Table 8 *Edinburgh SSR details*

3.5 Spadeadam (Deadwater Fell) Radar Details

Radar	Military PSR
Height of Ground at the radar above OS Datum (m)	565.9
Height of radar above ground level (agl) (m)	20.4
Overall Radar Height above OS Datum (m)	586.3
Average Distance between the wind farm and radar (km)	93.5
Average grid bearing from the radar to the wind farm (°)	278.2

Table 9 Spadeadam (Deadwater Fell) PSR *details*

Radar	Military SSR
Height of Ground at the radar above OS Datum (m)	565.9
Height of radar above ground level (agl) (m)	20.5
Overall Radar Height above OS Datum (m)	586.4
Average Distance between the wind farm and radar (km)	93.5
Average grid bearing from the radar to the wind farm (°)	278.2

Table 10 Spadeadam (Deadwater Fell) SSR *details*

3.6 Spadeadam (Berry Hill) Radar Details

Radar	Military PSR
Height of Ground at the radar above OS Datum (m)	283.5
Height of radar above ground level (agl) (m)	17.6
Overall Radar Height above OS Datum (m)	301.1
Average Distance between the wind farm and radar (km)	101.9
Average grid bearing from the radar to the wind farm (°)	291.6

Table 11 Spadeadam (Berry Hill) PSR *details*

Radar	Military SSR
Height of Ground at the radar above OS Datum (m)	329.7
Height of radar above ground level (agl) (m)	30.7
Overall Radar Height above OS Datum (m)	360.4
Average Distance between the wind farm and radar (km)	98.6
Average grid bearing from the radar to the wind farm (°)	291.4

Table 12 Spadeadam (Berry Hill) SSR *details*

Radar co-ordinates details are taken from Pager Powers database.

3.7 Radar Location Map

The relevant PSR and SSR along with the Proposed Development's location can be seen in figure 2 below:

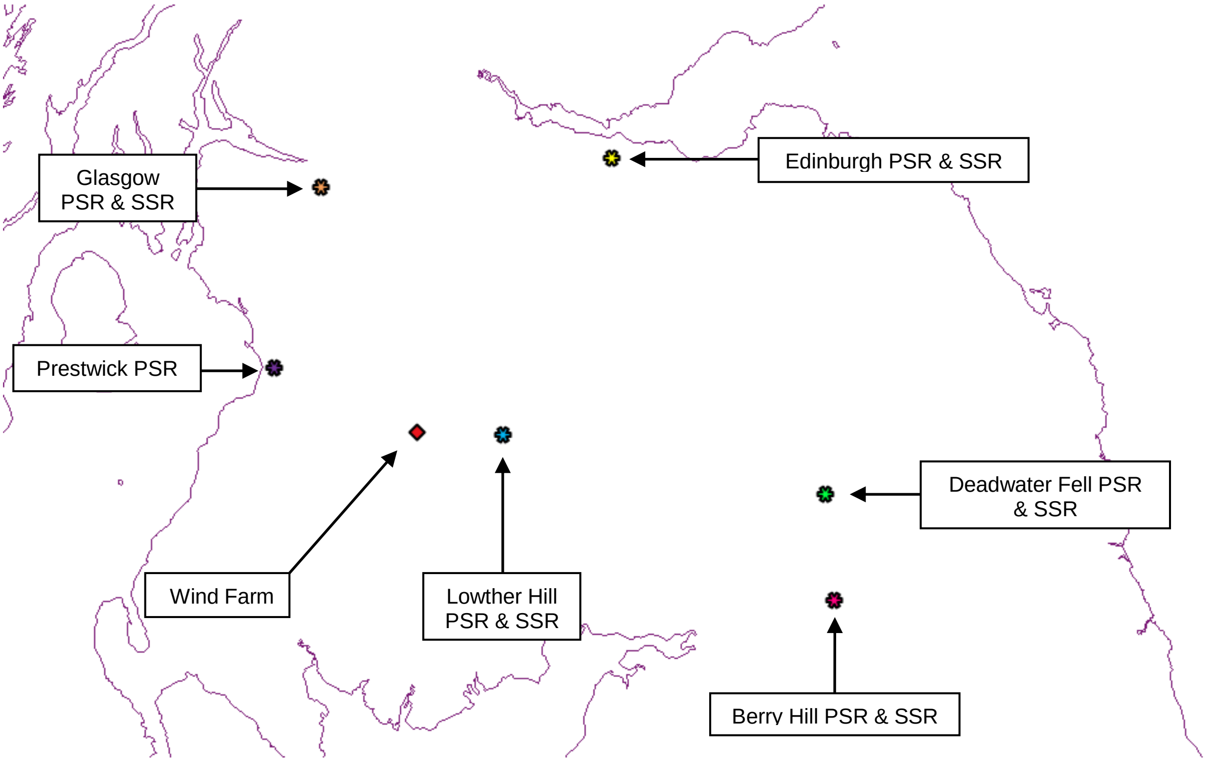

Figure 2 Relevant PSR, SSR and Proposed Development

4 METHODOLOGY OF ASSESSMENT

4.1 Terrain Based Analysis - Overview

There are many approaches that may be used to undertake terrain based assessments such as radar line of sight profile charts.

The overall accuracy of any terrain based assessment is dependent on the following factors:

- accuracy of coordinates and height data for the infrastructure being assessed;
- resolution and quality of digital terrain or surface data; and
- choice of algorithm for determining land height from terrain data.

Coordinates and height of existing infrastructure may be obtained from the infrastructure owner, custom databases and various forms of mapping or via a site survey. Sometimes the coordinate and height data used may be inaccurate because of coordinate rounding or confusion between height and altitude. Verification of infrastructure position data makes the results of terrain based assessments more reliable.

The resolution of digital data is described by its post spacing – in the case of OS panorama data the resolution is 50 metres. Digital terrain and surface data has a vertical accuracy described by a statistical relationship between database and actual vertical values – a typical rms[1] vertical accuracy being 2 metres.

Digital terrain data is used to calculate the terrain or surface height at specific locations. There are many processing algorithms for achieving this. These algorithms vary in accuracy and some are more appropriate for certain types of calculations than others. The nearest neighbour algorithm runs quickly and is effective for some applications. A weighted average algorithm is more accurate and generally gives conservative results for wind farm radar calculations. A more advanced algorithm using 12 data points is more accurate yet less conservative when determining the likelihood of a radar detecting a wind turbine.

The figure on the following page shows an example of how terrain data will be interpreted for an algorithm using the nearest neighbour approach, the weighted average approach and the 12 points approach. The circles represent the DTM points, which are effectively the raw data and can be considered accurate. The coloured lines show the apparent height that will be calculated by the three algorithms. It can be seen that whilst the 12 points method is in most cases more accurate, it is less conservative than the bilinear weighted average method for line of sight analysis and radar detectability analysis. This is because the weighted average method is more likely to reduce the apparent height of the blocking point, thereby increasing the visibility of the turbine.

Pager Power employs the bilinear weighted average method for its analysis.

[1] Root mean square

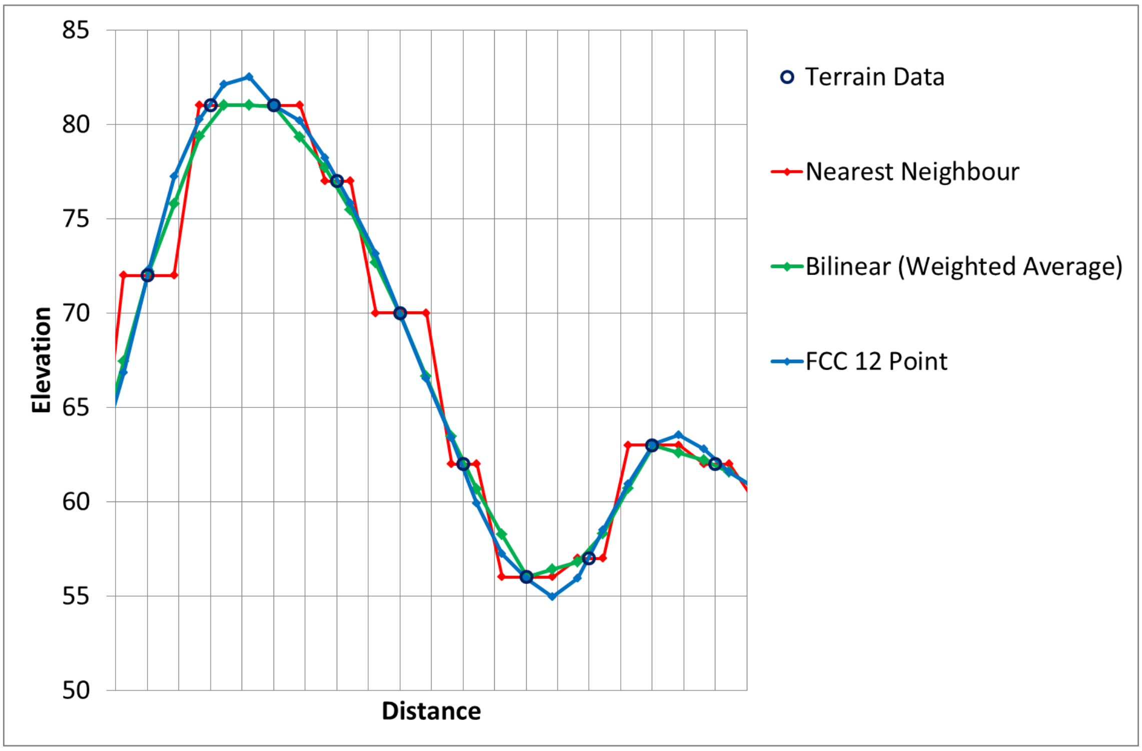

Figure 3 *Example of Terrain Data Algorithms*

4.2 Radar Analysis- General Principles

Line of sight (LOS) analysis is used to determine the extent to which a planned wind turbine could be detected by a specific radar installation. This analysis takes into account:

- the curvature of the Earth;
- refraction of the radar signal by the atmosphere;
- the Effective Radar Height;
- the Effective Turbine Height; and
- the height profile of the terrain between the radar and turbine.

The diagram on the following page shows how radar line of sight is determined, together with the various terms used in the analysis:

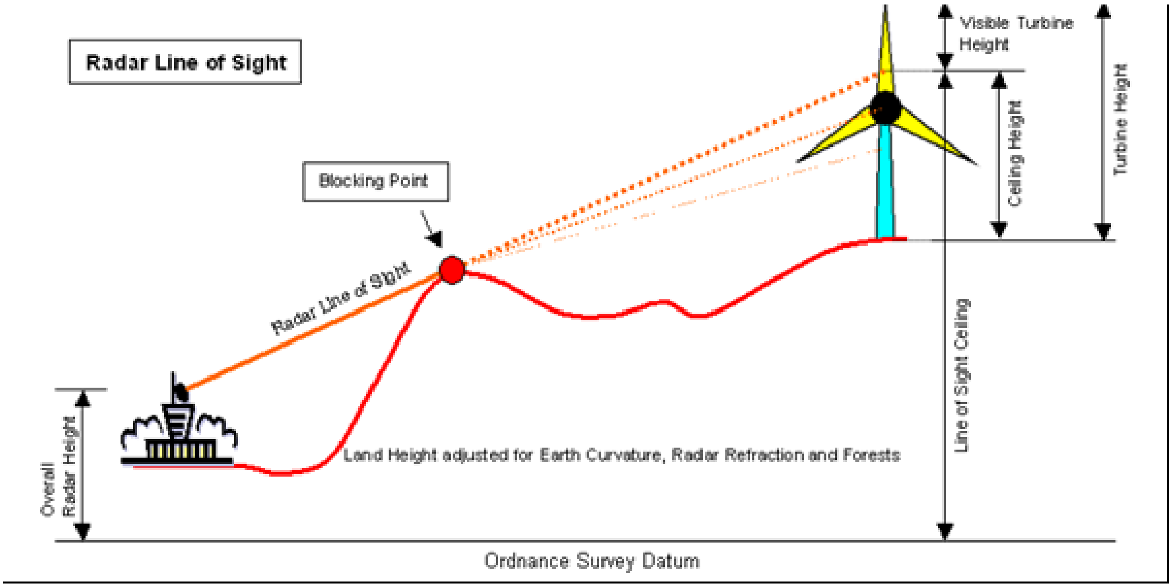

Figure 4 LOS diagram

4.3 Turbine Height

Higher wind turbines are more likely to be detected by radar than lower ones.

4.4 Earth Curvature

Curvature of the Earth limits the distance at which objects can be detected, using visual and radar techniques.

The effect of Earth Curvature increases as the separation between radar and wind turbine increases.

The effect of Earth Curvature is calculated by determining the vertical separation of two lines running between the radar and wind turbine.

The first is the arc of the great circle that passes through the radar and wind turbine. This is the shortest arc between the two points.

The second is the chord between the radar and wind turbine. This line cuts through the Earth's surface.

A curve representing the distance between the Earth's surface and the straight line is plotted. This is shown on Land Profile charts denoted as 'Earth Curvature'.

4.5 Radar Signal Refraction

Radar signals travel in straight lines in free space. Variations in the atmosphere cause bending of radar signals. This bending is caused by lower denser air having a higher refractive index than higher less dense air.

The result of this bending is that effective radar range is extended beyond the visible horizon. Radar system designers compensate for this effect by using a larger effective Earth Radius in their calculations. This compensation allows radar signals to be treated as straight lines, even though they are actually being refracted.

The Earth Radius is multiplied by a refraction constant k to give an increased effective Earth Radius. The standard figure used for k is 4/3. This value is known as Standard Refraction.

The Earth Curvature curve is redrawn, by recalculating each point using the adjusted Earth radius. This is shown on the Land Profile charts denoted as ‘Curvature with Refraction’, and has been used for this analysis.

4.6 Land Height Profile

A Land Height Profile is generated by determining the height of a series of equally spaced points along the line between the radar and a single wind turbine. The Digital Terrain Model (DTM) data used has the following characteristics:

DTM Model	Characteristics
DTM data source origin	Ordnance Survey
DTM data point interval / m	50
DTM height data resolution	1 metre

Table 13 *Digital terrain model characteristics*

The height of a specific point is calculated by taking an average of the height values of the four surrounding DTM data points. The average is weighted using interpolation in both X (Easting) and Y (Northing) directions.

The Land Height Profile is shown on Land Profile charts denoted as ‘Land Height’.

4.7 Adjusted Land Height Profile

The Adjusted Land Height Profile takes Earth Curvature and Radar Refraction into account.

It is calculated by adding the ‘Land Height’ curve, the ‘Earth Curvature with compensation for Radar Refraction’ curve.

This is shown on Land Profile charts denoted as ‘Land Height adjusted for Earth Curvature and Radar Refraction’.

4.8 Radar Line of Sight

The Radar Line of Sight is determined by taking the straight line which:

- originates at the radiation centre of the radar;
- has the highest tangent with the Adjusted Land Height Profile; and
- passes through or over the wind turbine.

4.9 Ceiling Height

The Ceiling Height is the height above ground level of the point at which the Line of Sight passes the wind turbine.

4.10 Visible Turbine Height

The Visible Turbine Height is the vertical distance between the point at which the Line of Sight passes the wind turbine, and the top of the wind turbine.

[Visible Turbine Height] = [Turbine Height] - [Ceiling Height]

If the Line of Sight passes below the top of the Wind Turbine then Visible Turbine Height is positive.

If the Line of Sight passes above the top of the Wind Turbine then Visible Turbine Height is negative.

4.11 Blocking Point

The Predominant Blocking Point is defined as the point at which the Radar Line of Sight is tangential to the Adjusted Land Height Profile.

The Blocking Point is the piece of land that physically prevents or limits the radar's detection of the wind turbine.

If a wind turbine lies in the shadow cast by the Predominant Blocking Point, the radar, discounting weak diffraction effects, cannot detect it.

4.12 Land Profile Charts

These show the Line of Sight between the radar and a wind turbine.

The horizontal scale shows the distance between the radar and the wind turbine in kilometres. 0 km at the left hand side corresponds to the radar location. The right hand end of the scale represents the point in the wind farm.

The vertical scale shows land height in metres. All heights are with reference to the Ordnance Survey datum.

5 LINE OF SIGHT RESULTS

On the following pages the LOS diagram for turbine one is displayed from each radar assessed.

5.1 Lowther Hill PSR LOS

Radar Impact Assessment
LOS Lowther Hill PSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	**1**
Hub Height /m	**80**
Rotor Diameter /m	**90**
Turbine Height /m	**125**
Turbine Grid Reference	**E269539 N611439**
Turbine Land Height /m	**272.5**
Blocking Point Grid Reference	**E269539 N611439**
Blocking Point Adjusted Land Height /m	**272.5**
Distance from Turbine to Radar /km	**19.5**
Distance from Turbine to Blocking Point /km	**0.0**
Amount of turbine visible /m	**125.0**

Lowther Hill PSR (NATS)
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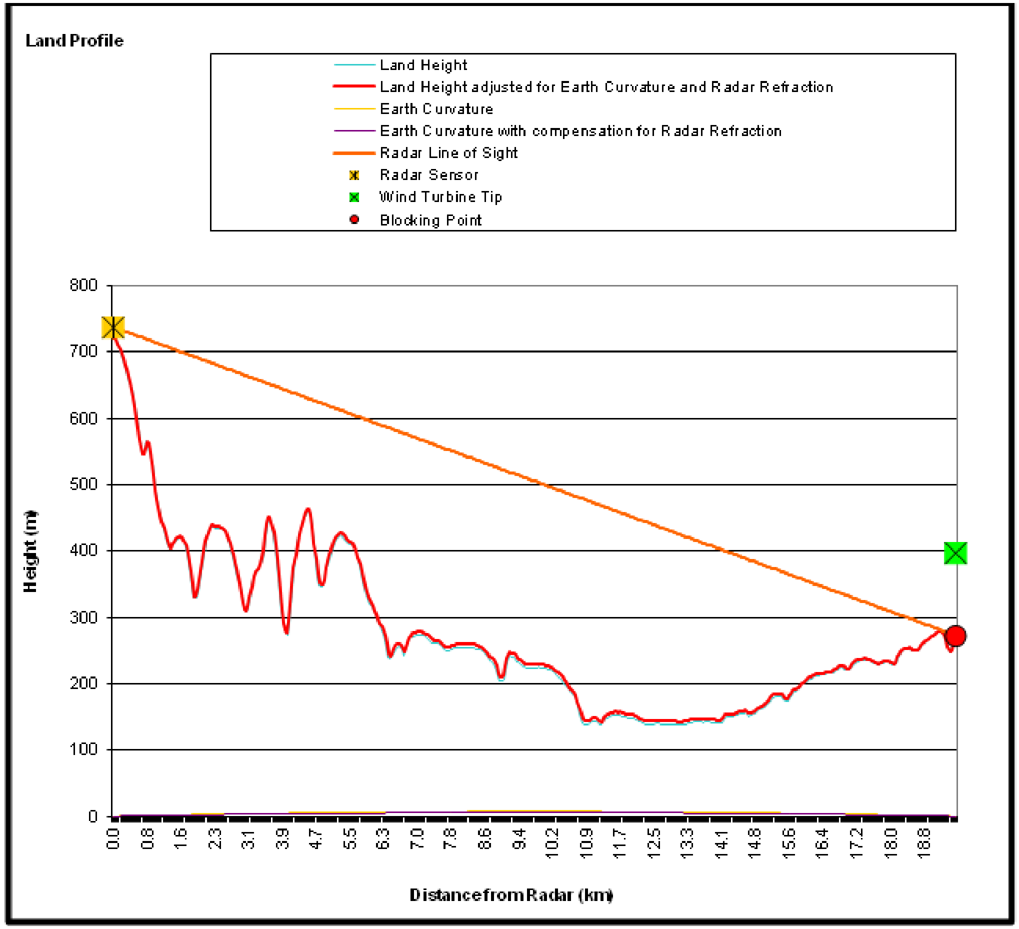

Figure 5 *Line of sight between Lowther Hill PSR and the Proposed Development*

The line of sight assessment shows that turbine 1 is fully visible to the radar.

5.2 Lowther Hill SSR LOS

Radar Impact Assessment
LOS Lowther Hill SSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E269539 N611439
Blocking Point Adjusted Land Height /m	272.5
Distance from Turbine to Radar /km	19.5
Distance from Turbine to Blocking Point /km	0.0
Amount of turbine visible /m	125.0

Lowther Hill SSR (NATS)

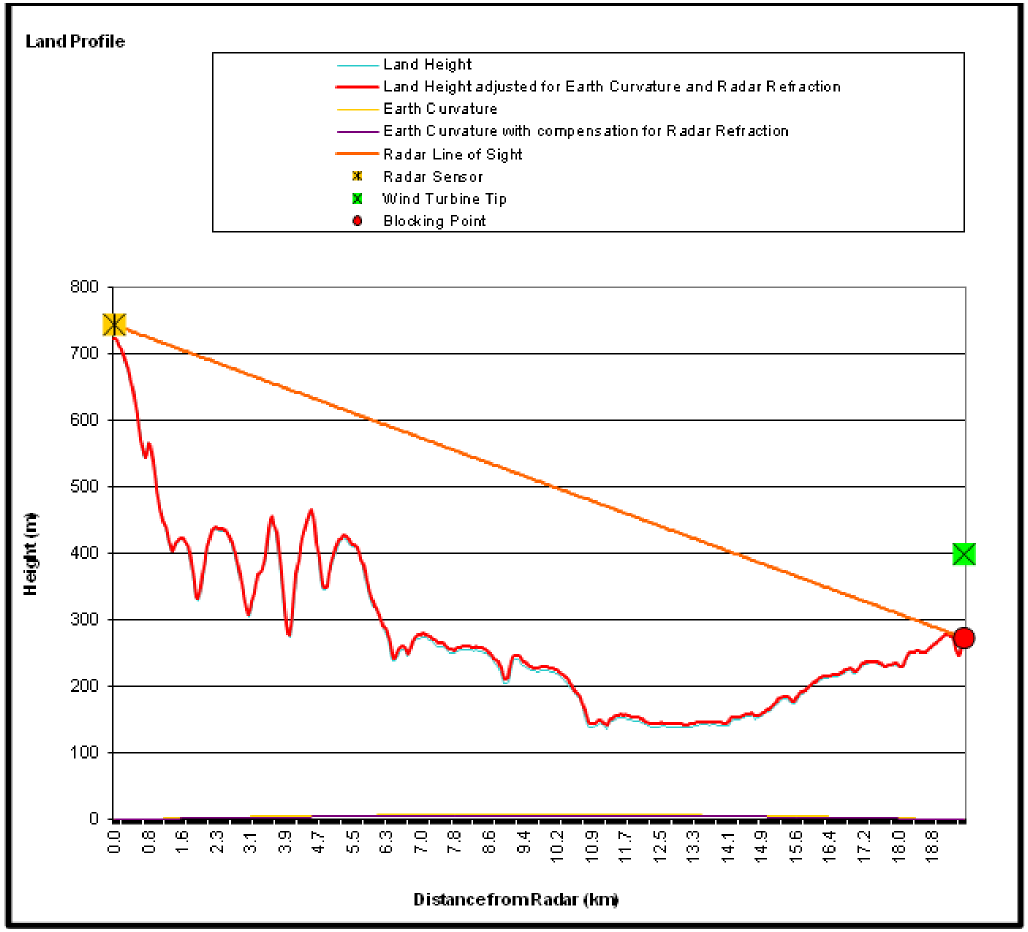

Figure 6 *Line of sight between Lowther Hill SSR and the Proposed Development*

The line of sight assessment shows that turbine 1 is fully visible to the radar.

5.3 Prestwick Airport PSR LOS

Radar Impact Assessment
LOS Prestwick PSR
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by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E248361 N620959
Blocking Point Adjusted Land Height /m	176.6
Distance from Turbine to Radar /km	35.8
Distance from Turbine to Blocking Point /km	23.2
Amount of turbine visible /m	-40.9

Glasgow Prestwick PSR

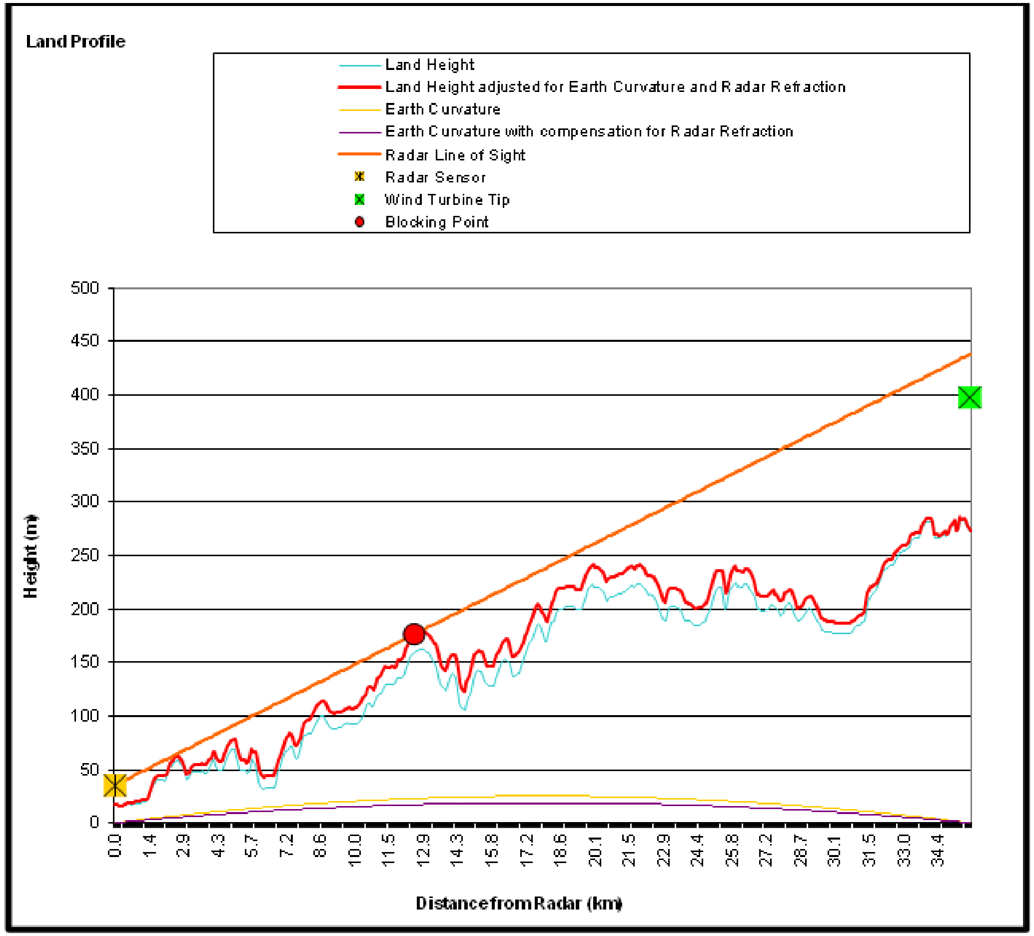

Figure 7 *Line of sight between Prestwick Airport PSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 40.9 m.

5.4 Glasgow Airport PSR LOS

Radar Impact Assessment
LOS Glasgow PSR
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Turbine Reference	**1**
Hub Height /m	**80**
Rotor Diameter /m	**90**
Turbine Height /m	**125**
Turbine Grid Reference	**E269539 N611439**
Turbine Land Height /m	**272.5**
Blocking Point Grid Reference	**E253973 N651295**
Blocking Point Adjusted Land Height /m	**316.2**
Distance from Turbine to Radar /km	**60.0**
Distance from Turbine to Blocking Point /km	**42.8**
Amount of turbine visible /m	**-643.5**

Glasgow PSR

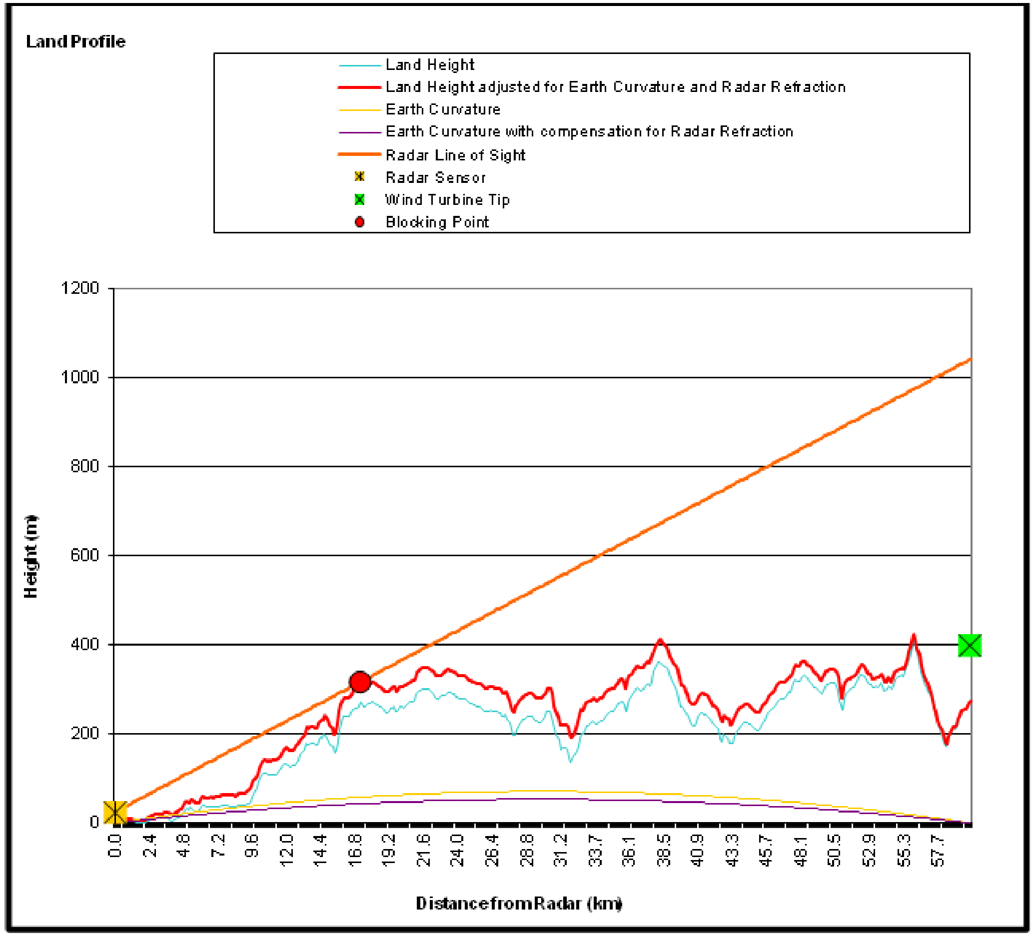

Figure 8 *Line of sight between Glasgow PSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 643.5 m.

5.5 Glasgow Airport SSR LOS

Radar Impact Assessment
LOS Glasgow SSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	**1**
Hub Height /m	**80**
Rotor Diameter /m	**90**
Turbine Height /m	**125**
Turbine Grid Reference	**E269539 N611439**
Turbine Land Height /m	**272.5**
Blocking Point Grid Reference	**E253973 N651295**
Blocking Point Adjusted Land Height /m	**316.2**
Distance from Turbine to Radar /km	**60.0**
Distance from Turbine to Blocking Point /km	**42.8**
Amount of turbine visible /m	**-636.3**

Glasgow SSR

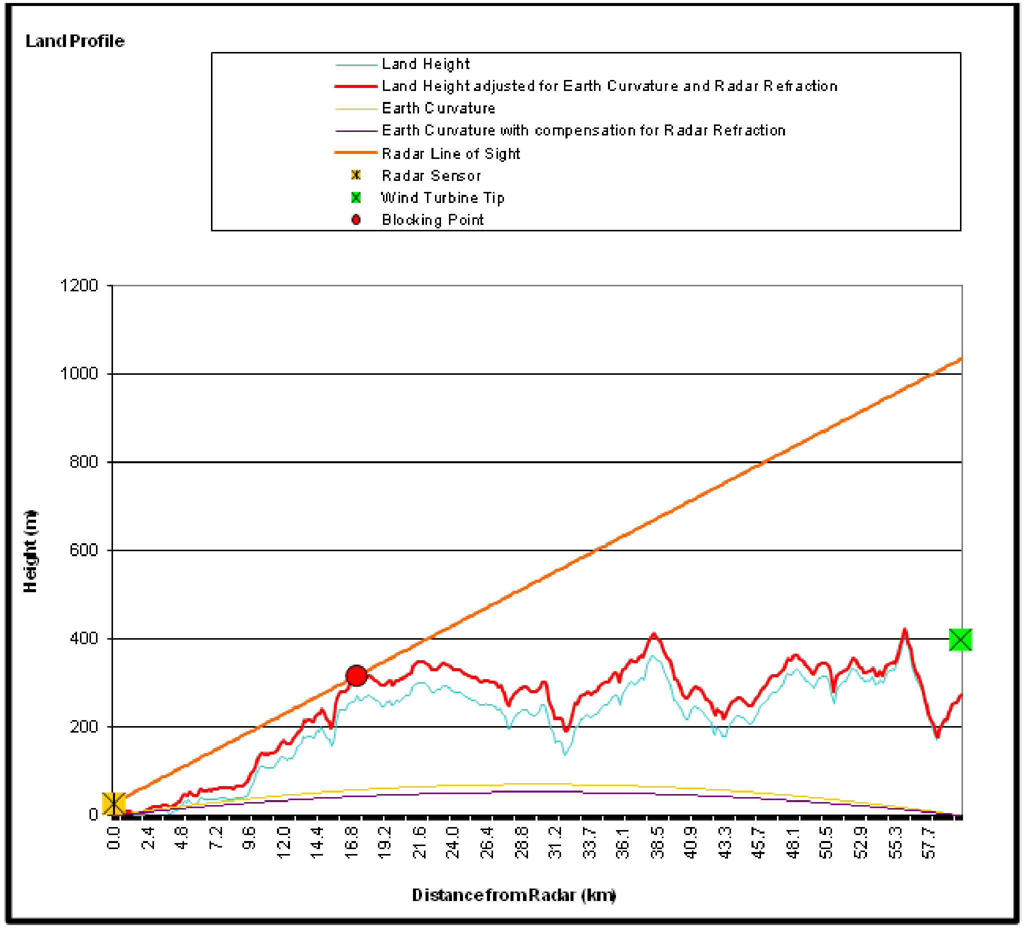

Figure 9 *Line of sight between Glasgow SSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 636.3 m.

5.6 Edinburgh Airport PSR LOS

Radar Impact Assessment
LOS Edinburgh PSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E308282 N665994
Blocking Point Adjusted Land Height /m	215.1
Distance from Turbine to Radar /km	76.8
Distance from Turbine to Blocking Point /km	66.9
Amount of turbine visible /m	-926.9

Edinburgh Airport PSR

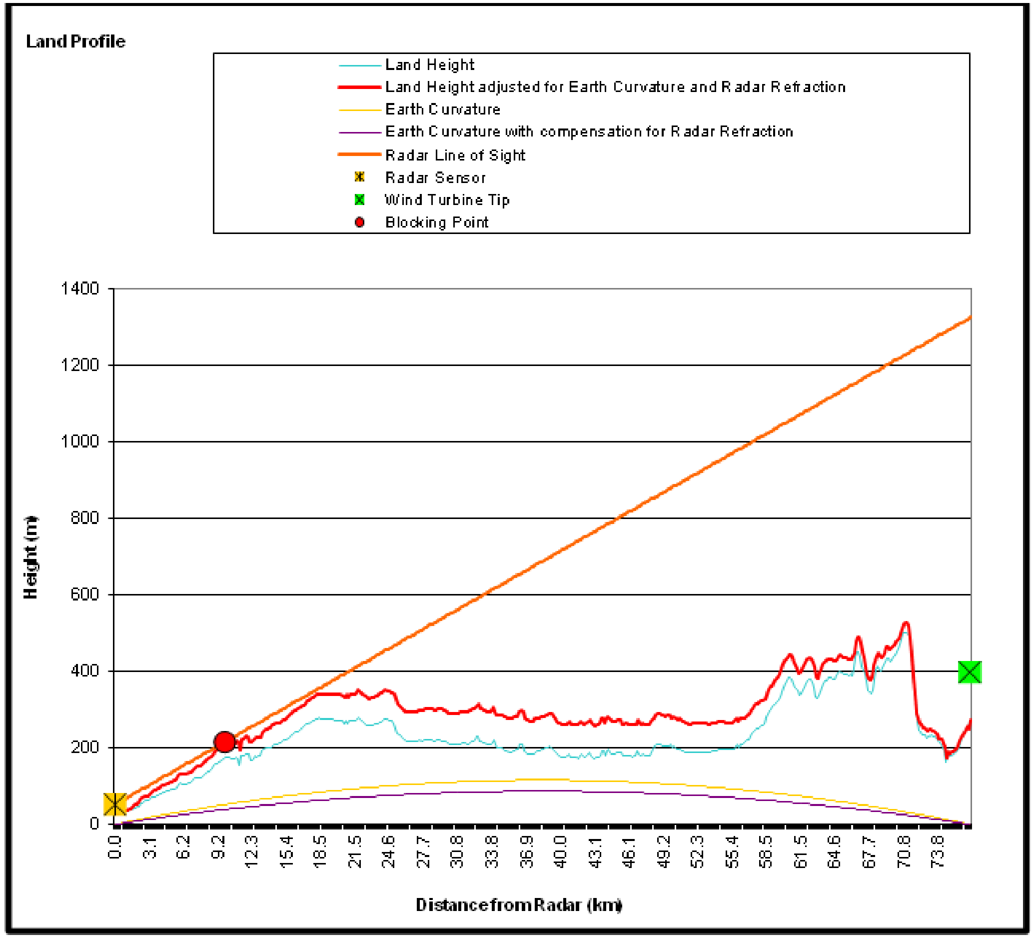

Figure 10 *Line of sight between Edinburgh PSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 926.9 m.

5.7 Edinburgh Airport SSR LOS

Radar Impact Assessment
LOS Edinburgh SSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E308282 N665994
Blocking Point Adjusted Land Height /m	215.1
Distance from Turbine to Radar /km	76.8
Distance from Turbine to Blocking Point /km	66.9
Amount of turbine visible /m	-905.8

Edinburgh Airport SSR

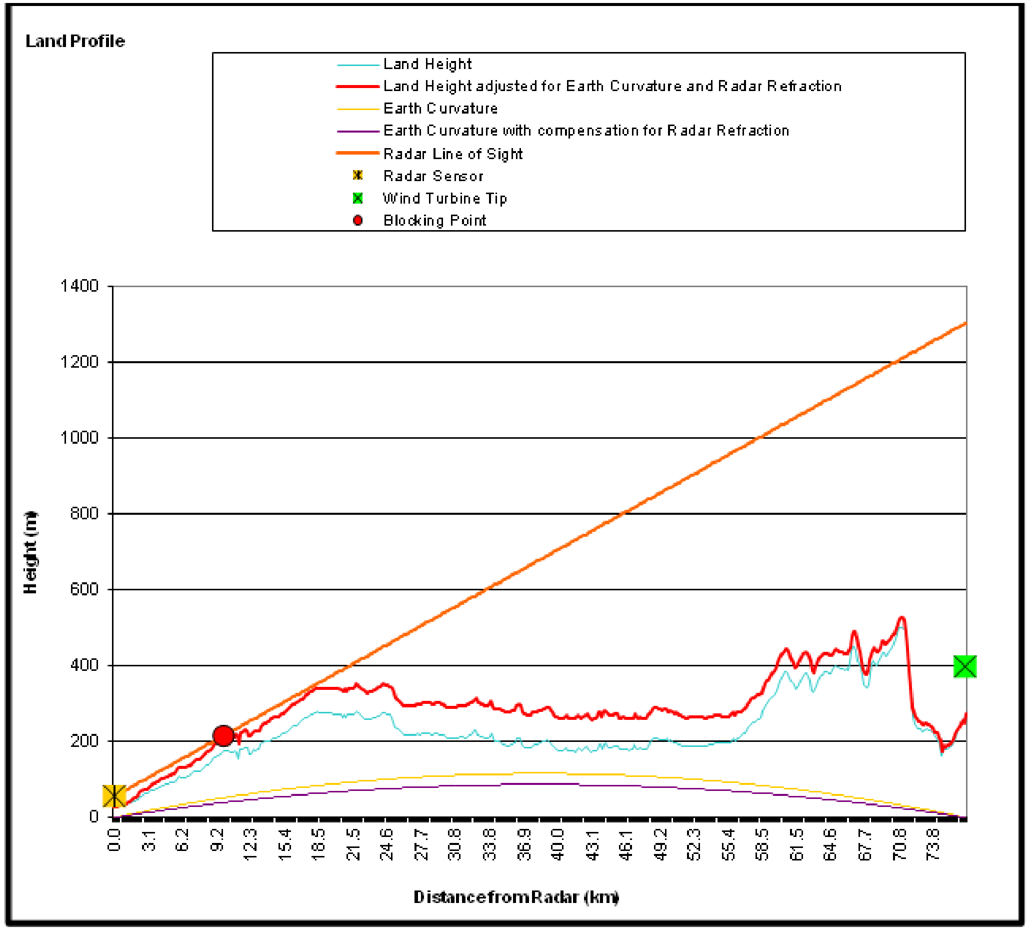

Figure 11 *Line of sight between Edinburgh SSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 905.8 m.

5.8 Spadeadam (Deadwater Fell) PSR LOS

Radar Impact Assessment
LOS Spadeadam Deadwater Fell PSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E345574 N599767
Blocking Point Adjusted Land Height /m	668.2
Distance from Turbine to Radar /km	94.1
Distance from Turbine to Blocking Point /km	76.9
Amount of turbine visible /m	-637.8

Spadeadam - Deadwater South
(on Deadwater Fell) PSR (RAF)

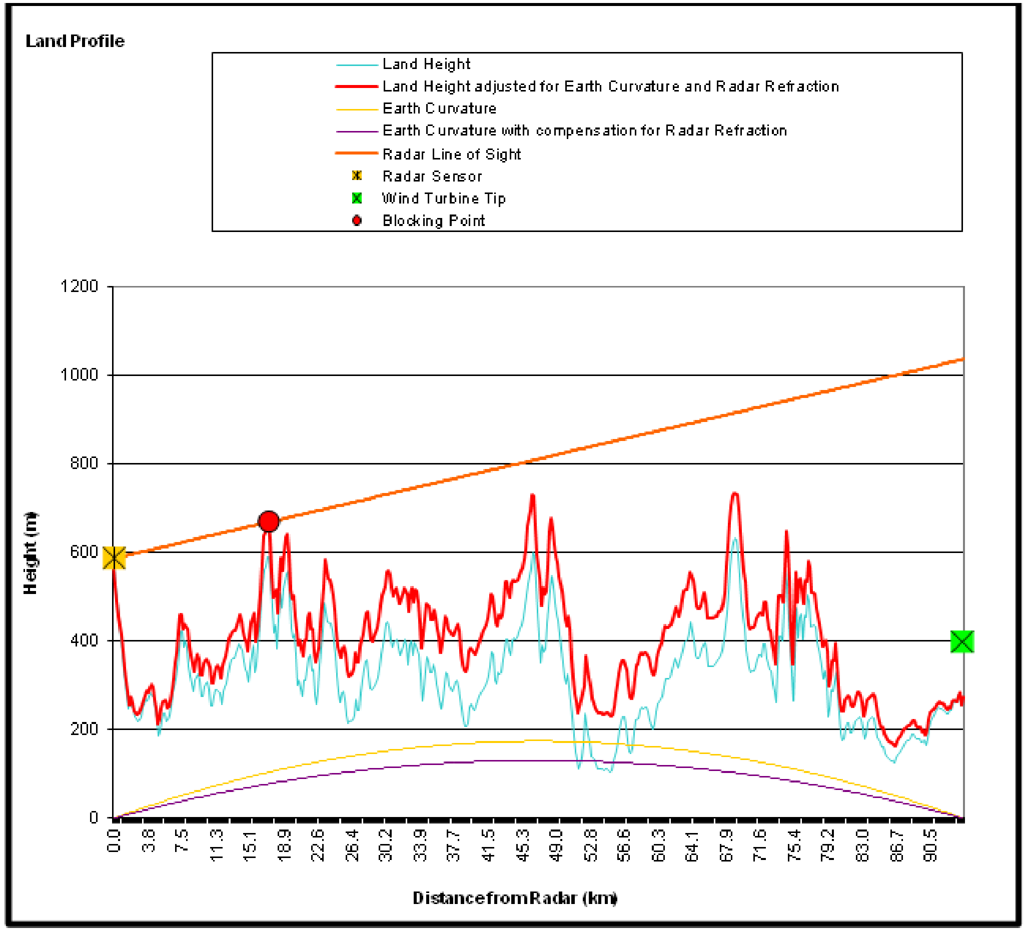

Figure 12 *Line of sight between Deadwater Fell PSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 637.8 m

5.9 Spadeadam (Deadwater Fell) SSR LOS

Radar Impact Assessment
LOS Spadeadam Deadwater Fell SSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	397.5
Blocking Point Grid Reference	E345574 N599767
Blocking Point Adjusted Land Height /m	668.2
Distance from Turbine to Radar /km	94.1
Distance from Turbine to Blocking Point /km	76.9
Amount of turbine visible /m	-512.4

Spadeadam - Deadwater South
(on Deadwater Fell) SSR (RAF)
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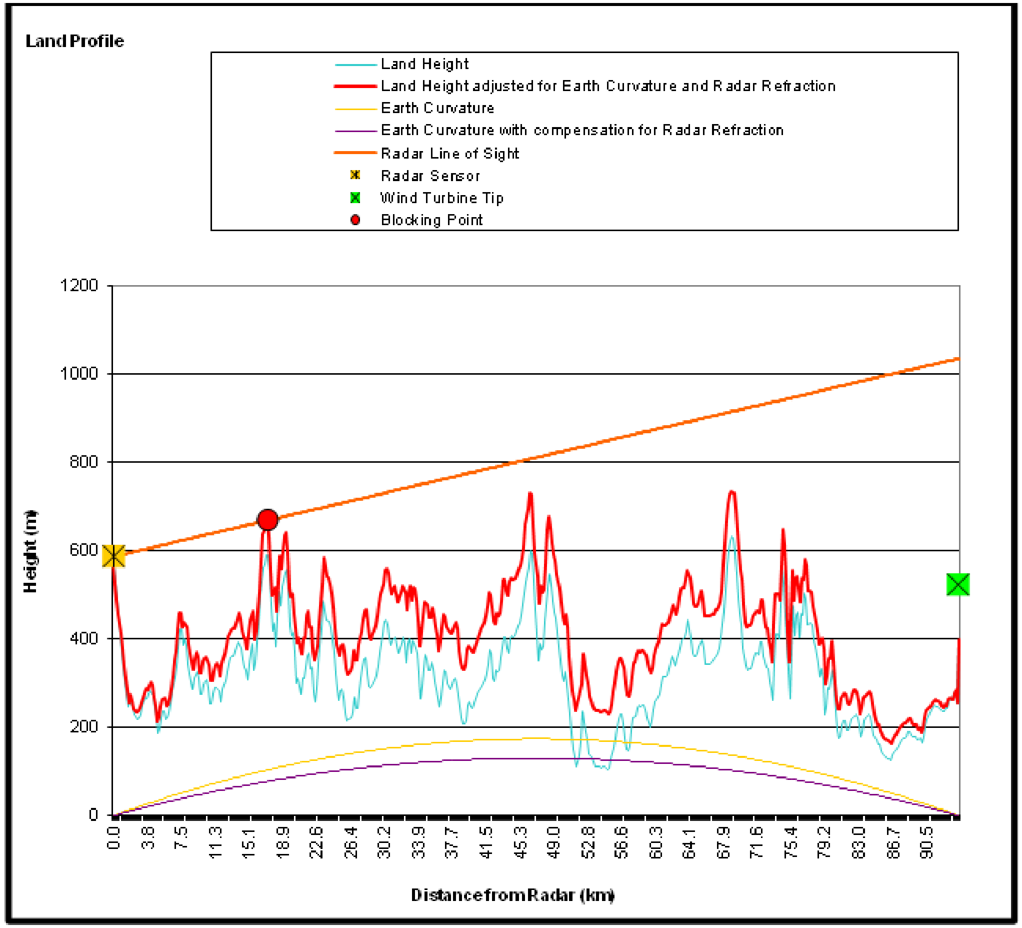

Figure 13 *Line of sight between Deadwater Fell SSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 512.4 m.

5.10 Spadeadam (Berry Hill) PSR LOS

Radar Impact Assessment
LOS Spadeadam Berry hill PSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E360525 N574736
Blocking Point Adjusted Land Height /m	366.2
Distance from Turbine to Radar /km	102.6
Distance from Turbine to Blocking Point /km	98.1
Amount of turbine visible /m	-1380.9

Spadeadam - Berry Hill PSR (RAF)

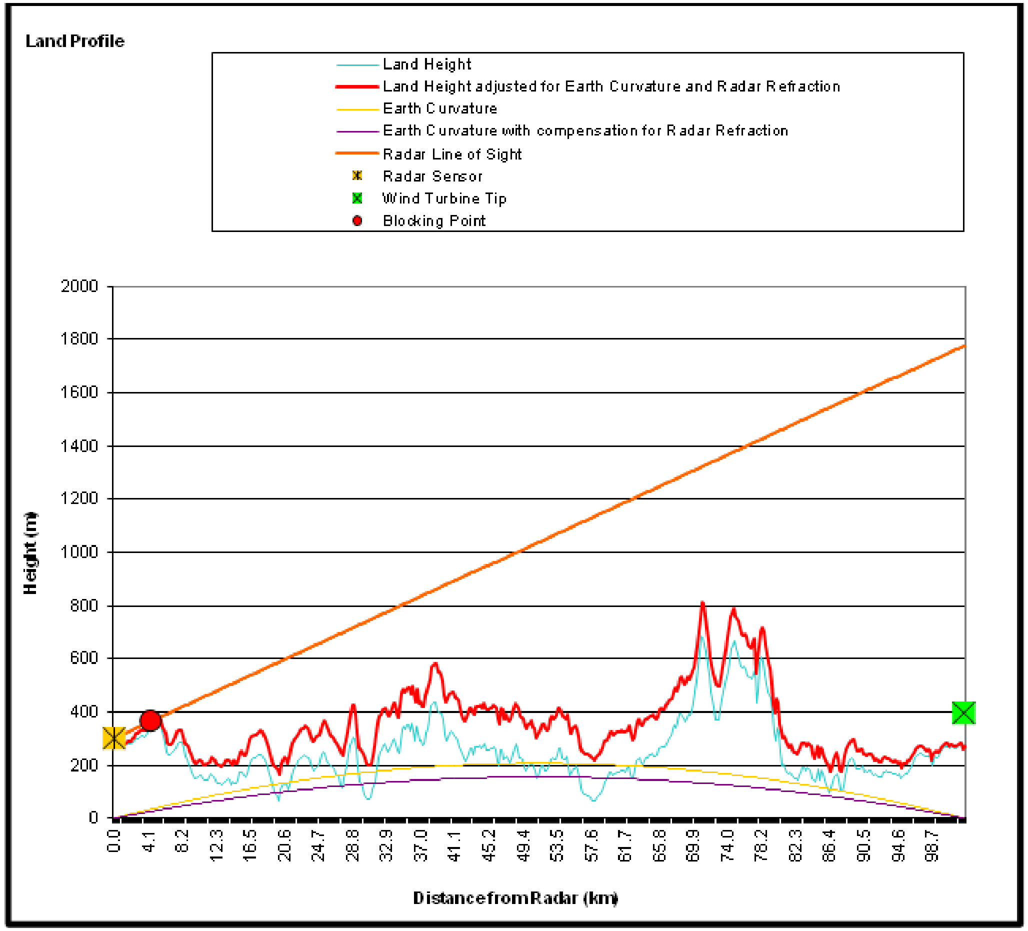

Figure 14 *Line of sight between Berry Hill PSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 1380.9 m.

5.11 Spadeadam (Berry Hill) SSR LOS

Radar Impact Assessment
LOS Spadeadam Berry hill SSR
Prepared for WSP Environment and Energy
by Pager Power Limited

Turbine Reference	1
Hub Height /m	80
Rotor Diameter /m	90
Turbine Height /m	125
Turbine Grid Reference	E269539 N611439
Turbine Land Height /m	272.5
Blocking Point Grid Reference	E298936 N599677
Blocking Point Adjusted Land Height /m	813.0
Distance from Turbine to Radar /km	99.4
Distance from Turbine to Blocking Point /km	31.7
Amount of turbine visible /m	-627.1

Spadeadam - Berry Hill SSR (RAF)

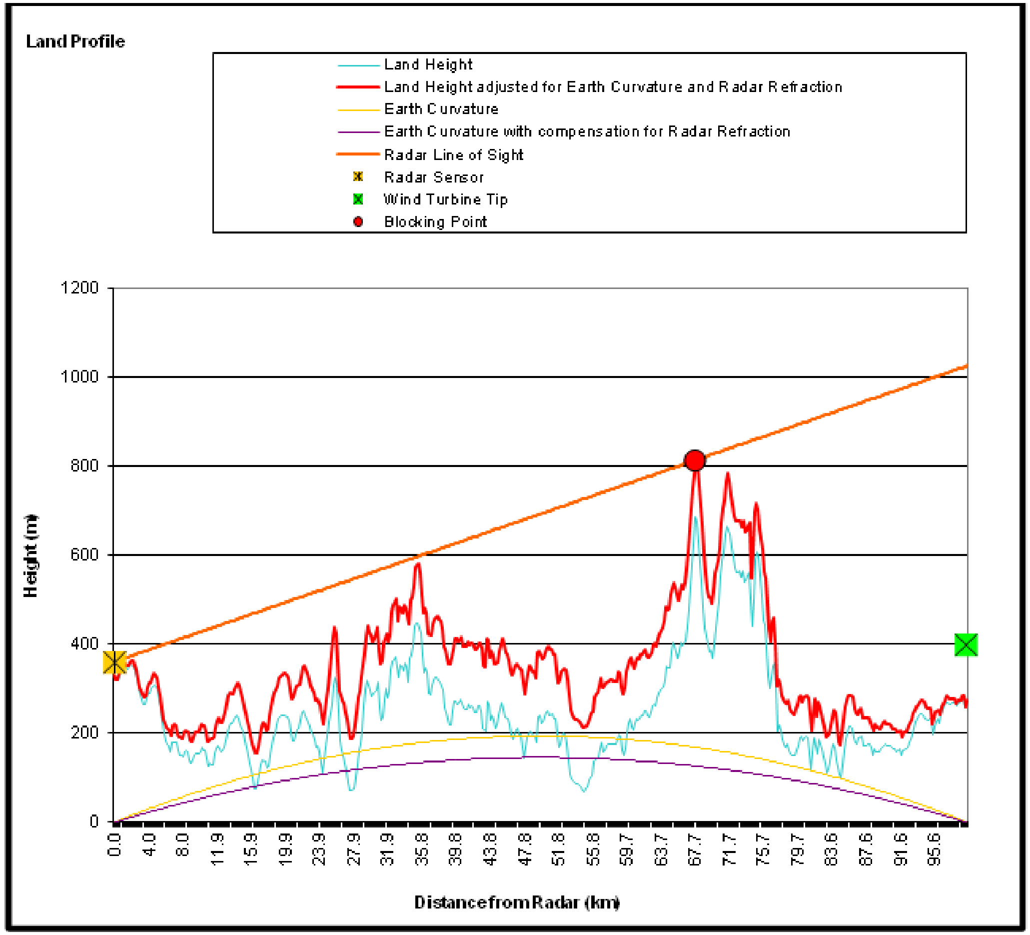

Figure 15 *Line of sight between Berry Hill SSR and the Proposed Development*

The line of sight assessment shows that the turbine is below the LOS by 627.1 m.

5.12 LOS Summary for Lowther Hill's PSR & SSR

The table bellows presents all of the LOS results from the assessments:

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
1	125	Fully Visible	125	Fully Visible
2	125	Fully Visible	125	Fully Visible
3	125	Fully Visible	125	Fully Visible
4	125	Fully Visible	125	Fully Visible
5	125	Fully Visible	125	Fully Visible
6	125	Fully Visible	125	Fully Visible
7	125	Fully Visible	125	Fully Visible
8	125	Fully Visible	125	Fully Visible
9	125	Fully Visible	125	Fully Visible
10	125	Fully Visible	125	Fully Visible
11	125	Fully Visible	125	Fully Visible
12	125	Fully Visible	125	Fully Visible
13	125	Fully Visible	125	Fully Visible
14	125	Fully Visible	125	Fully Visible
15	125	Fully Visible	125	Fully Visible
16	125	Fully Visible	125	Fully Visible
17	125	Fully Visible	125	Fully Visible
18	125	Fully Visible	125	Fully Visible
19	125	Fully Visible	125	Fully Visible
20	125	Fully Visible	125	Fully Visible
21	125	Fully Visible	125	Fully Visible
22	125	Fully Visible	125	Fully Visible

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
23	125	Fully Visible	125	Fully Visible
24	125	Fully Visible	125	Fully Visible
25	125	Fully Visible	125	Fully Visible
26	125	Fully Visible	125	Fully Visible
27	125	Fully Visible	125	Fully Visible
28	125	Fully Visible	125	Fully Visible
29	125	Fully Visible	125	Fully Visible
30	125	Fully Visible	125	Fully Visible

Table 14 *Lowther Hill LOS summary*

5.13 LOS Summary for Prestwick Airport's PSR

	PSR				
Turbine	**Visibility (m)**	**Visibility**	**Turbine**	**Visibility (m)**	**Visibility**
1	-40.9	Not visible	16	3.7	Visible
2	-16.5	Not visible	17	-48.9	Not visible
3	-2.0	Not visible	18	-37.2	Not visible
4	26.2	Visible	19	-22.1	Not visible
5	42.4	Visible	20	1.8	Visible
6	71.3	Visible	21	4.2	Visible
7	44.1	Visible	22	-12.3	Not visible
8	-5.5	Not visible	23	-33.7	Not visible
9	-33.3	Not visible	24	-55.8	Not visible
10	-7.9	Not visible	25	-47.1	Not visible
11	47.3	Visible	26	-56.8	Not visible
12	0.9	Visible	27	-66.5	Not visible
13	-41.4	Not visible	28	-73.8	Not visible
14	-26.2	Not visible	29	-61.6	Not visible
15	-1.0	Not visible	30	-73.9	Not visible

Table 15 Prestwick Airport LOS *summary*

5.14 LOS Summary for Glasgow Airport's PSR and SSR

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
1	-643.5	Not Visible	-636.3	Not Visible
2	-592.1	Not Visible	-584.9	Not Visible
3	-574.9	Not Visible	-567.3	Not Visible
4	-556.1	Not Visible	-549.2	Not Visible
5	-537.7	Not Visible	-530.8	Not Visible
6	-530.7	Not Visible	-523.7	Not Visible
7	-524.9	Not Visible	-517.9	Not Visible
8	-559.6	Not Visible	-552.5	Not Visible
9	-618.3	Not Visible	-610.9	Not Visible
10	-588.7	Not Visible	-581.3	Not Visible
11	-524.2	Not Visible	-517.2	Not Visible
12	-540.2	Not Visible	-533.2	Not Visible
13	-640.4	Not Visible	-632.9	Not Visible
14	-615.5	Not Visible	-608.1	Not Visible
15	-589.6	Not Visible	-582.1	Not Visible
16	-564.4	Not Visible	-556.9	Not Visible
17	-626.4	Not Visible	-619.0	Not Visible
18	-626.1	Not Visible	-618.6	Not Visible
19	-605.7	Not Visible	-598.2	Not Visible
20	-596.9	Not Visible	-589.4	Not Visible
21	-590.5	Not Visible	-582.9	Not Visible
22	-602.9	Not Visible	-595.3	Not Visible
23	-603.1	Not Visible	-595.5	Not Visible

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
24	-621.3	Not Visible	-613.5	Not Visible
25	-608.2	Not Visible	-600.5	Not Visible
26	-627.3	Not Visible	-619.6	Not Visible
27	-637.6	Not Visible	-629.9	Not Visible
28	-648.0	Not Visible	-640.4	Not Visible
29	-632.3	Not Visible	-624.7	Not Visible
30	-653.1	Not Visible	-645.4	Not Visible

Table 16 Glasgow Airport *LOS summary*

5.15 LOS Summary for Edinburgh Airport’s PSR and SSR

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
1	-926.9	Not Visible	-905.8	Not Visible
2	-883.8	Not Visible	-862.7	Not Visible
3	-863.9	Not Visible	-842.4	Not Visible
4	-848.7	Not Visible	-827.2	Not Visible
5	-855.4	Not Visible	-833.9	Not Visible
6	-827.6	Not Visible	-806.1	Not Visible
7	-809.9	Not Visible	-788.3	Not Visible
8	-829.7	Not Visible	-808.2	Not Visible
9	-927.3	Not Visible	-906.1	Not Visible
10	-914.3	Not Visible	-893.1	Not Visible
11	-864.0	Not Visible	-842.4	Not Visible
12	-868.7	Not Visible	-847.2	Not Visible
13	-958.9	Not Visible	-937.7	Not Visible
14	-961.1	Not Visible	-939.6	Not Visible
15	-947.8	Not Visible	-926.3	Not Visible
16	-937.8	Not Visible	-916.3	Not Visible
17	-997.8	Not Visible	-976.7	Not Visible
18	-1002.2	Not Visible	-980.7	Not Visible
19	-999.7	Not Visible	-978.2	Not Visible
20	-974.2	Not Visible	-952.7	Not Visible
21	-975.2	Not Visible	-953.3	Not Visible
22	-1011.5	Not Visible	-989.9	Not Visible
23	-1033.3	Not Visible	-1011.7	Not Visible

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
24	-1057.9	Not Visible	-1036.4	Not Visible
25	-1029.5	Not Visible	-1008.0	Not Visible
26	-1037.9	Not Visible	-1016.8	Not Visible
27	-1080.7	Not Visible	-1059.6	Not Visible
28	-1075.4	Not Visible	-1054.3	Not Visible
29	-1025.3	Not Visible	-1004.2	Not Visible
30	-1052.2	Not Visible	-1031.0	Not Visible

Table 17 Edinburgh Airport *LOS summary*

5.16 Spadeadam (Deadwater Fell) Airport's PSR and SSR

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
1	-637.8	Not Visible	-512.4	Not Visible
2	-615.4	Not Visible	-489.9	Not Visible
3	-584.6	Not Visible	-459.1	Not Visible
4	-546.2	Not Visible	-420.8	Not Visible
5	-495.3	Not Visible	-369.8	Not Visible
6	-454.5	Not Visible	-329.1	Not Visible
7	-417.1	Not Visible	-291.7	Not Visible
8	-405.0	Not Visible	-279.6	Not Visible
9	-611.4	Not Visible	-486.0	Not Visible
10	-558.4	Not Visible	-432.9	Not Visible
11	-439.9	Not Visible	-314.5	Not Visible
12	-426.6	Not Visible	-301.2	Not Visible
13	-598.1	Not Visible	-472.6	Not Visible
14	-551.6	Not Visible	-426.2	Not Visible
15	-508.6	Not Visible	-383.2	Not Visible
16	-462.4	Not Visible	-337.0	Not Visible
17	-597.7	Not Visible	-472.2	Not Visible
18	-561.4	Not Visible	-436.0	Not Visible
19	-525.4	Not Visible	-399.9	Not Visible
20	-475.0	Not Visible	-349.5	Not Visible
21	-461.6	Not Visible	-336.1	Not Visible
22	-492.5	Not Visible	-367.0	Not Visible
23	-517.0	Not Visible	-391.5	Not Visible

	PSR		SSR	
Turbine	**Visibility (m)**	**Visibility**	**Visibility (m)**	**Visibility**
24	-551.4	Not Visible	-426.0	Not Visible
25	-575.4	Not Visible	-450.0	Not Visible
26	-598.1	Not Visible	-472.6	Not Visible
27	-586.3	Not Visible	-460.8	Not Visible
28	-616.5	Not Visible	-491.0	Not Visible
29	-633.4	Not Visible	-507.9	Not Visible
30	-651.6	Not Visible	-526.2	Not Visible

Table 18 Deadwater Fell *LOS summary*

5.17 Spadeadam (Berry Hill) Airport's PSR and SSR

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
1	-1380.9	Not Visible	-627.1	Not Visible
2	-1343.1	Not Visible	-591.3	Not Visible
3	-1309.9	Not Visible	-533.7	Not Visible
4	-1264.7	Not Visible	-444.2	Not Visible
5	-1234.2	Not Visible	-450.3	Not Visible
6	-1176.9	Not Visible	-429.1	Not Visible
7	-1149.1	Not Visible	-403.0	Not Visible
8	-1150.9	Not Visible	-397.4	Not Visible
9	-1345.6	Not Visible	-580.5	Not Visible
10	-1297.7	Not Visible	-467.6	Not Visible
11	-1174.2	Not Visible	-431.6	Not Visible
12	-1162.3	Not Visible	-420.4	Not Visible
13	-1347.0	Not Visible	-549.0	Not Visible
14	-1314.4	Not Visible	-466.9	Not Visible
15	-1256.9	Not Visible	-481.8	Not Visible
16	-1211.2	Not Visible	-460.1	Not Visible
17	-1360.0	Not Visible	-591.4	Not Visible
18	-1327.5	Not Visible	-504.9	Not Visible
19	-1290.2	Not Visible	-466.2	Not Visible
20	-1253.8	Not Visible	-467.1	Not Visible
21	-1225.8	Not Visible	-458.8	Not Visible
22	-1258.1	Not Visible	-470.4	Not Visible
23	-1290.7	Not Visible	-462.5	Not Visible

	PSR		SSR	
Turbine	Visibility (m)	Visibility	Visibility (m)	Visibility
24	-1332.8	Not Visible	-532.7	Not Visible
25	-1342.2	Not Visible	-539.5	Not Visible
26	-1369.8	Not Visible	-596.3	Not Visible
27	-1360.1	Not Visible	-583.2	Not Visible
28	-1394.6	Not Visible	-623.2	Not Visible
29	-1388.2	Not Visible	-619.4	Not Visible
30	-1412.6	Not Visible	-611.4	Not Visible

Table 19 *Berry Hill LOS summary*

5.18 Line of Sights Summary and Conclusions

Radar	Overview
Lowther Hill PSR	**All turbines are fully visible.**
Lowther Hill SSR	**All turbines are fully visible.**
Prestwick Airport PSR	**9 turbines visible and 21 are not visible.**
Glasgow PSR	**All turbines are below the LOS by a minimum of 524.2m.**
Glasgow SSR	**All turbines are below the LOS by a minimum of 517.2m.**
Edinburgh PSR	**All turbines are below the LOS by a minimum of 809.9m.**
Edinburgh SSR	**All turbines are below the LOS by a minimum of 788.3m.**
Spadeadam (Deadwater Fell) PSR	**All turbines are below the LOS by a minimum of 405.0m.**
Spadeadam (Deadwater Fell) SSR	**All turbines are below the LOS by a minimum of 279.6m.**
Spadeadam (Berry Hill) PSR	**All turbines are below the LOS by a minimum of 1149.1m.**
Spadeadam (Berry Hill) SSR	**All turbines are below the LOS by a minimum of 397.4m.**

Table 20 *All LOS summary*

The results show that the Proposed Development is in line of sight to the radars at Lowther Hill and Prestwick. For all the other radars the turbines are below the LOS. Detectability will now be undertaken for the relevant radars. Analysis will be undertaken for the Prestwick PSR because LOS has confirmed that the radar can see some of the turbines. In addition, detectability analysis will be undertaken from the Deadwater Fell PSR and Berry Hill PSR. This is because the radars are military owned and safeguarded by the MOD. The MOD undertakes their analysis based on detectability alone. Therefore to confirm that the radar will not detect the Proposed Development, detectability analysis from these radars will also be undertaken.

Detectability analysis for the Lowther Hill PSR has not been undertaken because the installation is an L-Band en-route radar and the detectability analysis is not applicable to a radar of this type. However, based on the distance from the Proposed Development and that all the turbines are fully visible to the PSR, it is likely that the Proposed Development will have an operational effect and should be treated as such.

6 RADAR DETECTABILITY ANALYSIS

Detectability analysis has been undertaken for all the relevant PSR. Detectability analysis is not possible for SSR. The detectability analysis, as described in the Civil Aviation Authority's (CAA) Civil Aviation Publication 764 1st edition (CAP 764), uses a number of radar parameters such as receiver sensitivity and down tilt, to determine whether a particular wind turbine will be detected by a particular radar. The 1st edition of CAP 764 gives typical parameters, understood to be based on an airfield surveillance radar operating in the S-band (i.e., 2-4Ghz). The radars are assumed to be fitted with a moving target indicator/ detector ('speed filter').

The following tables present the radar parameters used:

Radar	Sensitivity (dBm)	Frequency (MHz)
Prestwick PSR	-100	2,765
Spadeadam (Deadwater Fell) PSR	-123	2,765
Spadeadam (Berry Hill) PSR	-123	2,765

Table 21 *Detectability analysis – Edinburgh and Kincardine PSR parameters*

Antenna Gain – This determines how great the intensity of a signal is in a given direction. A higher value indicates a higher intensity, and therefore a stronger emitted and returned signal. Pager Power is aware that the value recommended in CAP 764 is significantly lower than the typical value for a Watchman radar, and the value has been increased accordingly. Standard CAP 764 parameters have been applied throughout the remainder of the calculation.

6.1 Results

A single radar detectability calculation has been attached in the Appendix at the end of this report. Each calculation has 5 pages with the results being shown on the final page. The results are summarised in the following tables (the positive value for detection margin indicates that the turbine will be detected):

6.2 Prestwick PSR Detectability Results

Turbine	Detection of a 125 m tip height turbine	Detection Margin (dBm)
1	Unlikely	-54.94
2	Unlikely	-43.44
3	Unlikely	-34.81
4	Unlikely	-15.02
5	Unlikely	-11.43
6	Unlikely (very marginal)	-0.09

Turbine	Detection of a 125 m tip height turbine	Detection Margin (dBm)
7	Likely (marginal)	+6.03
8	Unlikely	-47.03
9	Unlikely	-52.38
10	Unlikely	-37.47
11	Unlikely (marginal)	-6.49
12	Unlikely	-36.84
13	Unlikely	-56.15
14	Unlikely	-48.38
15	Unlikely	-38.06
16	Unlikely	-26.81
17	Unlikely	-57.81
18	Unlikely	-52.03
19	Unlikely	-44.94
20	Unlikely	-31.97
21	Unlikely	-37.03
22	Unlikely	-42.89
23	Unlikely	-50.78
24	Unlikely	-60.87
25	Unlikely	-55.88
26	Unlikely	-63.12
27	Unlikely	-65.54
28	Unlikely	-67.55
29	Unlikely	-65.76
30	Unlikely	-67.25

Table 22 *Prestwick Hill detectability analysis results*

6.3 Spadeadam (Deadwater Fell & Berry Hill) PSR Detectability Results

The detectability analysis was undertaken to ensure that the turbines were undetectable to the two military radars in the assessment. The MOD method of assessment is by detectability analysis, not solely by LOS. The results showed that the turbines would be undetectable to the radars by a very significant margin. The returns to each PSR are enough to establish that the Proposed Development will be undetectable to the radars.

6.4 Summary

Detectability analysis as described in the Civil Aviation Authority's (CAA) Civil Aviation Publication 764 1st edition (CAP 764) has been undertaken for the Proposed Development from the three relevant PSRs, namely Prestwick, Spadeadam Deadwater Fell and Spadeadam Berry Hill. A detectability margin of -25dBm is considered significant enough to confirm if a turbine is realistically likely to be undetected by a radar. Between -25dBm and 0dBm, the certainty decreases. It has been concluded that up to 3 turbines could be detectable to Prestwick Airport's PSR and none will be detectable to the PSRs at Deadwater Fell or Berry Hill.

In regards to the Lowther Hill PSR, even though detectability analysis for this radar type is not possible, it is likely that the Proposed Development will be detectable and therefore have a adverse operational effect upon the radar due to the distance between the radar and full visibility of all the turbines.

7 DESK TOP ANALYSIS OF ADDITIONAL SHIELDING

7.1 Desk Based Additional Shielding Analysis

Additional shielding analysis has been undertaken along the LOS from Lowther Hill and PSR and SSR and the PSR at Prestwick. It has not been undertaken from any of the other radar because the turbines are already well shielded from the radar's LOS.

7.2 Desk Based Additional Shielding Analysis for Lowther Hill

The line of sight from the PSR to the Proposed Development location has been assessed. The blocking point for all 30 lines of sight is at the base of the turbine and the terrain is also very similar, therefore only one LOS has been assessed (the LOS for turbine 1). A check of aerial photography and online mapping resources has identified two areas of elevated terrain beneath the line of sight profile. Area 1 is around the location of the radar and area two is approximately at the base of the turbine where the blocking point is also located. These areas are highlighted on the diagram below:

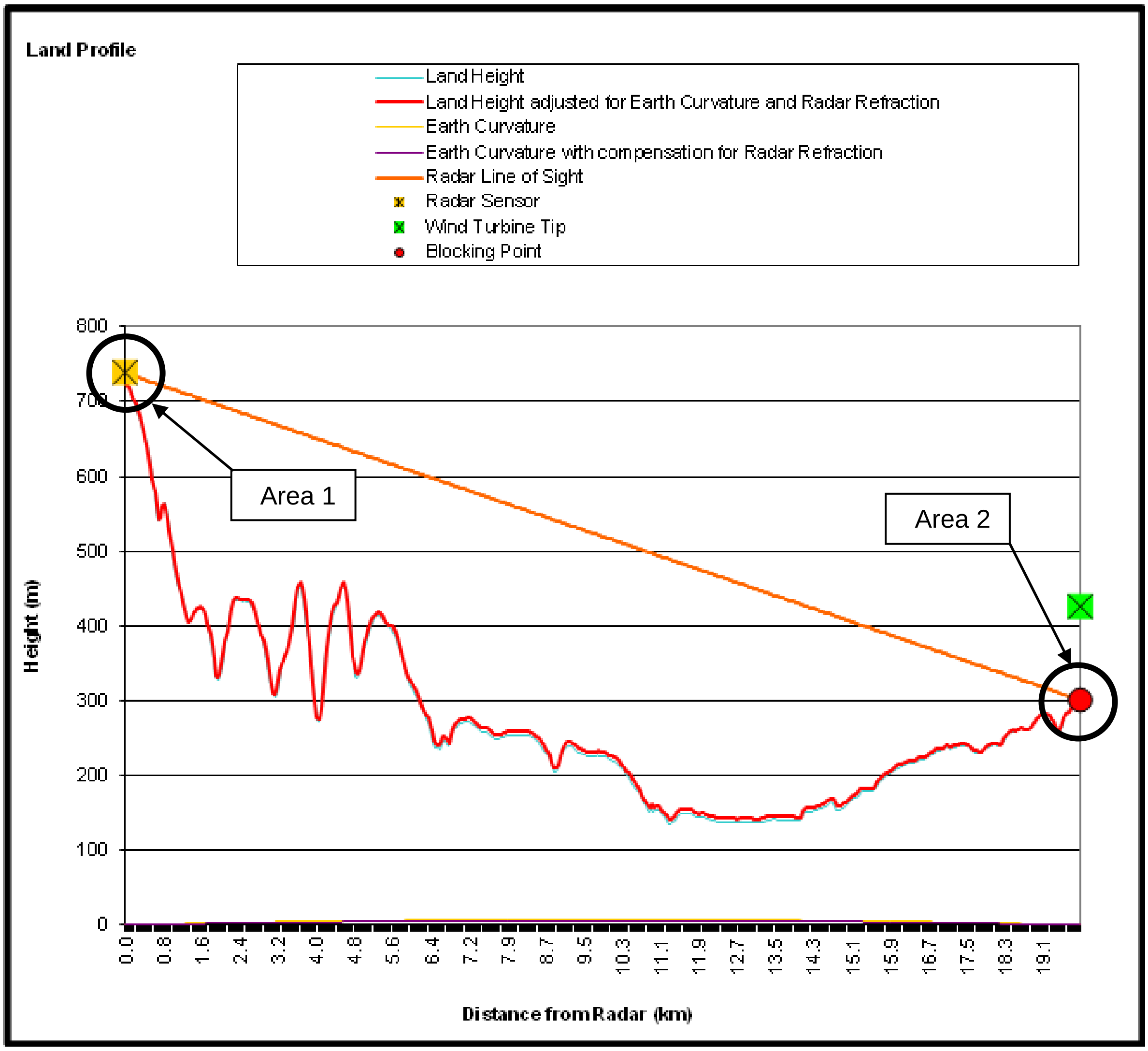

Figure 16 *Possible location of additional shielding along the line of sight path for Lowther Hill*

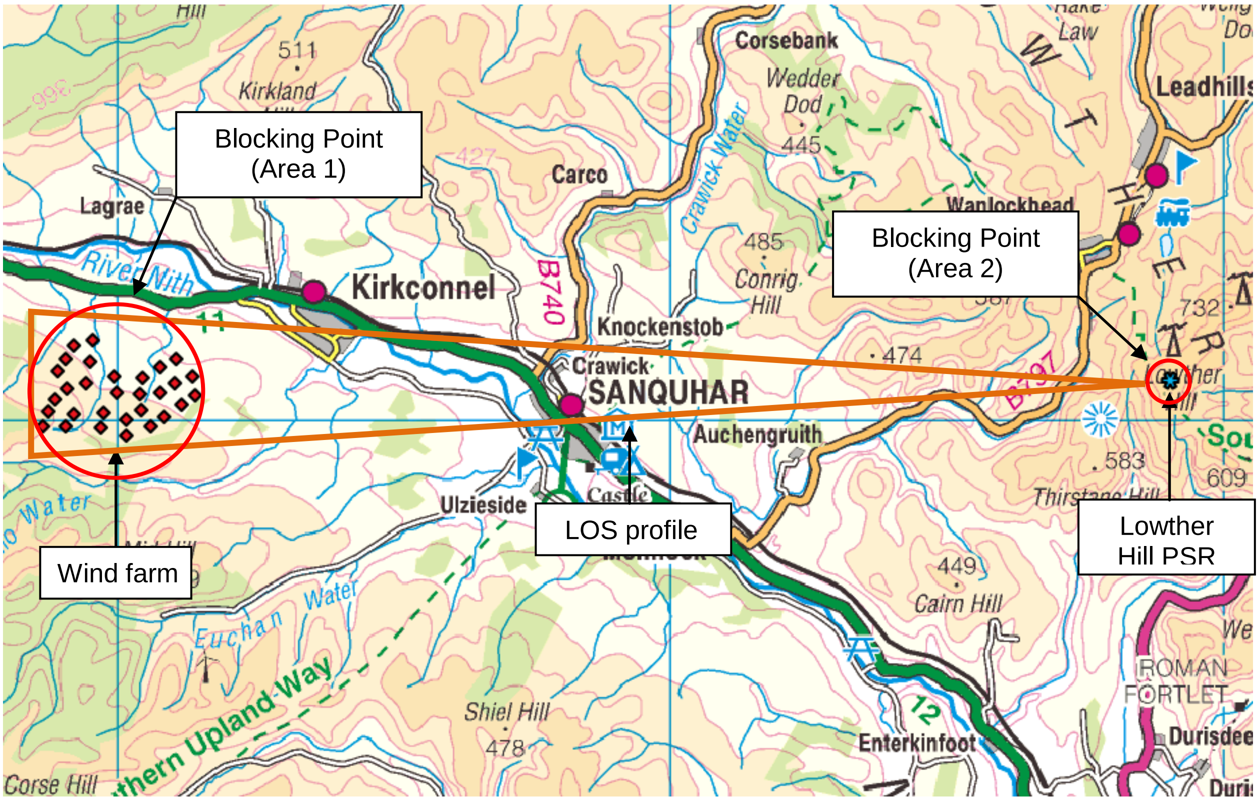

Figure 17 *LOS profile on a map for Lowther Hill*

A review of the LOS of has revealed that there will be no significant additional shielding along the LOS.

7.3 Desk Based Additional Shielding Analysis for Prestwick PSR

The line of sight from the PSR to the Proposed Development location has been assessed. Only the turbines which are visible and have produced a detectability analysis result of >-25dB have been analysed. This means that turbines **4**,**5**,**6**,**7** and **11** have been assessed. Below are the relevant LOS profiles for each of the turbine:

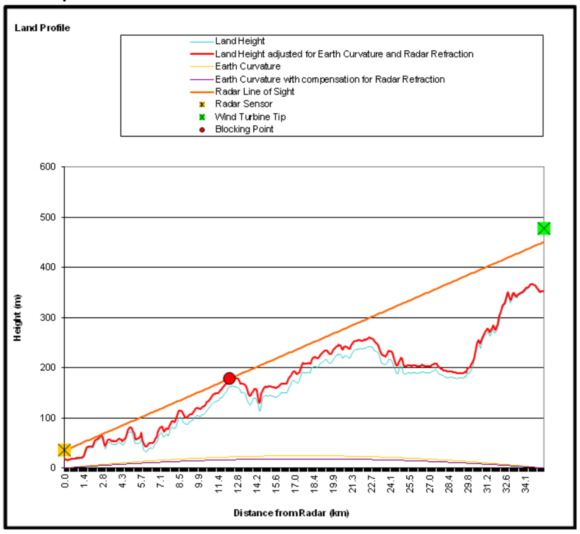

Figure 18 LOS profiles for turbine 4

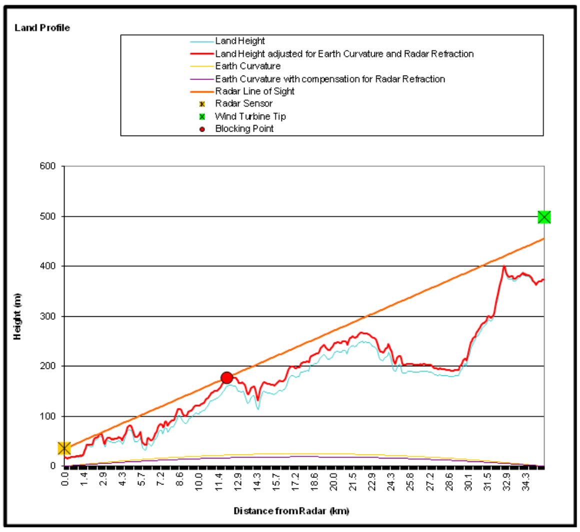

Figure 19 LOS profiles for turbine 5

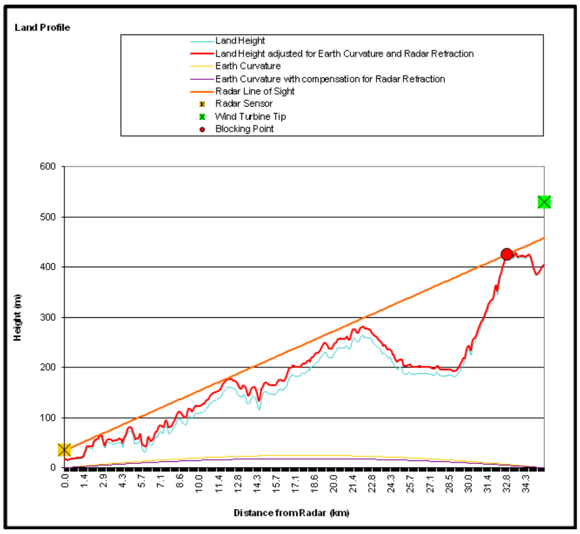

Figure 20 LOS profiles for turbine 6

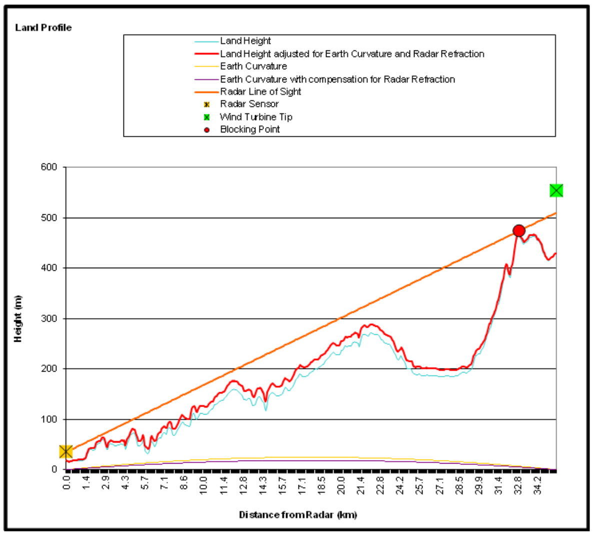

Figure 21 LOS profiles for turbine 7

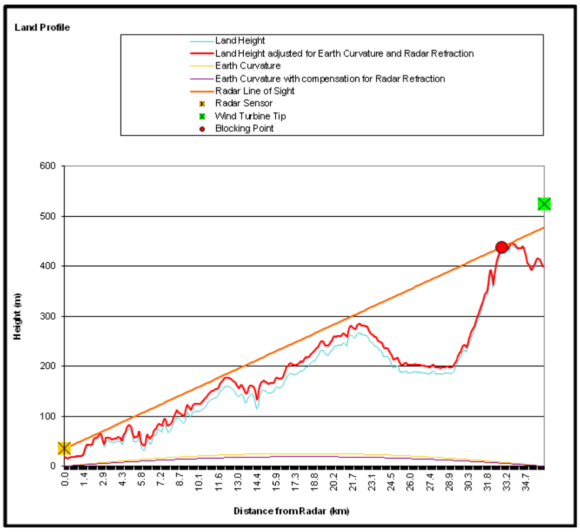

Figure 22 LOS profiles for turbine 11

The terrain profile for turbine 4 is slightly different to the profiles for turbines 5, 6, 7 and 11. Therefore the profiles for turbine 4 and turbine 5 will be analysed in more details for additional shielding and are presented on the following pages.

7.4 Turbine 4 LOS Additional Shielding Analysis for the Prestwick PSR

A check of aerial photography and online mapping resources has identified two areas of elevated terrain beneath the line of sight profile. This location is located at approximately 2.7 km and 12.5 km (the blocking point) along the LOS as highlighted on the below diagram:

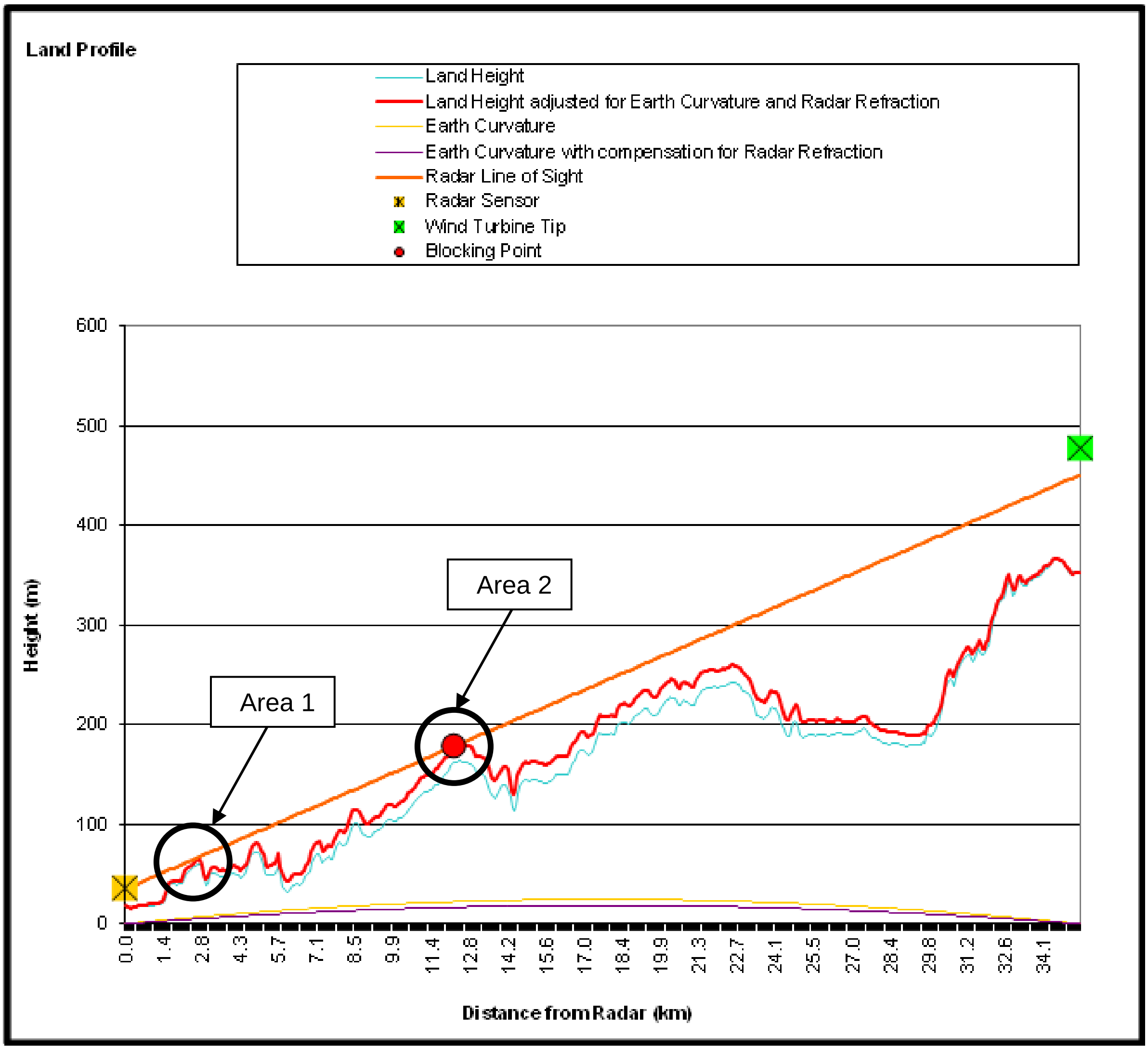

Figure 23 *Possible location of additional shielding along the turbine 4 line of sight path for Prestwick*

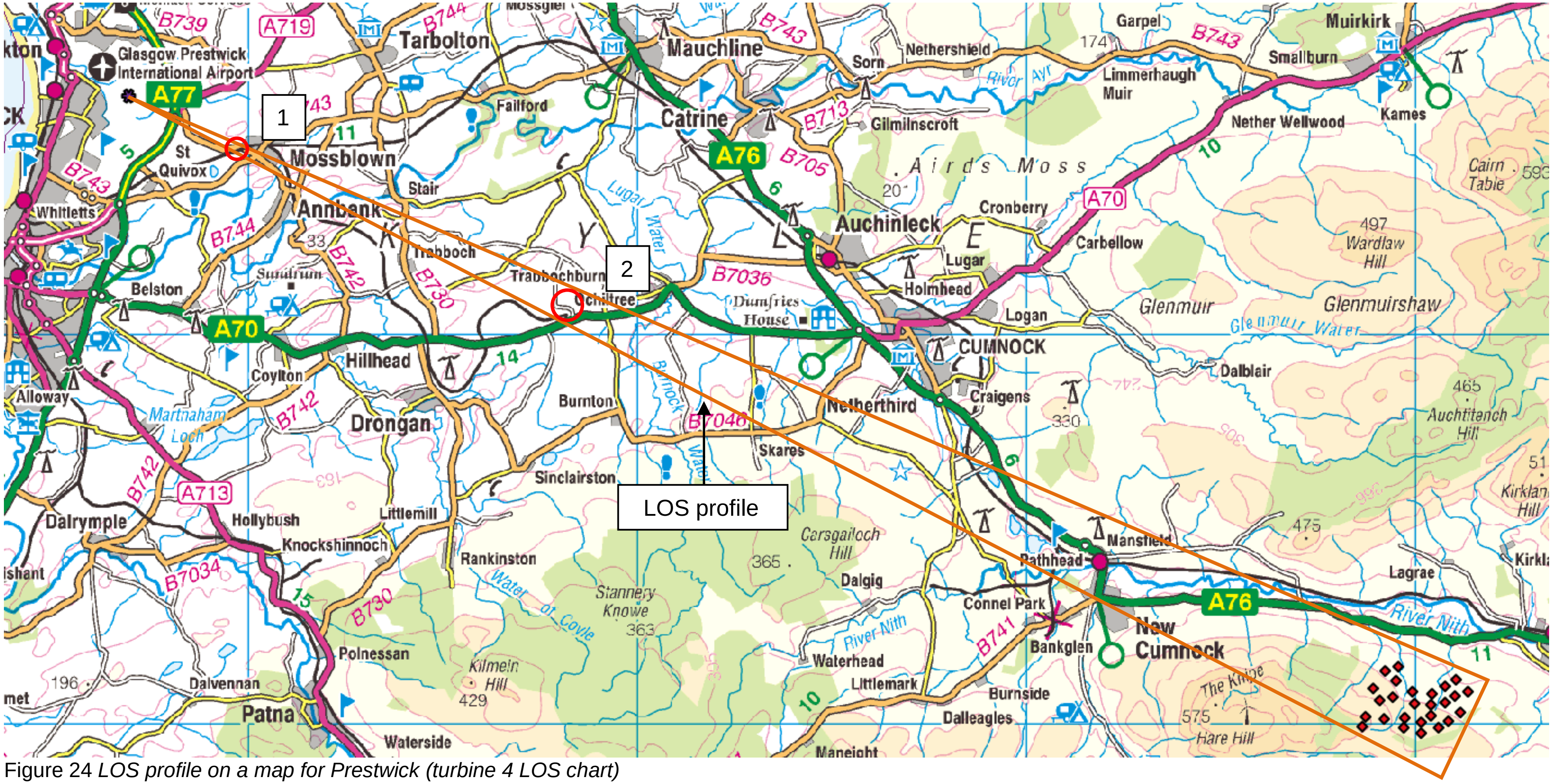

Figure 24 *LOS profile on a map for Prestwick (turbine 4 LOS chart)*

At site 1 there is the potential for minor shielding. At the site there is a small farm with buildings of approximately 2-5 m in height, however as this is only a small dwelling, complete shielding of the whole Proposed Development is unlikely.

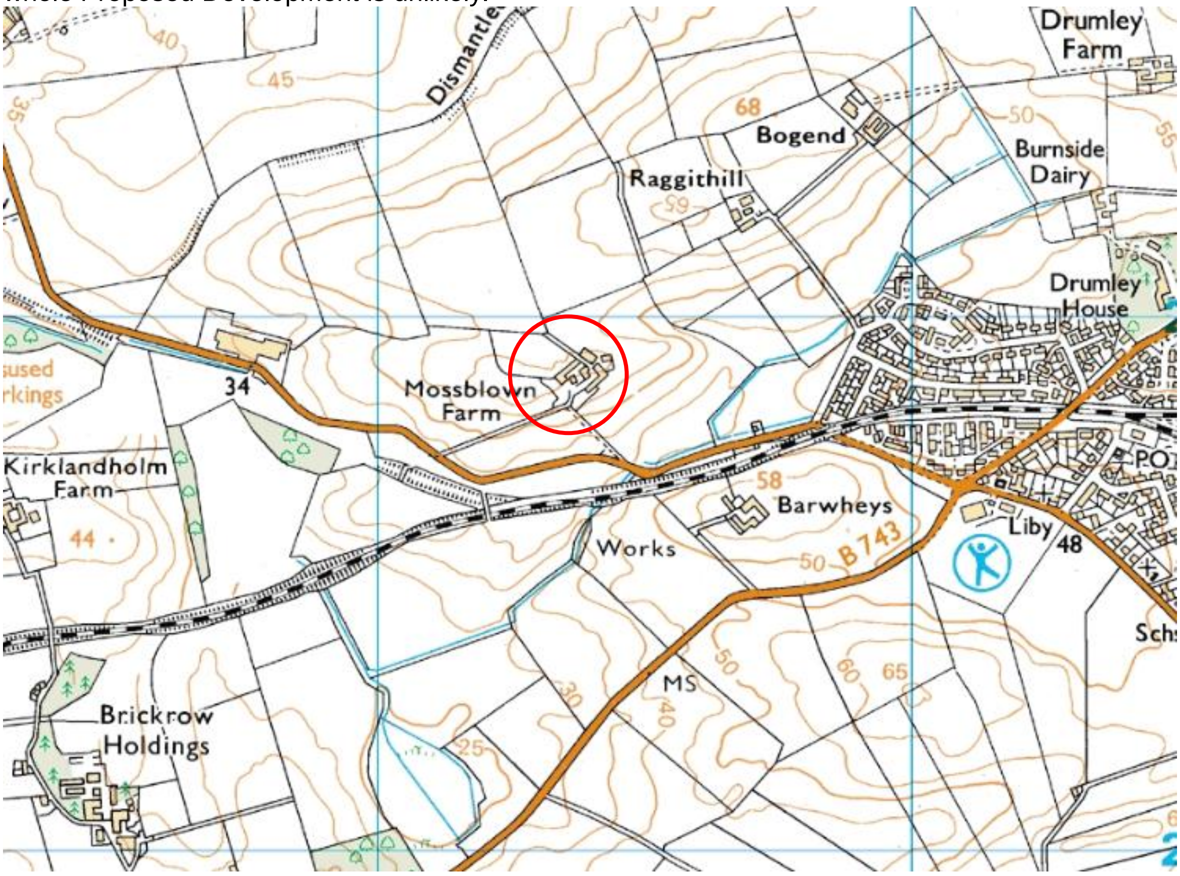

Figure 25 Site 1 location on the Prestwick LOS

At site 2 there are no features that could produce significant additional shielding.

The LOS passes through two places of interest. The table below summaries the features which are present along the LOS and an estimate of the amount of shielding has been made:

Area ID	Site Description	Range from Radar	Estimated Height of Feature (agl)	Estimated Required Height to Raise LOS (agl*)	Estimated Required Height to Shield Turbine (agl^)
1	Mossblown Farm	2.7 km	2-5 m	>4 m	>5 m
2	Farmers field	12.5 km	0-1 m	>0 m	~10 m

Table 23 *Additional shielding assessment summary for Turbine 4 from Prestwick PSR*

* Estimated required height to raise the line-of-sight profile.
^ Estimated required height to completely shield the turbine from the radar.

The farm at site 1 is just below the brow of a hill and it is unlikely that the farm buildings will be tall enough to provide significant shielding from the radar for all of the turbines.

7.5 Turbine 5 LOS Additional Shielding Analysis for the Prestwick PSR

A check of aerial photography and online mapping resources has identified four areas of elevated terrain beneath the line of sight profile. This location is located at approximately 2.7 km and 12.5 km (the blocking point), 22.5 km and 32.7 km along the LOS as highlighted on the below diagram:

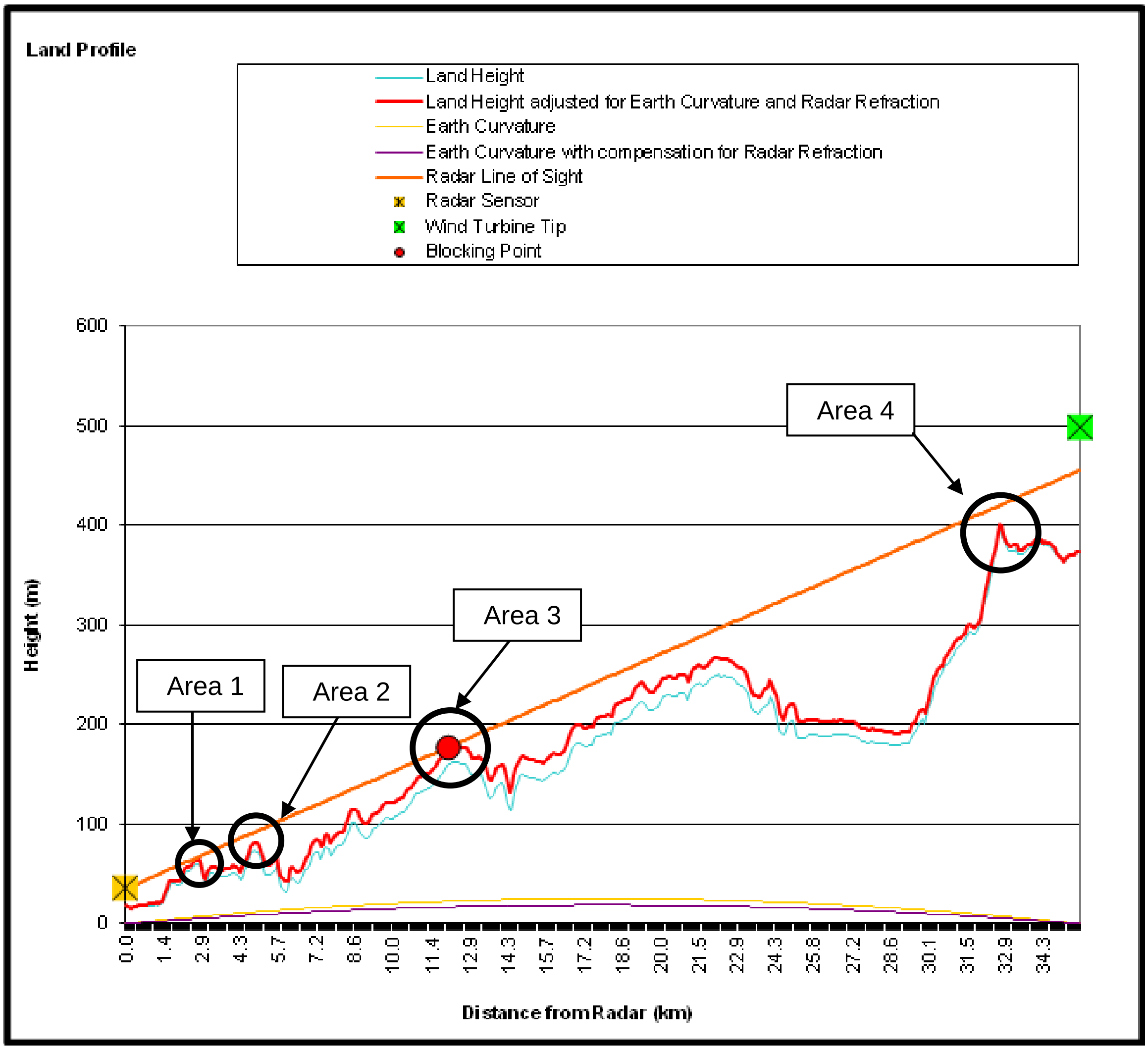

Figure 26 *Possible location of additional shielding along the turbine 5 line of sight path for Prestwick*

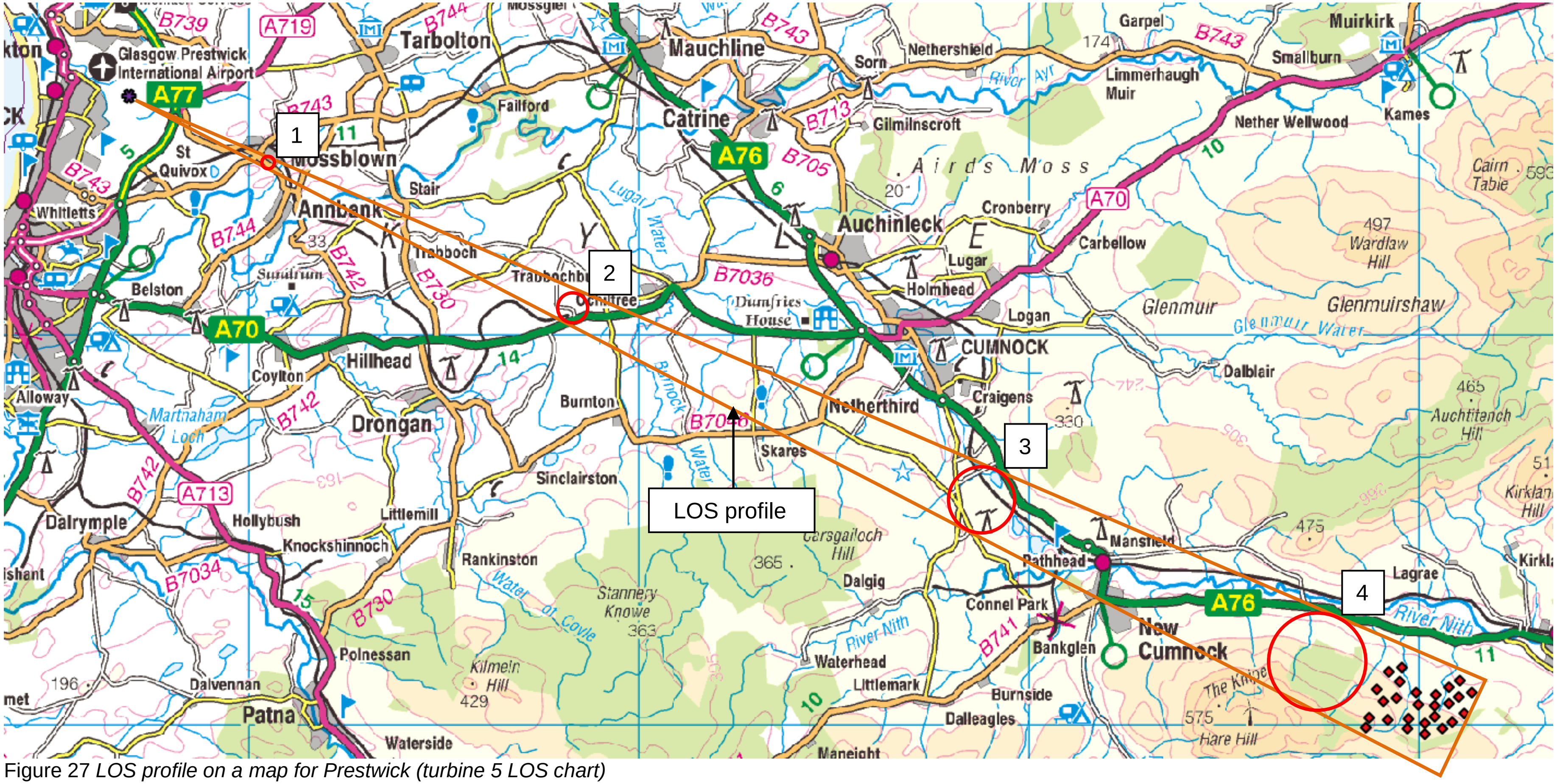

Figure 27 *LOS profile on a map for Prestwick (turbine 5 LOS chart)*

Area ID	Site Description	Range from Radar	Estimated Height of Feature (agl)	Estimated Required Height to Raise LOS (agl*)	Estimated Required Height to Shield Turbine (agl^)
1	Mossblown Farm	2.7 km	2-5 m	>4 m	>5 m
2	Farmers field	12.5 km	0-3 m	>8 m	>20 m
3	Farmers field	22.5 km	0-5 m	>0 m	>10 m
4	Farmers field	35.7 km	0-3 m	>15 m	>50 m

Table 24 *Additional shielding assessment summary for turbine 5 from Prestwick PSR*

After reviewing the LOS profile on a map it has been revealed that it is unlikely that there will any man-made structures or dense forest that will create significant shielding from the radar. At area 1 (Mossblown Farm) there are farm buildings just below the brow of a hill however it is unlikely that the buildings on the site will be sufficient enough to shield the whole Proposed Development.

7.6 Additional Shielding Summary

Desk based assessment of additional shielding has revealed that it is unlikely that significant additional shielding will be available to obstruct the view of the turbines form the PSR at Lowther Hill. It was also revealed that it will be unlikely that any significant shielding will be available from the Prestwick Airport's PSR.

In summary, having assessed the identified landscape features below the line of sight for additional shielding for features such as buildings and dense forest, it appears there is no possibility of significant additional shielding from both of the assessed radars.

8 HIGH LEVEL ASSESSMENT OF THE OPERATIONAL IMPACT ON RELEVANT INSTALLATIONS

The following section highlights briefly the expected operational effect that the Proposed Development may have on the assessed radars:

- Lowther Hill PSR- The Proposed Development is visible and is expected to be detectable to the radar. Clutter impacts are expected. No significant shielding is expected along the LOS.
- Lowther Hill SSR- The Proposed Development is far enough away to predict that no adverse effects upon the SSR will occur. Further in-depth analysis may be needed to confirm this.
- Prestwick Airport's PSR- Turbines 4, 5, 6, 7 and 11 are all in LOS and, following detectability analysis, all produce a return of more than -25 dB. Some shielding is available along the LOS however it is unlikely that the additional shielding will be enough to shield every turbine from the radar. Therefore it is expected that the turbines will produce a minor adverse operational effect upon the radar.
- Glasgow Airport's PSR-No adverse effect is expected.
- Glasgow Airport's SSR- No adverse effect is expected.
- Edinburgh Airport's PSR- No adverse effect is expected.
- Edinburgh Airport's SSR- No adverse effect is expected.
- Spadeadam Deadwater Fell PSR- No adverse effect is expected.
- Spadeadam Deadwater Fell SSR- No adverse effect is expected.
- Spadeadam Berry Hill PSR- No adverse effect is expected.
- Spadeadam Berry Hill SSR- No adverse effect is expected.

9 EVALUATION OF AIRSPACE USAGE ABOVE THE TURBINE

Airspace may be classified as controlled or uncontrolled. Pilots need permission and a clearance to fly in controlled airspace. Pilots may fly at will in uncontrolled airspace. Airspace designations and classifications vary with altitude resulting in layers of airspace.

9.1 Airspace

Type	Classification	Altitude Range	Description
Uncontrolled	Class G	Above 66,000f t	Upper Airspace: Open UIR ('free airspace').
Controlled	Class C	66,000 ft to 24,500 ft	Upper Airspace, Upper Airway UN552, UM89, UN590 and UN615 are in the vicinity of the Proposed Development.
Controlled	Class C	24,500 ft to 19,500 ft	Upper Airspace
Controlled	Class D	19,500 ft to 5,500 ft	Lower Airspace- Scottish TMA to FL195[1]
Uncontrolled	Class G	5,500 ft to Surface	Lower Airspace

Table 25 *Airspace usage over the Proposed Development*

[1] Flight level

10 ASSESSMENT OF MILITARY OF LOW FLY ZONES

10.1 Operational Low Flying and Wind Farms – United Kingdom

In the United Kingdom the military low flying system is safeguarded against wind farm developments. These arrangements are described in Chapter 3.4 of the Wind Energy and Aviation Interests Interim Guidelines.

Military low flying occurs across the majority of the United Kingdom. There is a published map which classifies any point in the UK as one of the following:

- areas with no military concerns (white);
- low priority military low flying areas less likely to raise concerns (blue);
- regular military low flying area where mitigation may be necessary to resolve concerns (yellow[2]); and
- high priority military low flying area likely to raise considerable and significant concerns (red).

Below is a map showing the Proposed Development's position in relation to Military Low Flying Zones:

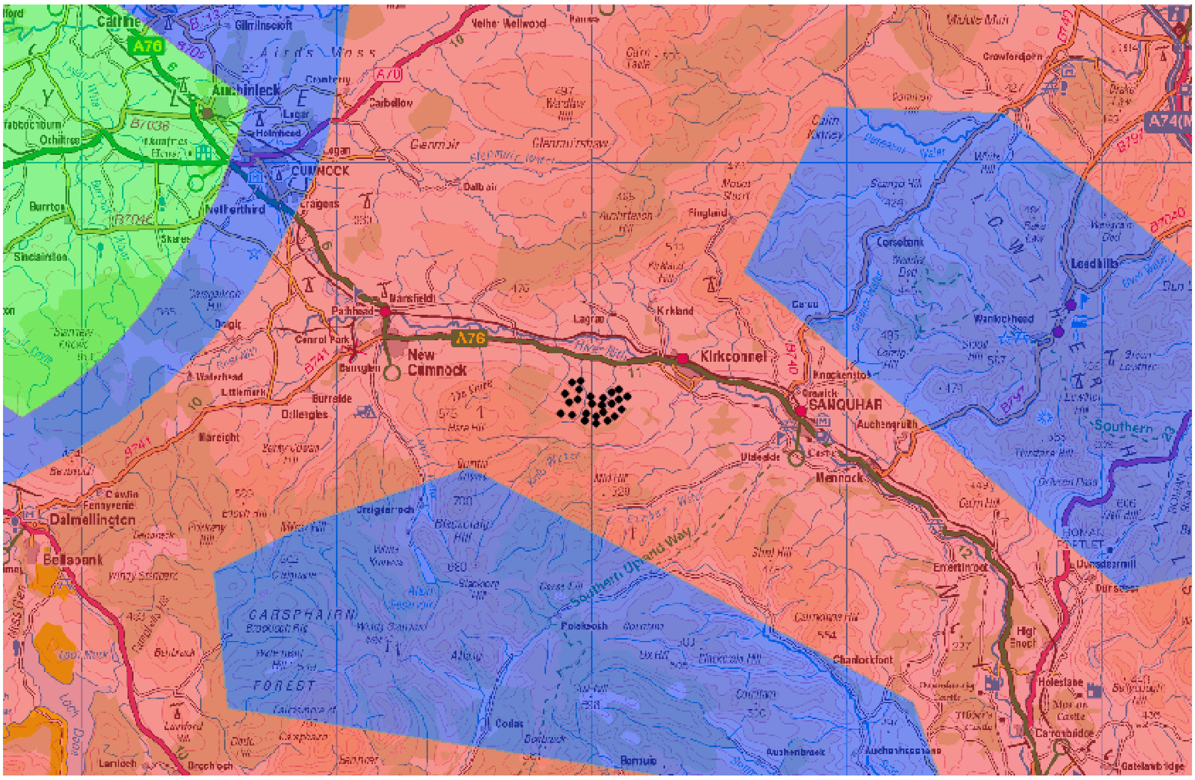

Figure 28 Proposed Development's *location in relation to Military Low Flying Zones*

It can be seen that the Proposed Development lies in the red area which is a high priority low flying zone. The UK has three tactical training areas in which aircraft fly as low as 100 feet for training

[2] Illustrated as green in the diagram

purposes. One of these areas is in Wales and two are in Scotland. The Proposed Development lies in a tactical training area (LFA 20T). Wind farm proposals within tactical training areas can be:

1. accepted;
2. accepted following turbine layout changes;
3. rejected on an interim basis for cumulative reasons; or
4. rejected outright.

In the busiest tactical training area developments may be accepted following turbine layout changes. These layout changes are normally requested to accommodate specific routes flown by low flying military jets during training exercises. The layout changes are often required because jets have to route away from populated areas and/or other wind farm developments.

In the other two, less busy, tactical training areas an outcome may be that development is accepted without changes.

In all other areas developments are accepted. There is often a request, not usually an insistence, that low intensity aeronautical ground lights are fitted to the turbine nacelles.

10.2 Summary of Military Low Flying System Analysis

Early consultation with the MOD is strongly advised to determine their position towards the Proposed Development. Currently the Proposed Development is located in an area which is a high priority military tactical training low flying zone which is of significant concern.

11 MITIGATION OPTIONS, RECOMMENDATIONS AND ASSOCIATED COSTS

The following section highlights the relevant mitigation options for the PSR at Lowther Hill and Prestwick Airport, and the presence of the Proposed Development in a Military Low Flying Zone where applicable.

11.1 Mitigation Option 1 – Layout Changes

In some cases, micrositing a wind turbine or reducing the tip height can overcome a radar issue. This is generally applicable in cases where visibility is marginal or where there is a significant shielding structure in the vicinity.

The table below shows which of the issues could be resolved using this option:

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Potentially	Further analysis to establish the required changes in turbine height could be carried out. This may restrict the economic potential of the site.
Lowther Hill PSR	No	No feasible reduction in height is likely to alleviate this issue.
Wind farm in a high priority low fly zone	Potentially	Layout changes could be recommended by the MOD to reduce the impact upon the Military Low Flying Zone. Consultation with the MOD needed.

Table 26 *Mitigation Option 1 Suitability*

If layout changes prove to be a suitable mitigation method for Prestwick Airport, it may be that the PSR situated at the airport is a viable In-fill solution for coverage over the area.

11.2 Mitigation Option 2 – Beam Tilt

For this solution, the radar's beam is tilted such that the emitted wave passes over the turbines. This can be achieved by physically adjusting the tilt angle of the radar. This solution does mean the radar sacrifices a certain amount of long range low level coverage. The cost associated with such a solution is estimated to be approximately £75,000.

The table below shows which of the issues could be resolved using this option:

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Potentially	Technically feasible but Prestwick may not agree. Consultation needed.
Lowther Hill PSR	No	NATS unlikely to be amenable to beam tilt as a solution.

Table 27 *Mitigation Option 2 Suitability*

11.3 Mitigation Option 3 – In-Fill Radar

The principle behind this solution is to rely on a feed from a second radar which has coverage over the wind farm, but does not 'see' the turbines. The radar screen then displays the feed from the second radar over the required area, thereby removing the false returns from the turbines. The costs associated with such a solution are dependent on whether an existing radar can be identified which meets the requirements outlined above, or whether a new radar must be purpose built to address the issue. If existing radars can be found, there may still be a requirement for new displays and display processing systems, the cost which is expected to be £100,000 – £200,000. There may also be an annual cost of up £50,000 – £100,000. If a new radar needs to be provisioned, the cost will certainly be prohibitive, as this can add approximately £5 million to the cost.

The analysis has revealed that the turbines are below radar line of sight for all the other nearby radars that have been assessed in this report. These radars are therefore potentially suitable for in-fill purposes but further investigation would be necessary.

The table below shows which of the issues could be resolved using this option:

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Yes	Other radars in the area could potentially provide a feed over the wind farm site.
Lowther Hill PSR	Potentially	This solution could be discussed with NATS/NERL.

Table 28 *Mitigation Option 3 Suitability*

11.4 Mitigation Option 4 – Local In-fill

The most advanced local in-fill technology is understood to be Cambridge Consultants (Aveillant). Cambridge Consultants are understood to be in consultation with the Fund Management Board (FMB). This solution is not expected to commercially available until 2014. The sensor which must be located at the wind farm does not have any moving parts. It emits pulses across the whole field of view and the reflections are simultaneously processed. Physically, the system comprises a sensor assembly to be located at/near the wind farm. The amount of information received, which includes the Doppler Spectrum and three-dimensional location, allows clear differentiation between wind turbines and aircraft. The outputs of the sensor are understood to be available in a standard format for straightforward integration with current radar display systems. These are compatible with the Cyrrus RVSE solution. It is understood that a single quadrant 8x8 sensor can provide coverage out to a range of 5 km and vertical coverage up to 10,000 ft, however the solution is understood to be scalable depending on requirements. The size and shape of the in-fill patch can be altered as required.

The cost of implementing the Cambridge Consultants solution is thought to be approximately £500,000. There will be an annual fee associated with maintenance and management of the radar data feed which is estimated to be up to £12,000, assuming the Cyrrus RVSE is used.

The table shows which of the issues could be resolved using this option:

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Yes	This option may be suitable for the developments.

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Lowther Hill PSR	Yes	This option may be suitable for the developments.

Table 29 *Mitigation Option 4 Suitability*

11.5 Mitigation Option 5 – Thruput

Thruput Limited has developed a primary surveillance radar screen mitigation solution which controls the effects of the wind turbine clutter on the radar display. The CAA regulates the colour of radar screen clutter plots, and these are therefore well defined. Through the computer logic of the individual radar screen pixel colour, it is possible to identify the clutter and either make the plot appear dimmer on the screen, or change it to the background colour so that it disappears from view allowing overflying targets to be clearly viewed. Aircraft targets will however have small gaps in their tracks as they pass over pixels that are dimmed or that match the background colour. It is understood to have been successfully demonstrated at a UK regional airport; expected costs are in the region of £275,000. The table below shows which of the issues could be resolved using this option.

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Yes	This is technically feasible for a civil airfield PSR and should be discussed.
Lowther Hill PSR	No	This solution is not likely to be acceptable to NATS due to the nature of the En-Route radar network and the type of radar used by NATS.

Table 30 *Mitigation Option 5 Suitability*

11.6 Mitigation Option 6 – Raytheon Solution

It is understood that the Raytheon Solution would enable the base of radar coverage to change as it sweeps past known wind farm locations. As the radar faces a wind farm which generates unwanted radar screen clutter due to a lack of suitable terrain shielding, the radar does not detect returns for a pre-set vertical angle above the wind farm. The value of 0.8° has been referenced in discussions with NATS/NERL; however this is yet to be finalised and is expected to be a different value. For the purpose of this discussion, 0.8° has been used as an example as the radar beam sweeps past the wind farm.

Despite current uncertainty as to the exact angle parameters, the principle of the solution remains the same. The zone of non-detection is switched on and off as required for wind farms which have been programmed in to the radar system. The 0.8° zone above a wind farm is equivalent to a rise of approximately 85 feet in the base of radar coverage for every nautical mile distance out from the radar. This unit height per nautical mile will increase for larger angles and decrease for smaller ones. The zone of non-detected airspace along the azimuth of the wind farm from the radar therefore becomes greater with distance, effectively reducing usable coverage further away from the radar behind the wind farm.

The exact parameters regarding the proposal are still under discussion with NATS/NERL, and the exact technical parameters for the solution are not confirmed at this time.

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	No	This is a solution designed for L-Band En-Route radar specifically.
Lowther Hill PSR	Yes	This is a solution designed for L-Band En-Route radar specifically and may be implementable.

Table 31 Mitigation Option 6 Suitability

11.7 Mitigation Option 7 – Establishing a Non-Automatic Initiation Zone

Some plot extracted Primary Radar systems have the ability to define zones where plot extracted tracks will be prevented from initiating. However, mature tracks flying through the zone will not be inhibited. These zones are referred to as Non-Auto Initiation Zones (NAIZ). This is a modification to the radar software, which allows construction of a zone in which the radar will 'ignore' aircraft tracks that are initiated within it. This then means that false plots will not spontaneously be created by the moving turbine blades. Aircraft that are already being tracked must continue to be tracked as they pass over the wind farm, which is likely to be achieved if the aircraft is travelling in a straight line. If the aircraft were to turn over the wind farm, its anticipated position will be known with less accuracy. Consequently, the chances of a false continuation of the track would increase. It should be noted that smaller NAIZs are less likely to result in aircraft tracks being lost. NAIZ mitigation is relatively simple to implement, and this may be a potential solution. The number of NAIZ that can operate simultaneously is limited by both technical and regulatory restraints. Technical restraints relate to how much processing the system can adequately perform, and regulatory constraints relate to how many zones the Air Navigation Service Providers and the Civil Aviation Authority (CAA) deem acceptable operationally.

The costs relating to such a solution are split into three areas:

- Configuration of the existing equipment (estimated cost of approximately £10,000 per radar).
- Production of design and safety case documentation and gaining approvals (estimated cost of approximately £40,000 per radar).
- Upgrading radar processor to enable additional processing (estimated cost of approximately £200,000 per radar).

The table below shows which of the issues could be resolved using this option:

Issue	Is This Mitigation Option Likely to be Suitable?	Remarks
Prestwick PSR	Yes	This option is technically feasible and should be discussed with the airport.
Lowther Hill PSR	Potentially	This option is technically feasible and could be discussed.

Table 32 *Mitigation Option 7 Suitability*

11.8 Mitigation Options – Conclusions

- It is possible that more than one mitigation option could be used to alleviate the issues impacts caused by the presence of the Proposed Development.
- All mitigations options could reduce the impacts of the turbines on the radar however only some could alleviate the issues for both radar with one mitigation option, these are:
  - In-fill;
  - Local In-fill; and
  - establishing a NAIZ.
- Altering the layout is likely to be the only form of technical mitigation for alleviating the issues concerning the presence of the Proposed Development in a High Priority Military Low Flying Zone.
- The most suitable mitigation option to alleviate the impacts upon the Prestwick PSR is regarded to be layout and height optimisation of the turbines. If this is not possible then In-fill radar or Local In-fill radar could be used.
- The most suitable solution for the NATS Lowther Hill PSR issue is likely to be the Raytheon Solution or In-fill radar. For In-fill, the feed from the other radar would need to be able to see between 1,000 ft and 5,000 ft below the base of controlled airspace due to the potential for the presence of high speed low flying jets in the Military Low Fly Zone.

12 CONCLUSIONS AND RECOMMENDATIONS

In summary, the analysis in this report has shown:

- At 12 5m tip height, eight wind turbines within the Proposed Development would be in line of sight (LOS) to the Prestwick Airport Primary Surveillance Radar (PSR).
- All 30 turbines are in full line of sight to the Lowther Hill PSR and Secondary Surveillance Radar (SSR).
- None of the turbines within the Proposed Development will be in line of sight to Glasgow Airport's PSR and SSR and Edinburgh Airport's PSR and SSR.
- None of the turbines will be in LOS to the MOD's PSR and SSR at Spadeadam Deadwater Fell and the Spadeadam Berry Hill PSR.
- Detectability analysis has shown that turbine 7 is likely to be detectable to the PSR at Prestwick Airport. Turbines 4, 5, 6 & 11 are all expected to produce a return to the radar of between approximately -15 dBm and 0 dBm as detailed in the report. At this margin the certainty of remaining undetected decreases and therefore it cannot be guaranteed that these turbines will be undetectable. All other turbines are expected to be undetectable.
- Detectability analysis, based on the first addition of CAP764, was not initially designed for analysis on L-Band en-route radar however, due to the distance and full visibility of all turbines, it is likely that all the turbines will be detectable to the Lowther Hill PSR and should be considered as such.
- None of the turbines will be detectable to the Military PSR at Deadwater Fell and Berry Hill.
- No additional shielding along the LOS is available for the wind turbines from the Lowther Hill PSR.
- Marginal additional shielding is available along the Prestwick Airport's LOS for turbines 4,5,6,7 and 11 however it is unsure whether the buildings at Mossblown Farm will provide enough shielding to fully obscure the turbines from view. A field survey may be beneficial to determine this.
- The Proposed Development lies in a high priority low flying zone and tactical training area (LFA 20T) where aircraft can fly as low as 100 feet for training purposes. Early consultation with the MOD is strongly advised to determine their position towards the Proposed Development.
- Altering the layout is likely to be the only form of technical mitigation for alleviating the issues concerning the presence of the Proposed Development in a High Priority Military Low Flying Zone.
- The most suitable form of mitigation to alleviate the impacts upon the Prestwick PSR is considered to be layout and height optimisation to reduce effects upon the PSR. In-fill radar or Local In-fill could be used if layout optimisation is unviable.
- The most suitable mitigation solution for the NATS Lowther Hill PSR issue is likely to be the Raytheon Solution or In-fill radar. For In-fill, the feed from the other radar would need to be able to see between approximately 1,000 ft and 5,000 ft below the base of controlled airspace due to the potential for the presence of high speed low flying jets in the Military Low Fly Zone.
- Prestwick Airport could object initially, however, because the effects upon the PSR are marginal, mitigation can be easily implemented. If layout and height optimisation can alleviate the issues, Prestwick Airport's PSR may be a viable In-fill radar solution.
- It is likely that the effects upon the NATS and MOD installations will be the biggest aviation threat to the Proposed Development. It is likely that both stakeholders will object due to the expected operational effect caused by theProposed Development. Mitigation options are available but may be costly.

- Consultation with Prestwick Airport, NATS and the MOD will be required to determine their position and to suggest the possibility of implementing the mitigation options presented in this report.

Conclusion summary

It is likely that some aviation stakeholders in the area will have significant concerns to the Proposed Development however mitigation is available to alleviate the issues identified. The main issues and stakeholders concerned are:

- presence of the Proposed Development in a High Priority Low Flying Zone (MOD);
- the likelihood of detectability of all of the turbines to the Lowther Hill PSR (NATS/NERL); and
- detectability of up to five wind turbines to the PSR at Prestwick (Prestwick Airport).

Mitigation options have been presented and recommendations have been made. Based on Pager Power's experience it is advised that the next steps should be to initiate consultation with the MOD and Prestwick Airport followed by NATS. The aims of these consultations should be to determine their position towards the Proposed Development and discuss the viability of mitigation where necessary.

13 APPENDIX

13.1 CAP764 Assessment

Indicative Wind Turbine Radar Detection Calculation - CAP 764 v1 Method [CAP76401]

Turbine Reference	1

WSP Environment and Energy
Glasgow Prestwick PSR
1

A1.1 Input Parameters

Generic Wind Turbine

	Value	Units	Data Source
Height of Tower	50	m	CAP 764 v1
Tower Radar Cross Sectional Area	80	m^2	CAP 764 v1
Blade Length	30	m	CAP 764 v1
Blade Radar Cross Sectional Area	9	m^2	CAP 764 v1

Wind Turbine

	Value	Units	Data Source
Height of Tower	80.0	m	Customer
Blade Length (Rotor Radius)	45.0	m	
Number of Blades	3	N/A	Assumed
Location Easting	269539.0	m	
Location Northing	611439.0	m	
Base Elevation	272.5	m aod	DTM Terrain Database
Tip Height	125.0	m agl	
Tip Elevation	397.5	m aod	

Radar

	Value	Units	Data Source
Power Radiated	80.0	dBW	CAP 764 v1 Typical
Sensitivity	-130.0	dBW	Customer
Sensitivity	-100.0	dBm	
Down Tilt	0.0	degrees	CAP 764 v1 Typical
Frequency	2765.0	MHz	Customer
Receiver Loss	3.0	dB	CAP 764 v1 Typical
Speed Filter (0 = None 1=Operational)	1	N/A	
Location Easting	236921.55	m	Pager Power Online
Location Northing	626100.21	m	
Base Elevation	16.0	m aod	
Antenna Height	19.2	m agl	
Antenna Elevation	35.3	m aod	

Path details are in A1.4 below

Radar Antenna

Off-axis Elevation Angle	Gain (dBi)	Data Source
-3.0	16.5	Assumed Watchman Radar
-2.5	18.1	
-2.0	19.7	
-1.5	22.1	
-1.0	24.5	
-0.5	26.55	
0.0	28.6	
0.5	30.05	
1.0	31.5	
1.5	32.25	
2.0	33	
2.5	33.425	
3.0	33.85	
3.5	33.875	

A1.2 Assessment of the Radar Cross-Sectional Area of the Wind Turbine

	Value	Units
Static Element Scaling Factor	1.60	m
Static Element Radar cross-sectional area	204.80	m^2
Moving Element Scaling Factor	1.50	m
Moving Element Radar cross-sectional area	20.25	m^2

A1.3 Radar Antenna PLM Data

	Value	Units	
			29.6433337
Off-Axis elevation angle	0.36	degrees	28.6
Antenna gain towards turbine	29.6	dB	30.05

A1.4 Determine Elevation Angles and Separation Distance

	Value	Units
Length	35.8	km
Slope	0.36	degrees
Wavelength	0.11	metres
Free Space Path Loss (FSPL)	132.35	dB

A1.5	Divide Wind Turbine Structure into parts				

Height m	Static RCS m^2	Moving RCS m^2
10	25.6	#N/A
20	25.6	#N/A
30	25.6	#N/A
40	25.6	1.1
50	25.6	2.3
60	25.6	2.3
70	25.6	2.3
80	25.6	2.3
90	#N/A	2.3
100	#N/A	2.3
110	#N/A	2.3
120	#N/A	2.3
130	#N/A	1.1
140	#N/A	#N/A
150	#N/A	#N/A
160	#N/A	#N/A
170	#N/A	#N/A
180	#N/A	#N/A
190	#N/A	#N/A
200	#N/A	#N/A

Static	
RCS /m	2.56
Start	0
Finish	80.0

Moving	
RCS /m	0.225
Start	35.0
Finish	125.0

A1.6	Determine the radar return for each part of the turbine structure

Height m	Actual O/W Loss dB	FSPL dB	Additional Att. dB	Data Source
10	192.1	132.3	59.78	ITU-526
20	191.0	132.3	58.64	Pager Power Online
30	182.6	132.3	50.27	
40	181.6	132.3	49.24	
50	180.4	132.3	48.10	
60	179.2	132.3	46.84	
70	177.8	132.3	45.42	
80	176.4	132.3	44.01	
90	173.9	132.3	41.51	
100	171.2	132.3	38.82	
110	168.3	132.3	35.98	
120	165.4	132.3	33.02	
130	162.3	132.3	29.97	
140	159.2	132.3	26.83	
150	156.0	132.3	23.62	
160	153.2	132.3	20.85	
170	150.5	132.3	18.18	
180	147.5	132.3	15.18	
190	146.1	132.3	13.75	
200	144.3	132.3	11.99	

i Static parts (tower, nacelle etc)

	Value	Units
EIRP	80.0	dBW
Rx System Gain	26.6	dB

Height m	RCS m^2	Lbr dB	Latt dB	Lbr (act) dB	Pr dBm	Pr abs
10	25.60	220.29	59.78	339.85	-203.20	4.78128E-21
20	25.60	220.29	58.64	337.57	-200.92	8.08248E-21
30	25.60	220.29	50.27	320.83	-184.18	3.81544E-19
40	25.60	220.29	49.24	318.77	-182.12	6.13119E-19
50	25.60	220.29	48.10	316.49	-179.84	1.03644E-18
60	25.60	220.29	46.84	313.97	-177.32	1.85159E-18
70	25.60	220.29	45.42	311.13	-174.48	3.56077E-18
80	25.60	220.29	44.01	308.31	-171.66	6.81623E-18
90	#N/A	#N/A	41.51	#N/A	#N/A	0
100	#N/A	#N/A	38.82	#N/A	#N/A	0
110	#N/A	#N/A	35.98	#N/A	#N/A	0
120	#N/A	#N/A	33.02	#N/A	#N/A	0
130	#N/A	#N/A	29.97	#N/A	#N/A	0
140	#N/A	#N/A	26.83	#N/A	#N/A	0
150	#N/A	#N/A	23.62	#N/A	#N/A	0
160	#N/A	#N/A	20.85	#N/A	#N/A	0
170	#N/A	#N/A	18.18	#N/A	#N/A	0
180	#N/A	#N/A	15.18	#N/A	#N/A	0
190	#N/A	#N/A	13.75	#N/A	#N/A	0
200	#N/A	#N/A	11.99	#N/A	#N/A	0
Total					-168.5	1.42726E-17

ii Moving parts

EIRP and Rx System Gain as i above

Height m	RCS m^2	Lbr dB	Latt dB	Lbr (act) dB	Pr dBm	Pr abs
10	#N/A	#N/A	59.78	#N/A	#N/A	0
20	#N/A	#N/A	58.64	#N/A	#N/A	0
30	#N/A	#N/A	50.27	#N/A	#N/A	0
40	1.13	233.86	49.24	332.34	-195.70	2.69437E-20
50	2.25	230.85	48.10	327.05	-190.41	9.10934E-20
60	2.25	230.85	46.84	324.53	-187.89	1.62737E-19
70	2.25	230.85	45.42	321.69	-185.05	3.12959E-19
80	2.25	230.85	44.01	318.87	-182.23	5.99083E-19
90	2.25	230.85	41.51	313.87	-177.23	1.89447E-18
100	2.25	230.85	38.82	308.49	-171.85	6.53863E-18
110	2.25	230.85	35.98	302.81	-166.17	2.41817E-17
120	2.25	230.85	33.02	296.89	-160.25	9.4512E-17
130	1.13	233.86	29.97	293.80	-157.16	1.92512E-16
140	#N/A	#N/A	26.83	#N/A	#N/A	0
150	#N/A	#N/A	23.62	#N/A	#N/A	0
160	#N/A	#N/A	20.85	#N/A	#N/A	0
170	#N/A	#N/A	18.18	#N/A	#N/A	0
180	#N/A	#N/A	15.18	#N/A	#N/A	0
190	#N/A	#N/A	13.75	#N/A	#N/A	0
200	#N/A	#N/A	11.99	#N/A	#N/A	0
Total					-154.9	3.20831E-16

A1.7	Interpretation of the Results			
		Value	Units	Assessment
	Receiver Threshold	-100.00	dBm	
	Speed Filter (0 = None 1=Operational)	1	N/A	
	Received Power (Static)	-168.45	dBm	Detection unlikely
	Received Power (Moving)	-154.94	dBm	Detection unlikely
	Received Power (Static and Moving)	-154.75	dBm	Detection unlikely

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