Morecambe Offshore Windfarm: Generation Assets

Environmental Statement

Volume 5

Appendix 16.1 Airspace Analysis and Radar Modelling

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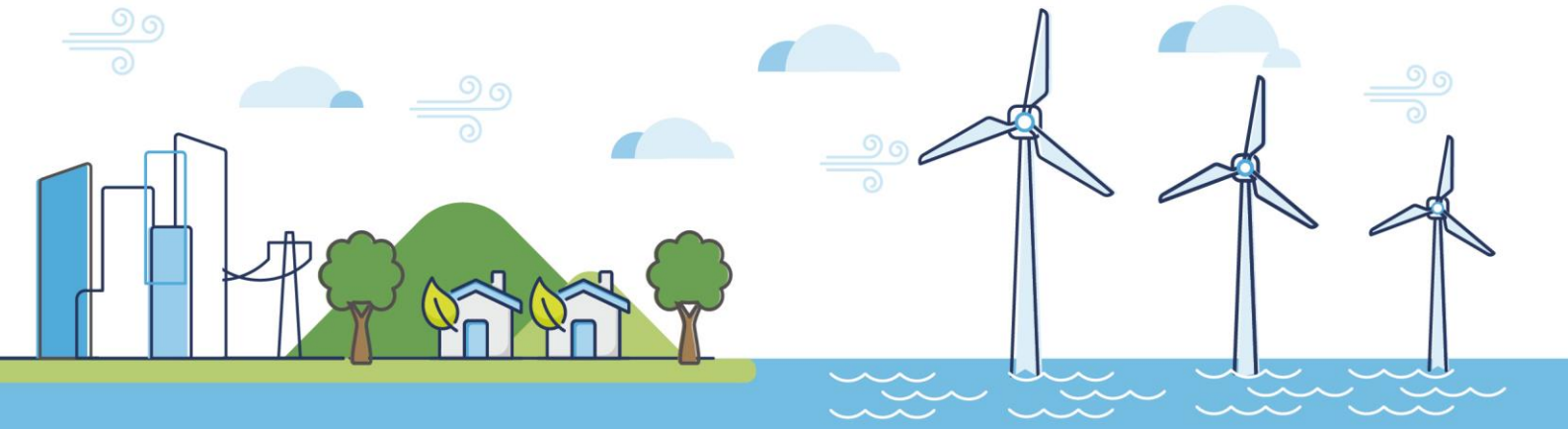

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Airspace Analysis and Radar Modelling

Morecambe Offshore Windfarm: Generation Assets

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www.cyrrus.co.uk

info@cyrrus.co.uk

Abbreviations

AIP	Aeronautical Information Publication
AMA	Area Minimum Altitude
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ATS	Air Traffic Service
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CTA	Control Area
DA	Danger Area
DOC	Designated Operational Area
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
FIR	Flight Information Region
FL	Flight Level
ft	feet
GIS	Geographic Information System
HAT	Highest Astronomical Tide
HTZ	Helicopter Traffic Zone
IAC	Instrument Approach Chart
IFP	Instrument Flight Procedure
km	kilometre
m	metre
MOD	Ministry of Defence
MRT	Multi Radar Tracking
MSA	Minimum Sector Altitude
NATS	National Air Traffic Services
NERL	NATS En Route Limited
nm	nautical mile
OSP	Offshore Substation Platform
PEIR	Preliminary Environmental Information Report
PSR	Primary Surveillance Radar
RAF	Royal Air Force

RLoS	Radar Line of Sight
RNP	Required Navigation Performance
RRH	Remote Radar Head
SAR	Search and Rescue
SSR	Secondary Surveillance Radar
SUA	Special Use Airspace
TAA	Terminal Arrival Altitude
TAP	Terminal Approach Procedure
TMZ	Transponder Mandatory Zone
TRA	Terminal Reserved Area
UK	United Kingdom
VFR	Visual Flight Rules
WTG	Wind Turbine Generator

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1. Introduction

1.1. Overview

1.1.1. This document is an appendix to Chapter 16 Civil and Military Aviation and Radar, Volume 1 of the Morecambe Offshore Windfarm Generation Assets (the Project) Environmental Statement (ES). It provides detailed airspace analysis and radar modelling and outlines potential mitigation options.

1.1.2. The Project includes the generation assets to be located within the Project windfarm site (wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSPs). The windfarm site (encompassing all Project infrastructure) is an area of around 87 square kilometres (km^2) in the eastern Irish Sea, approximately 30km from the Lancashire coast at its nearest point.

1.2. Effects of wind turbine generators on aviation

1.2.1. WTGs can be problematic for aviation Primary Surveillance Radars (PSRs) as the characteristics of a moving WTG blade are like an aircraft. The PSR is unable to differentiate between wanted aircraft targets and clutter targets introduced by the presence of WTGs.

1.2.2. Potential impacts on the NATS[1] En Route Limited (NERL) PSR facilities at St Annes, Great Dun Fell and Lowther Hill, and the Air Traffic Control (ATC) PSRs at Warton, Isle of Man and Hawarden airports were identified at the Project scoping stage. In this appendix all airfield PSRs within operational range of the windfarm site (up to 60 nautical miles (nm) away) and any NERL PSRs and military PSRs with potential Radar Line of Sight (RLoS) of WTGs are assessed for potential impacts.

1.2.3. The significance of any radar impacts depends on the airspace usage and the nature of the Air Traffic Service (ATS) provided in that airspace. The classification of the airspace in the vicinity of the windfarm site and the uses of that airspace (civil and military) are set out in this appendix. WTGs can also have a direct impact on airspace due to their physical presence. The airspace analysis considers the impact WTGs could have as obstacles for aviation activities such as military low flying, Search and Rescue (SAR) operations and offshore oil and gas helicopter operations.

1.2.4. Radar impacts may be mitigated by either operational or technical solutions or a combination of both. In either case, the efficacy and acceptability of any operational and/or technical mitigation options available can only be determined by protracted consultations with the radar operators/ATS providers.

[1] NATS Holdings, formerly National Air Traffic Services, is the main air navigation service provider in the United Kingdom.

1.3. Technical data

1.3.1. Radar data

1.3.1.1. All radar parameters used in the assessment have been taken from data held on file by Cyrrus.

1.3.2. ES assessment boundary

1.3.2.1. The windfarm site boundary for the ES was supplied as a geo-referenced Shapefile:

- FT_MOR_ES_AfL_20230221.shp.

1.3.2.2. The windfarm site boundary is depicted in Figure 1.

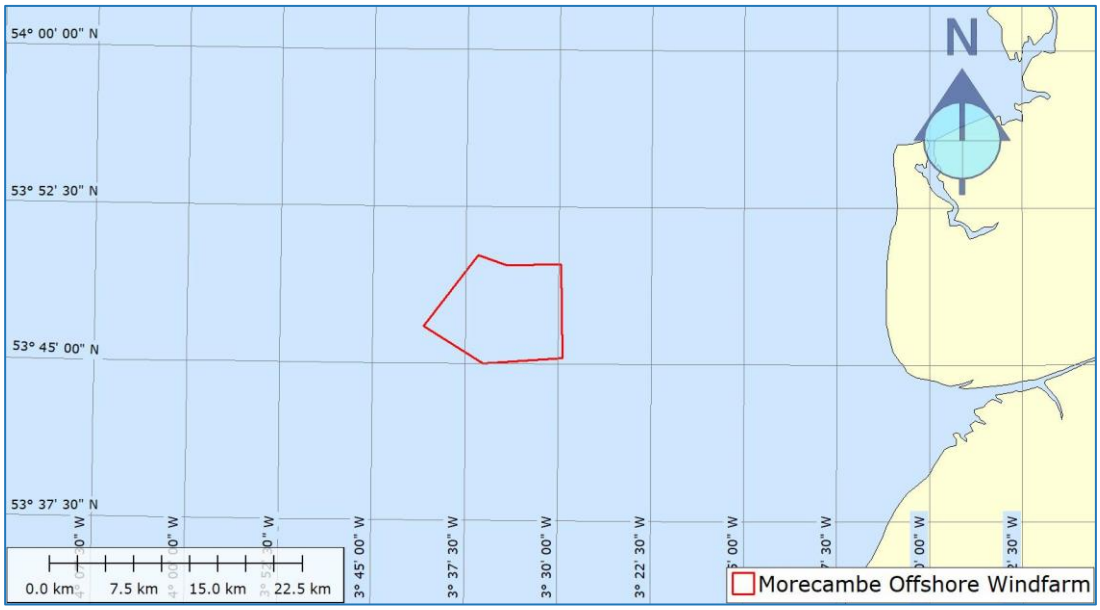

Figure 1: Windfarm site boundary

1.3.3. WTGs

1.3.3.1. Up to 35 WTGs with maximum tip height of 290 metres (m) or up to 30 WTGs with maximum tip height of 310m above Highest Astronomical Tide (HAT) are being considered. The design parameters for these WTGs are shown in Table 1.

Table 1: WTG design parameters

Parameter	Smallest WTG	Largest WTG
Blade tip height above HAT	290m	310m
Rotor diameter	260m	280m
WTG spacing	1,060m in-row 1,410m inter-row	1,260m in-row 1,680m inter-row

Parameter	Smallest WTG	Largest WTG
Number of WTGs	35	30

1.3.3.2. Note that blade tip heights are above HAT whereas radar assessments are based on tip heights above mean sea level (AMSL). Within the windfarm site HAT is 4.82m AMSL. Worst-case blade tip heights of 295m AMSL for the smallest WTGs and 315m AMSL for the largest WTGs are therefore used for the airspace and radar assessments which incorporates an additional buffer of 0.18m.

1.3.4. Terrain data

- ATDI UK 25m Digital Terrain Model (DTM).

1.3.5. Analysis tools

- ATDI HTZ communications V2022.7 release 1480 radio planning tool; and
- Blue Marble Global Mapper V21.1.1 Geographic Information System (GIS).

1.3.6. Mapping datum

1.3.6.1. UTM Zone 30N (WGS84 datum) is used as a common working datum for all mapping and geodetic references.

1.3.6.2. Where necessary, mapping datum transformations are made using Global Mapper or Grid Inquest II Coordinate Transformation Program.

1.3.6.3. All heights stated in this document are AMSL (Newlyn datum) unless otherwise stated.

2. Airspace analysis

2.1. Introduction

2.1.1. This assessment is a review of potential impacts on aviation in the Project windfarm site. For the purposes of this assessment a maximum tip height of 1,100 feet (ft) AMSL for the WTGs has been assumed, the equivalent to 315m rounded up to the nearest 100ft.

2.1.2. All information has been referenced from the United Kingdom (UK) Aeronautical Information Publication (AIP) available online from source and is therefore the latest information available. Additional information has been sourced from UK Civil Aviation Authority (CAA) publications, as appropriate.

2.1.3. The assessment does not draw any conclusions but merely identifies areas of potential impact.

2.2. Scope

2.2.1. The scope of the assessment includes the windfarm site and the surrounding airspace relating to aviation, its use and potential impact. The types of airspace and limitations on its use are identified.

2.3. Airspace classification

2.3.1. In general, airspace can be characterised as either controlled or uncontrolled airspace. Aircraft in controlled airspace are being positively managed by ATC the entire time they are within that designated area. This type of airspace is generally used by airlines and corporate aviation. Aircraft in uncontrolled airspace are operating within a framework of rules but are not being controlled by ATC, although many pilots flying in this environment may choose to report their position, altitude, and intentions to ATC to benefit from the enhanced situational awareness that brings. Users of this airspace tend to be small aircraft engaged in training or private (social) flying.

2.3.2. In addition, Special Use Airspace (SUA) is airspace designated for specific activities such that limitations on airspace access may be imposed on other non-participatory aircraft. An example of such airspace would be a Danger Area (DA) established for military flight training.

2.3.3. There are five classes of airspace in the UK, namely classes A, C, D, E and G. Classes A to E are types of controlled airspace, while class G is uncontrolled airspace. Class A is the most strictly regulated controlled airspace whereby aircraft are positively controlled by ATC, compliance with ATC clearance is mandatory, and aircraft are flown and navigated solely with reference to aircraft instruments. Certain onboard equipment is also a prerequisite. Flight in class G airspace is generally visual, meaning pilots fly and navigate with reference to the natural horizon and terrain features they see outside. Pilots are required to maintain minimum distances from notified obstacles, including WTGs, and may only fly within the minimum weather and visibility criteria.

2.4. Aircraft vertical reference

2.4.1. An aircraft's vertical reference above the ground or sea can either be an altitude AMSL or, above a designated altitude, a Flight Level (FL). An aircraft's altitude, expressed in feet, is based on the last known verified local barometric pressure while a FL, expressed in 100ft increments, is based on a common international barometric pressure setting of 1013.2 hectopascals. With aircraft using a common vertical datum safe separation can be achieved by either ATC or between pilots of different aircraft.

2.4.2. The airspace where vertical reference changes from altitude to FL and vice versa is known as the Transition Layer and consists of a (lower) Transition Altitude and (higher) Transition Level. In UK airspace the Transition Altitude is set at 3,000ft AMSL except in certain specified airspace where it is higher.

2.4.3. The vertical limits of airspace are defined in terms of either altitudes or FLs, with airspace commonly having a lower limit expressed as an altitude and an upper limit expressed as a FL.

2.5. Current airspace baseline

2.5.1. The windfarm site lies within the London Flight Information Region (FIR), airspace regulated by the UK CAA. The boundary between the London FIR and the adjacent Shannon FIR, regulated by the Irish Aviation Authority, lies 119km to the west of the windfarm site at its nearest point. Immediately surrounding the windfarm site is uncontrolled class G airspace, extending from sea level to FL195, approximately 19,500ft AMSL. This airspace is used by both civil and military aircraft, predominantly for low-level flight operations and generally by aircraft flying under Visual Flight Rules (VFR). Under VFR flight the pilot is responsible for maintaining a safe distance from terrain, obstacles, and other aircraft.

2.5.2. Above FL195 is class C controlled airspace in the form of a Temporary Reserved Area (TRA). This airspace, TRA 004, has an upper vertical limit of FL245, approximately 24,500ft AMSL, and is available for use by both military and civil aircraft, though its main use is to accommodate VFR military flying activity.

2.5.3. The Holyhead Control Area (CTA), which lies 5km south west of the windfarm site at its closest point as shown in Figure 2, is also Class C controlled airspace from a lower vertical limit of FL45 (CTA 6), approximately 4,500ft AMSL, to an upper limit of FL195. The Transition Altitude beneath the Holyhead CTA is 3,000ft AMSL. Embedded within this airspace are multiple Air Traffic Service routes connecting the Manchester, Birmingham and London regions with the Isle of Man and Northern Ireland.

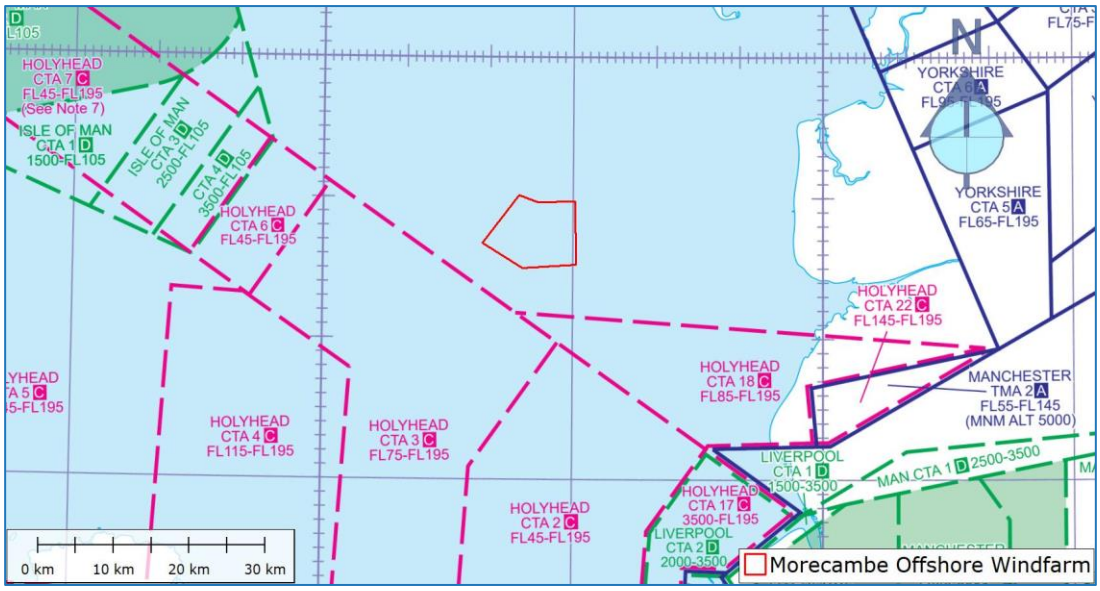

Figure 2: Windfarm site and Holyhead CTA

2.6. Special Use Airspace

2.6.1. The windfarm site lies within the Warton Advisory Radio Area, as highlighted in Figure 3, which exists between FL95, approximately 9,500ft AMSL, and FL190, approximately 19,000ft AMSL. Considerable test flight activity is undertaken within this airspace which requires pilots to fly profiles which limit their ability to manoeuvre their aircraft in compliance with the Rules of the Air. Such flights will be receiving a radar service from Warton.

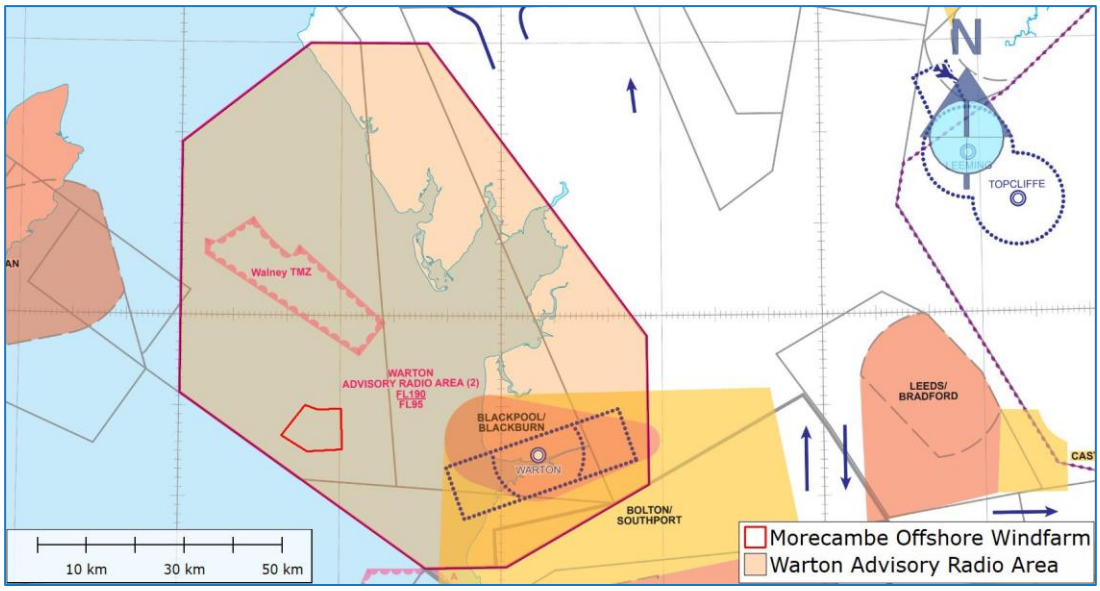

Figure 3: Warton Advisory Radio Area

2.6.2. To the north of the windfarm site are the Eskmeals Danger Areas D406A, D406B and D406C, shown in Figure 4. Within the airspace, which extends from the surface up to 50,000ft AMSL (occasionally notified up to 80,000ft AMSL), ordnance, munitions and explosives, unmanned

aircraft system and balloon activities take place, as well as electronic/optical hazards. It is unlikely that these activities will be impacted by WTGs within the windfarm site as they will take place more than 30km away.

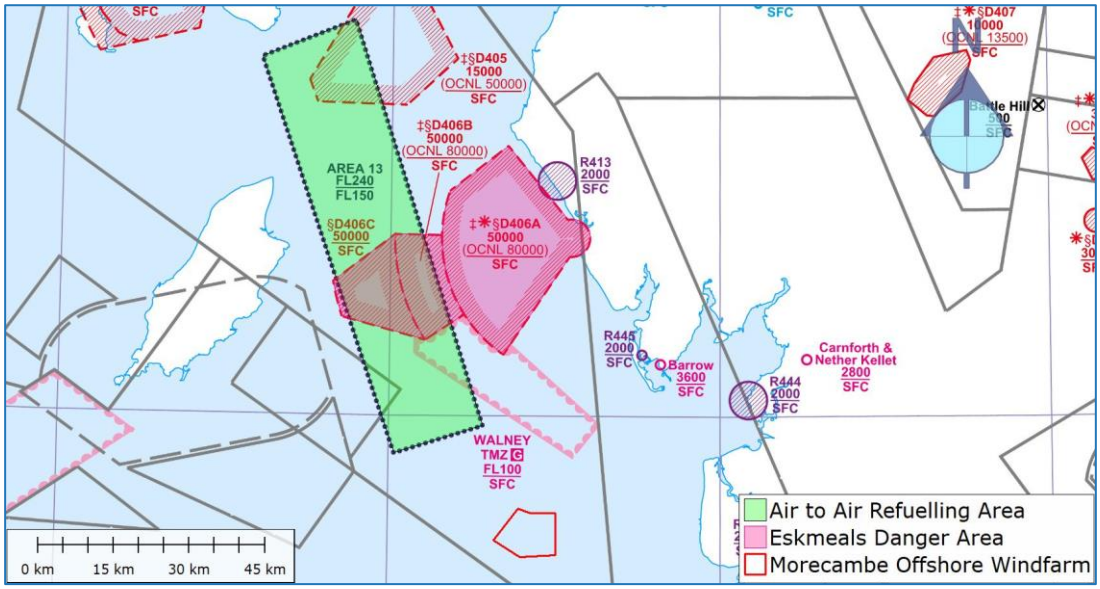

Figure 4: Eskmeals Danger Areas and Air to Air Refuelling Area 13

2.6.3. Also shown in Figure 4 is an Air to Air Refuelling Area, designated Area 13, with vertical limits of FL150, approximately 15,000ft AMSL, to FL240, approximately 24,000ft AMSL. Within such areas, fuel is transferred from tanker aircraft to receiver aircraft under the control of military controllers based at Swanwick. Area 13 is approximately 18km north west of the windfarm site at its closest point.

2.6.4. The Eskmeals Danger Areas and Area 13 airspace are not in operation continuously, but on an 'as notified' basis. A pilot will be informed by an Air Traffic Service Unit about the operational status of the airspace at the time of their flight in the vicinity.

2.7. Transponder Mandatory Zones

2.7.1. Approximately 11km north of the windfarm site is the Walney Transponder Mandatory Zone (TMZ), as shown in Figure 5. Within a TMZ the carriage and operation of aircraft transponder equipment is mandatory. This enables such aircraft to be detected and tracked by Secondary Surveillance Radar (SSR) systems while transiting the Zone. The Walney TMZ is established around the existing Walney, Walney Extension and West of Duddon Sands offshore windfarms and is used to mitigate the impact of the associated WTGs on Warton PSR. The establishment of a TMZ over the windfarm site is one of the potential mitigation measures to be considered during the design process.

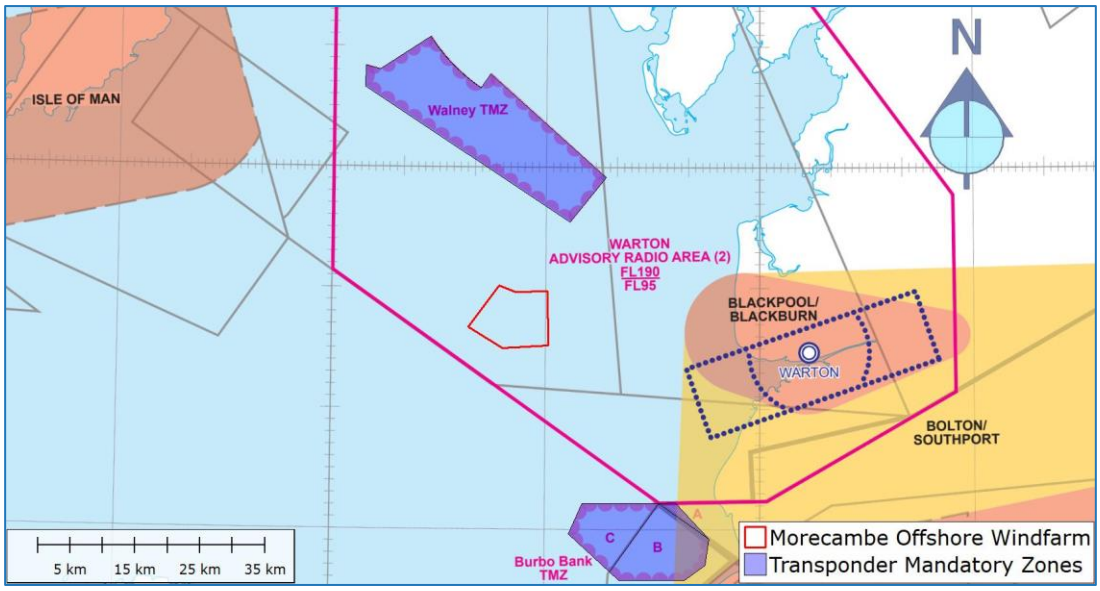

Figure 5: Walney and Burbo Bank TMZs

2.7.2. A further TMZ is established approximately 25km south of the windfarm site. The Burbo Bank TMZ is used to mitigate the impact of the Burbo Bank and Burbo Bank Extensions WTGs on Warton PSR.

2.8. Offshore helidecks

2.8.1. To help achieve a safe operating environment, a 9nm consultation zone for planned obstacles exists around offshore helicopter destinations. Within 9nm, obstacles such as WTGs can potentially impact upon the feasibility of helicopters to safely fly low visibility procedures or missed approaches at the associated helideck site. There are nine offshore helidecks within 9nm of the windfarm site, as depicted in Figure 6. Six helidecks are associated with platforms within the Morecambe Bay gas field (AP1, Calder (CA1), DP1, DP6, DP8, and DPPA), two are associated with platforms within the Liverpool Bay gas field (Hamilton North, Off Shore Storage Installation) and the other is on the Conwy platform.

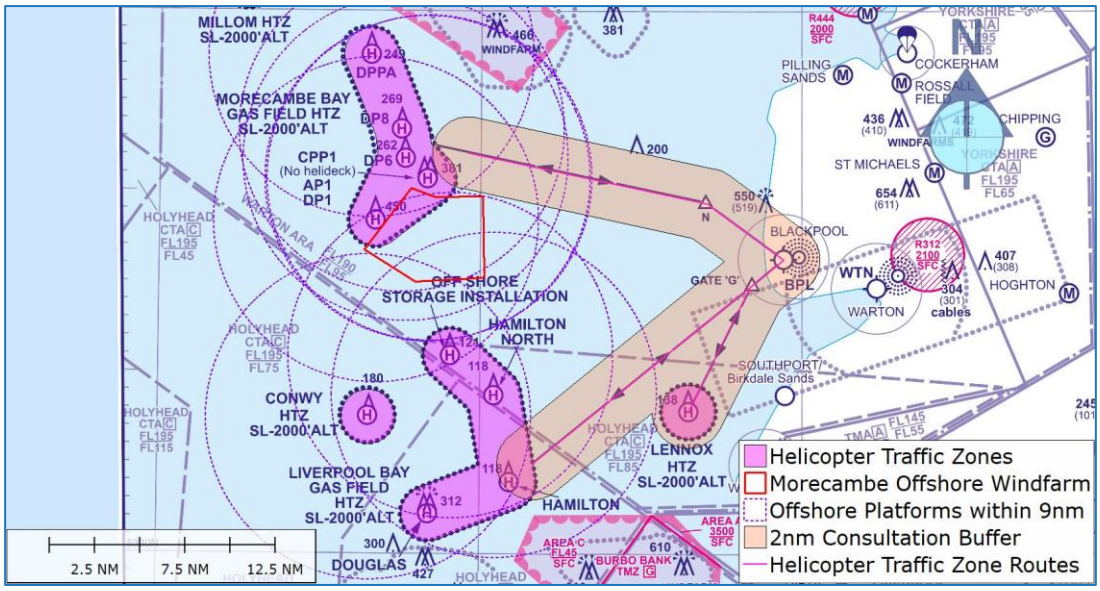

Figure 6: Platforms within 9nm and Helicopter Traffic Zones

2.8.2. The CAA publication Civil Aviation Publication (CAP) 764 Policy and Guidelines on Wind Turbines (CAA, 2016) states that the 9nm zone does not prohibit development but is a trigger for consultation with offshore helicopter operators, the operators of existing installations and exploration and development locations to determine a solution that maintains safe offshore helicopter operations alongside proposed developments. The CAA advises wind energy lease holders, oil and gas developers, and petroleum licence holders to discuss their development plans with each other to minimise the risks of unanticipated conflict.

2.8.3. Helicopter Traffic Zones (HTZs), as highlighted in Figure 6, are established around the Morecambe Bay and Liverpool Bay gas fields and the Conwy platform to notify of helicopters engaged in platform approaches, departures and inter-platform transits. The HTZ airspace is from sea level to 2,000ft AMSL and extends to 1.5nm from the platform helidecks.

2.8.4. Bi-directional routes are established for helicopter support flights from Blackpool Airport to these HTZs, with a normal operating height of 1,000ft AMSL. Whilst these routes have no official classification in airspace terms, they are published on aeronautical charts to alert other airspace users to the potential for frequent low-level helicopter traffic.

2.8.5. CAP 764 states that planned obstacles within 2nm of the route centrelines should be consulted upon with helicopter operators and the Air navigation Service Provider. A 2nm buffer around the HTZ routes is depicted in Figure 6 showing that the windfarm site boundary is beyond 2nm from the route centrelines.

2.9. Search and Rescue

2.9.1. SAR operations are a highly specialised undertaking involving not only aviation assets, but also small boats, ships, and shore-based personnel. SAR operations are generally carried out in extremely challenging conditions and at all times of the day and night. There are 10 helicopter SAR bases, incorporating 22 aircraft, around the UK with Bristow Helicopters providing helicopters and aircrew.

2.9.2. The nearest SAR base is at Caernarfon Aerodrome, approximately 87km (47nm) south west of the windfarm site, and its helicopters provide rescue services throughout the North-West region.

2.9.3. The random nature of people, watercraft or aircraft in distress makes it very difficult to determine the routes taken by SAR aircraft. Fixed wing SAR aircraft would tend to stay at higher altitudes in a command-and-control role during major incidents, whilst helicopters would be used in a low-level role, sometimes in support of small rescue boats.

2.10. Minimum Sector Altitudes

2.10.1. Obstacle clearance

2.10.1.1. Airports with Instrument Flight Procedures (IFPs) published on Instrument Approach Charts (IACs) have associated Minimum Sector Altitudes (MSAs). An MSA defines the minimum safe altitude an aircraft can descend to within a sector of radius 25nm, approximately 46km. These Sectors provide obstacle clearance protection of at least 300m to aircraft within that area. This allows pilots of aircraft flying under Instrument Flight Rules the reassurance of properly designated obstacle and terrain clearance protection whilst making an approach and landing at an airport in poor weather.

2.10.2. Blackpool Airport

2.10.2.1. Blackpool Airport is the nearest UK civil airport to the windfarm site, 31km to the east. IFPs are published for Blackpool Airport in the AIP which show the associated MSA. For example, an extract of the chart for the NDB(L)/DME RWY 10 approach procedure is depicted in Figure 7, overlaid with the windfarm site boundary. The 25nm MSA, shown at the top of the chart, is divided into four sectors. The lowest minimum safe altitude of 2,000ft AMSL is in the south western sector, which extends across the southern boundary of the windfarm site. Note that the MSA altitudes are marked as two digits, the larger digit representing thousands of feet and the smaller one representing hundreds. So, 2,000ft is shown as '2o'.

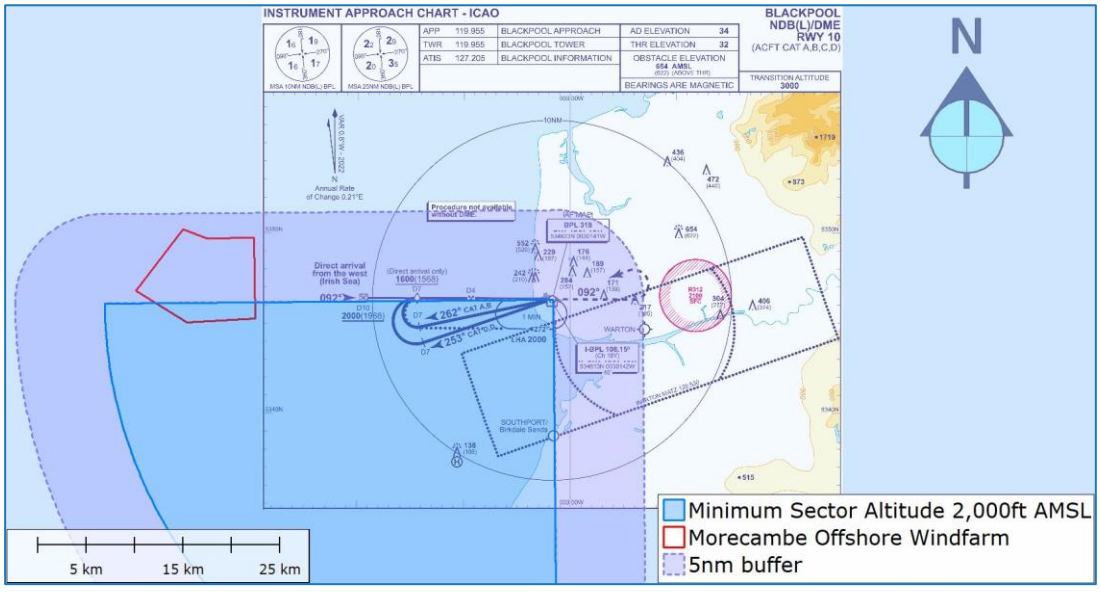

Figure 7: Blackpool Instrument Approach Chart – NDB(L)/DME RWY 10

2.10.2.2. Also highlighted in Figure 7 is a 5nm buffer which is applied when validating the MSA against the highest known obstacles. WTGs with a maximum tip height that exceeds 309.6m AMSL within the south western MSA sector and 5nm buffer will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.2.3. A Required Navigation Performance (RNP) IFP is published for runway 28 at Blackpool Airport. An extract of the IAC is depicted in Figure 8 overlaid with the windfarm site boundary.

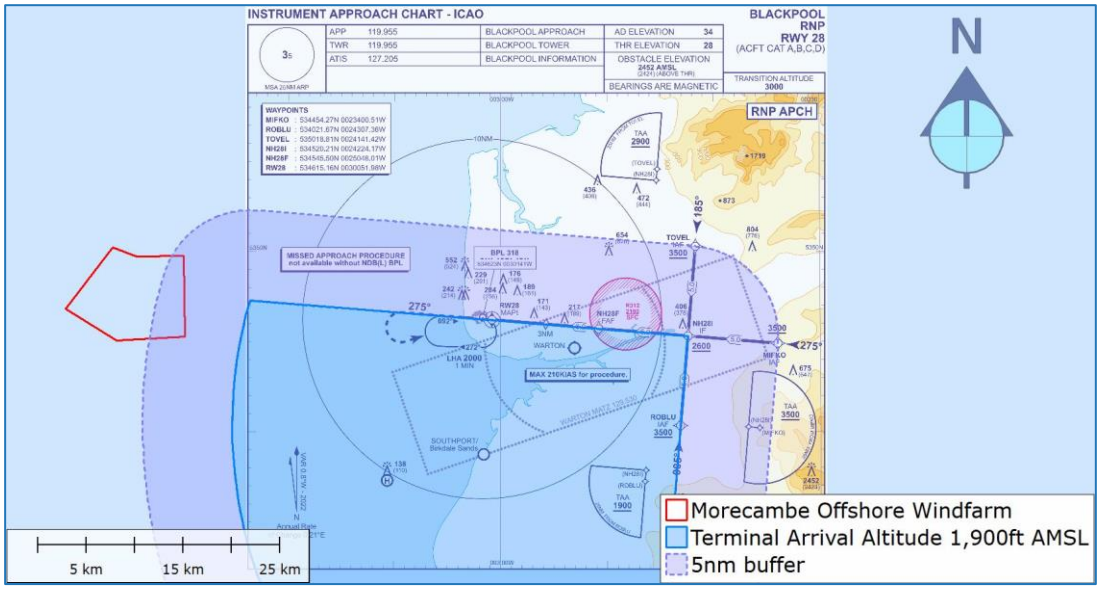

Figure 8: Blackpool Instrument Approach Chart – RNP RWY 28

2.10.2.4. Terminal Arrival Altitudes (TAAs) are associated with RNP approaches and provide the same 300m vertical obstacle clearance as MSAs but are more specific to the 'entry' points into an RNP procedure. The south western TAA is 1,900ft AMSL and is highlighted in Figure 8 along with the 5nm obstacle buffer. WTGs with a maximum tip height exceeding 279.1m AMSL within the 5nm buffer will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.2.5. Potential impacts on Blackpool Airport's IFPs are assessed in more detail in **Appendix 16.2**.

2.10.3. Barrow/Walney Island Aerodrome

2.10.3.1. Barrow/Walney Island Aerodrome is a private airport owned by BAE Systems which lies 37km north east of the windfarm site. The Aerodrome has IFPs published in the AIP with an associated 25nm radius MSA. The south western sector of the MSA extends across the windfarm site, as highlighted in Figure 9 which shows an extract of the chart for the NDB(L)/DME To Aerodrome approach procedure overlaid with the windfarm site boundary.

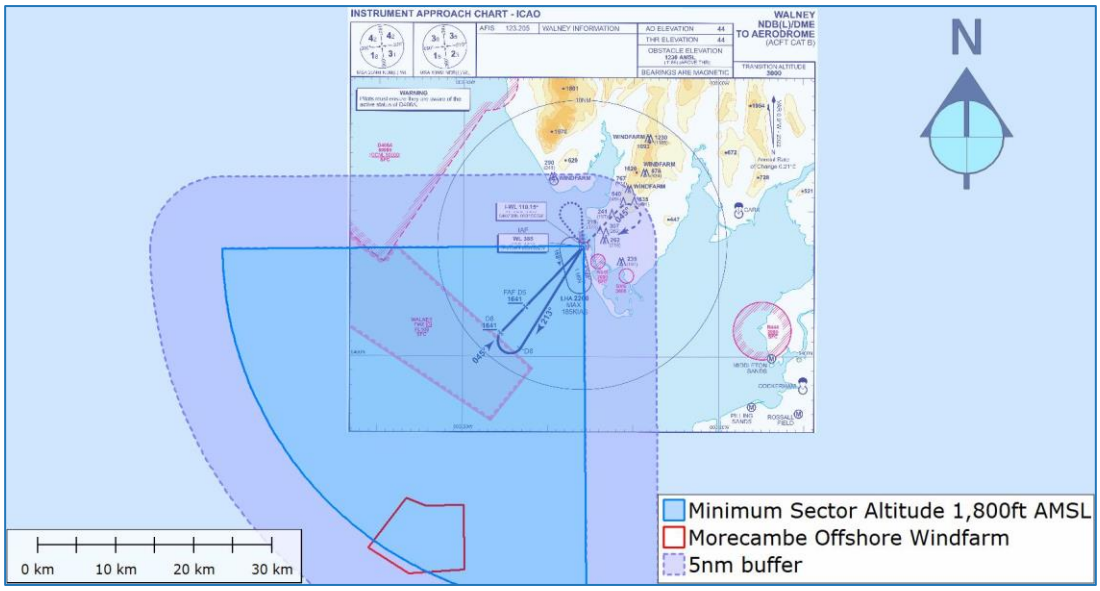

Figure 9: Barrow/Walney Island Instrument Approach Chart – NDB(L)/DME To Aerodrome

2.10.3.2. The lowest minimum safe altitude is 1,800ft AMSL in the south western sector, which means that WTGs within this sector and its buffer area with a maximum tip height exceeding 248.6m AMSL will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.3.3. The RNP IFP for runway 35 at Barrow/Walney Island Aerodrome is depicted in Figure 10 overlaid with the windfarm site boundary.

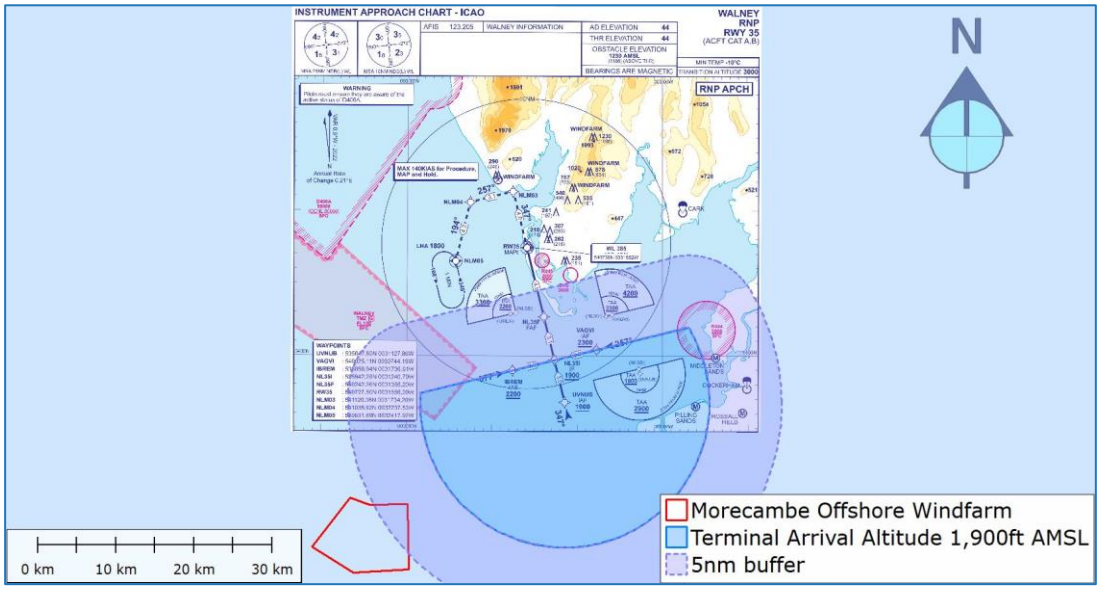

Figure 10: Barrow/Walney Island Instrument Approach Chart – RNP RWY 35

2.10.3.4. The southern TAA is 1,900ft AMSL to a range of 10nm from the waypoint 'UVNUB' and 2,900ft AMSL between 10nm and 25nm from UVNUB. The 10nm range is highlighted in Figure 10 along with the 5nm obstacle buffer. WTGs with a maximum tip height exceeding 279.1m AMSL within the 5nm buffer will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.3.5. Potential impacts on Barrow/Walney Island Airport's IFPs are assessed in more detail in **Appendix 16.3**.

2.10.4. Warton Aerodrome

2.10.4.1. Warton Aerodrome is a private airport owned by BAE Systems which lies 40km east of the windfarm site. The aerodrome is a major assembly and testing facility for military fixed-wing aircraft and has Terminal Approach Procedures (TAPs) published in the UK Military AIP with an associated 25nm MSA.

2.10.4.2. An extract of the chart for the TAC Rwy 07 TAP overlaid with the windfarm site boundary is depicted in Figure 11.

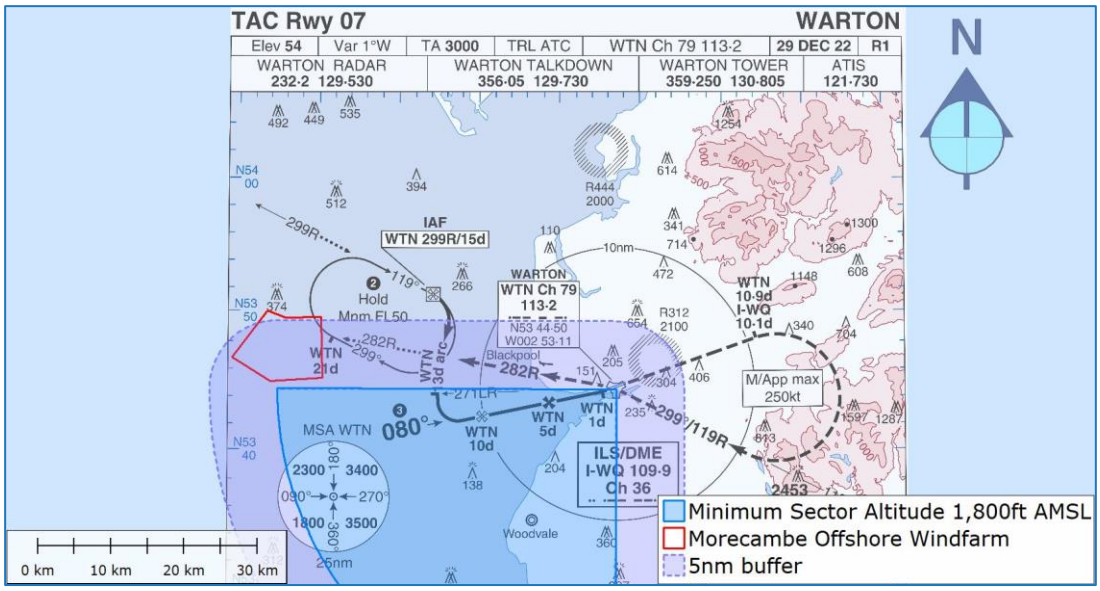

Figure 11: Warton Terminal Approach Procedure Chart – TAC Rwy 07

2.10.4.3. The south western MSA sector has the lowest minimum safe altitude of 1,800ft AMSL, and the 5nm obstacle buffer for this sector extends across the windfarm site, as highlighted in Figure 11. WTGs with a maximum tip height exceeding 248.6m AMSL within the 5nm buffer will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.4.4. Potential impacts on Warton Aerodrome's IFPs are assessed in more detail in **Appendix 16.3**.

2.10.5. RAF Valley

2.10.5.1. Royal Air Force (RAF) Valley is a military station 81km south west of the windfarm site. The station has an ATC Surveillance Minimum Altitude Area (SMAA) published in the UK military AIP that extends to 50nm from the station.

2.10.5.2. The windfarm site is within the confines of the SMAA in an area where the lowest minimum safe altitude is 1,500ft AMSL. WTGs with a maximum tip height exceeding 157.2m AMSL within the ATC SMAA will require the published minimum safe altitude to be increased to maintain the necessary 300m obstacle clearance protection.

2.10.5.3. Potential impacts on RAF Valley's IFPs are assessed in more detail in **Appendix 16.3**.

2.10.6. RAF Woodvale

2.10.6.1. RAF Woodvale is a military station 35km south east of the windfarm site. The station currently does not have any TAPs published in the UK Military AIP.

2.10.7. Area Minimum Altitudes

2.10.7.1. A chart of Area Minimum Altitudes (AMAs) across the London and Scottish FIRs is published in the AIP. An AMA provides a minimum obstacle clearance of 300m within a specified area in the same way as an MSA. The specified areas are formed by lines of latitude and longitude in half degree steps.

2.10.7.2. The windfarm site is within two AMA areas of 1,700ft AMSL, as shown in Figure 12.

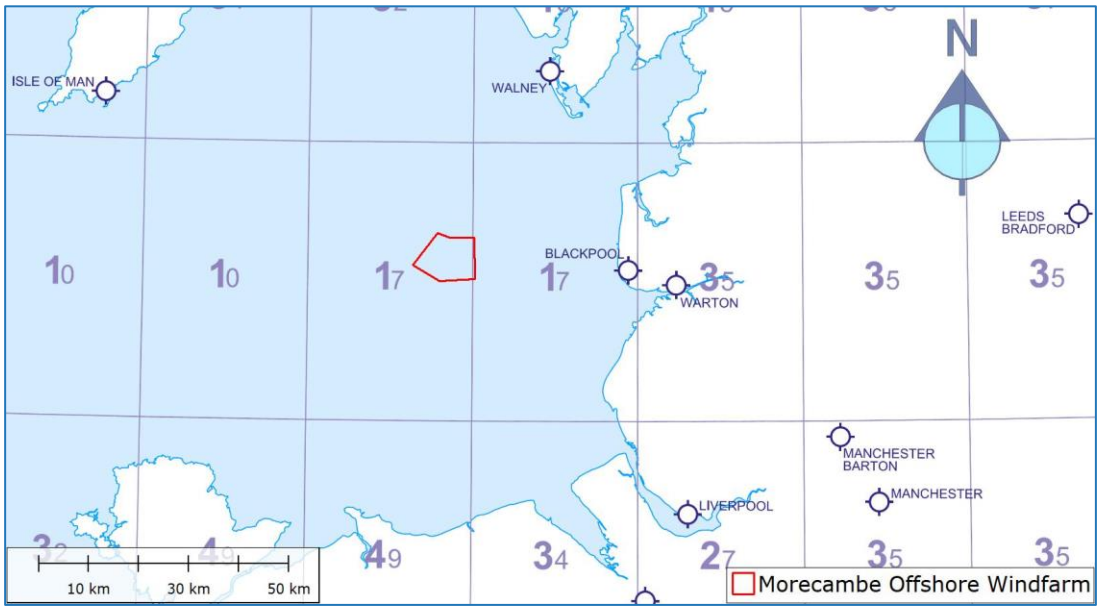

Figure 12: AMAs over the windfarm site

2.10.7.3. WTGs with a maximum tip height exceeding 218.1m AMSL will require the two 1,700ft AMAs to be increased to maintain the necessary 300m obstacle clearance protection.

3. Radar line of sight assessment

3.1. Methodology

3.1.1. RLoS is determined by use of a radar propagation model (ATDI HTZ communications) using 3D DTM data with 25m horizontal resolution. Radar data is entered into the model and RLoS to the WTGs from the radar is calculated.

3.1.2. Note that by using a DTM no account is taken of possible further shielding of the WTGs due to the presence of structures or vegetation that may lie between the radar and the WTGs. Thus, the RLoS assessment is a worst-case result.

3.1.3. For PSR the principal source of adverse windfarm effects are the WTG blades, so RLoS is calculated for the maximum blade tip heights of the WTGs, i.e. 295m and 315m AMSL.

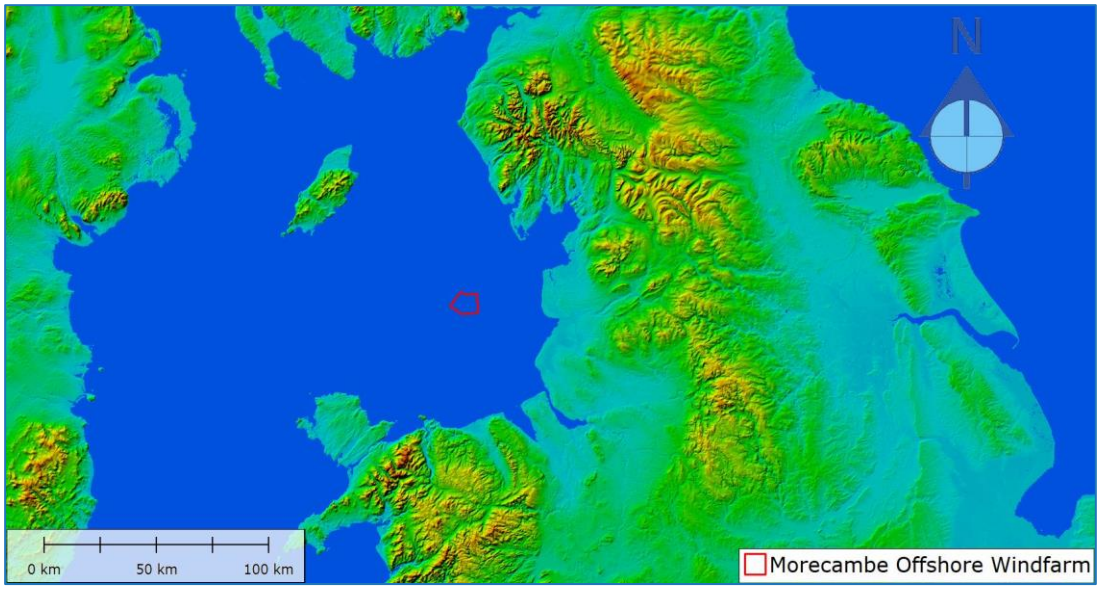

Figure 13: 25m resolution DTM used for RLoS modelling

3.2. Licensed airfields with surveillance radar

3.2.1. Closest civil airfields

3.2.1.1. The closest radar equipped airfields to the windfarm site are Isle of Man, 70km or 38nm to the north west, Liverpool, 63km or 34nm to the south east, Hawarden, 73km or 39nm to the south east and Manchester, 93km or 50nm to the south east. CAP 764 recommends consultation with any aerodromes with a surveillance radar facility that are within 30km of WTGs, however this distance can be greater depending on the type and coverage of the radar and the particular operation at the aerodrome.

3.2.2. Isle of Man

3.2.2.1. Isle of Man RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 14 and Figure 15 respectively.

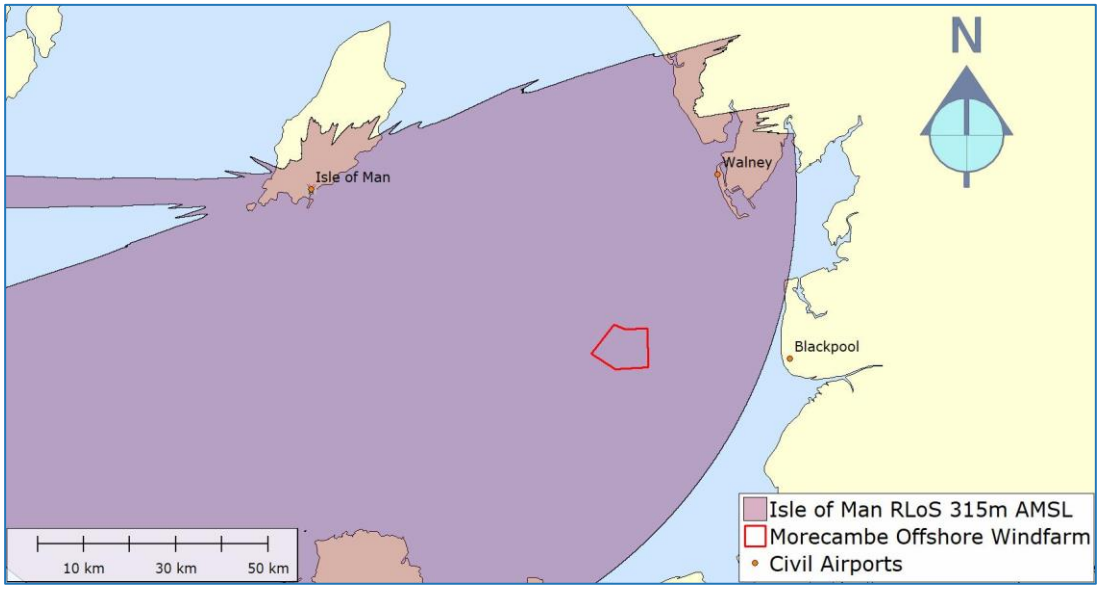

Figure 14: Isle of Man RLoS 315m AMSL

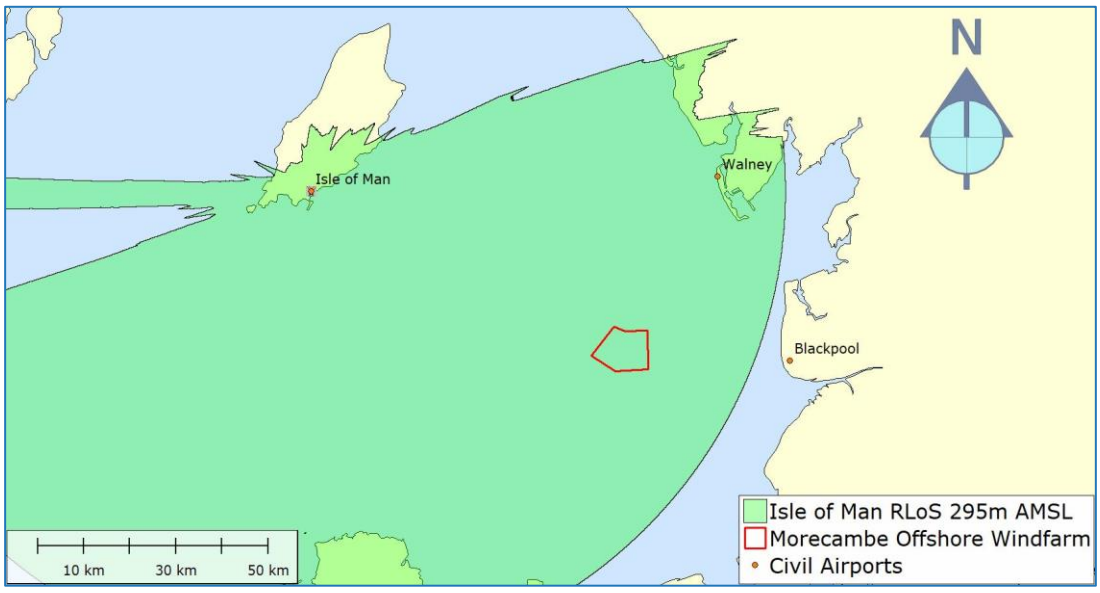

Figure 15: Isle of Man RLoS 295m AMSL

3.2.2.2. All WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the Isle of Man ATCR-33 PSR and highly likely to be detected. However, it is understood that the PSR is only used to a range of 30nm, and, at a minimum range of 38nm it is considered unlikely that Isle of Man ATC will be providing a radar control service for aircraft in the vicinity of the windfarm site. The impact on Isle of Man PSR is therefore not considered to be operationally significant, although this will be confirmed through consultation with the stakeholder.

3.2.3. Liverpool

3.2.3.1. Liverpool RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 16 and Figure 17 respectively.

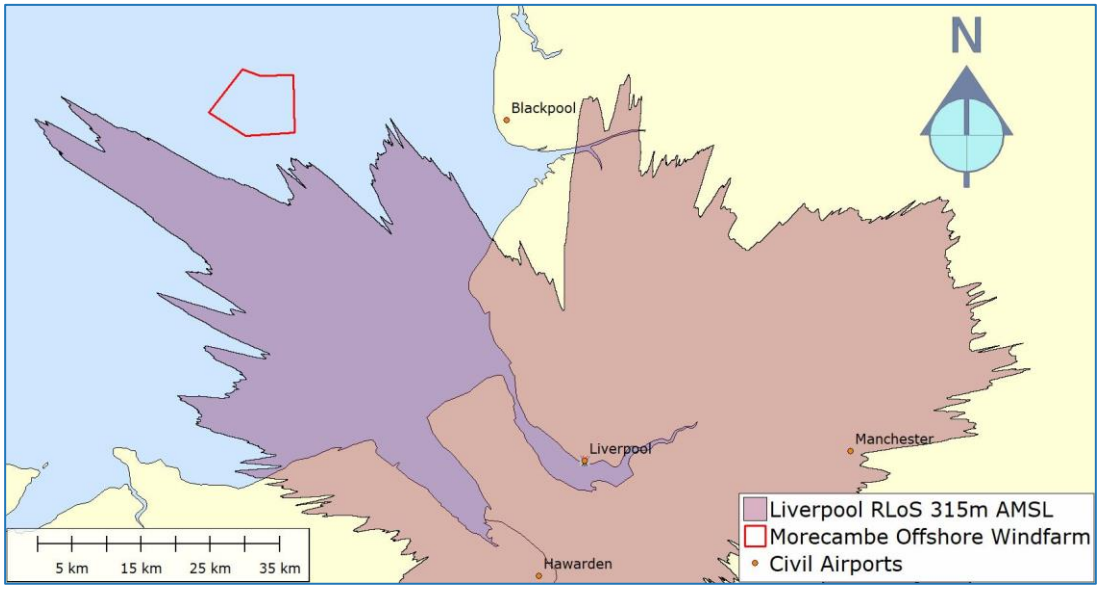

Figure 16: Liverpool RLoS 315m AMSL

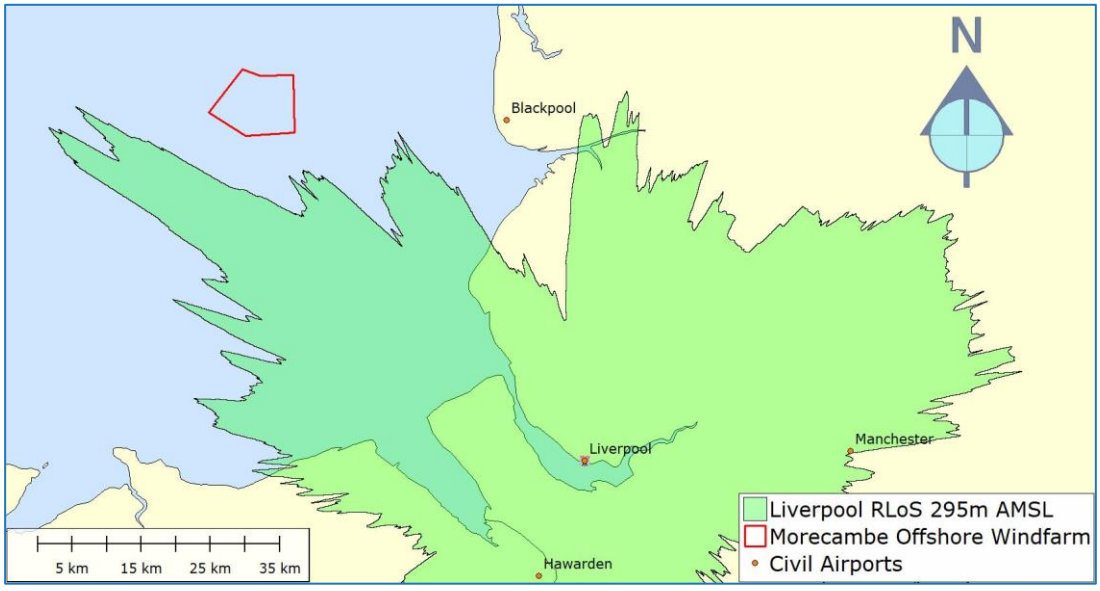

Figure 17: Liverpool RLoS 295m AMSL

3.2.3.2. For blade tip heights of between 295m and 315m AMSL, RLoS coverage of the Liverpool ASR-10SS PSR does not infringe the windfarm site. WTGs within the windfarm site are unlikely to be detected by the Liverpool PSR.

3.2.4. Hawarden

3.2.4.1. There are two PSR facilities installed at Hawarden Airport. The main ATC radar is an Easat EA5025 PSR, while the second radar, a Terma Scanter 4002 PSR, is used as part of a turnkey surveillance solution to mitigate the impact of the Frodsham onshore windfarm WTGs to the north east of the Airport.

3.2.4.2. Hawarden Easat RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 18 and Figure 19 respectively.

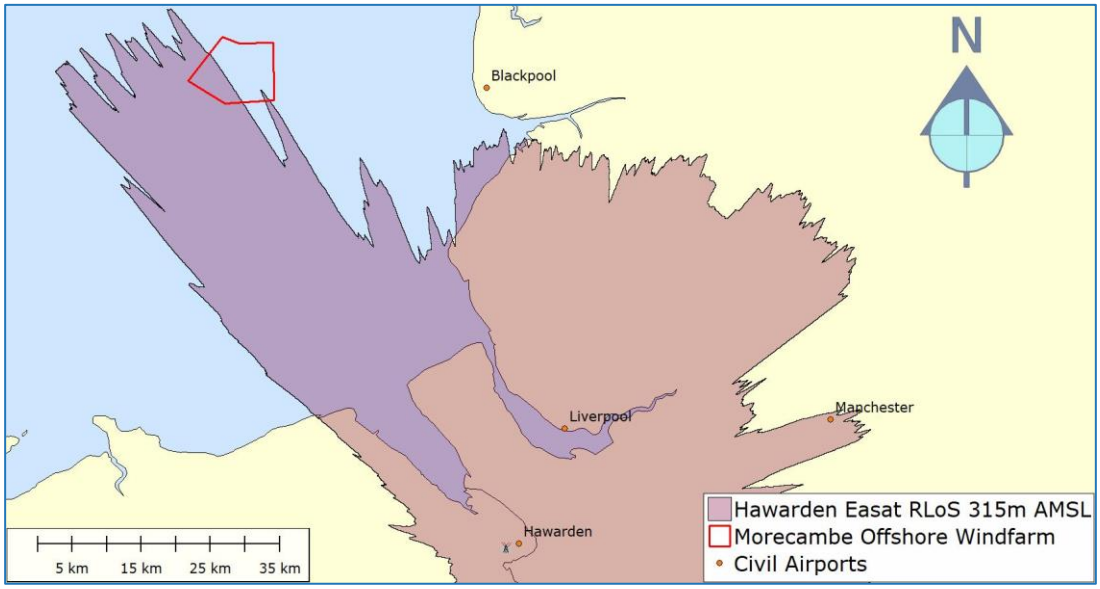

Figure 18: Hawarden Easat RLoS 315m AMSL

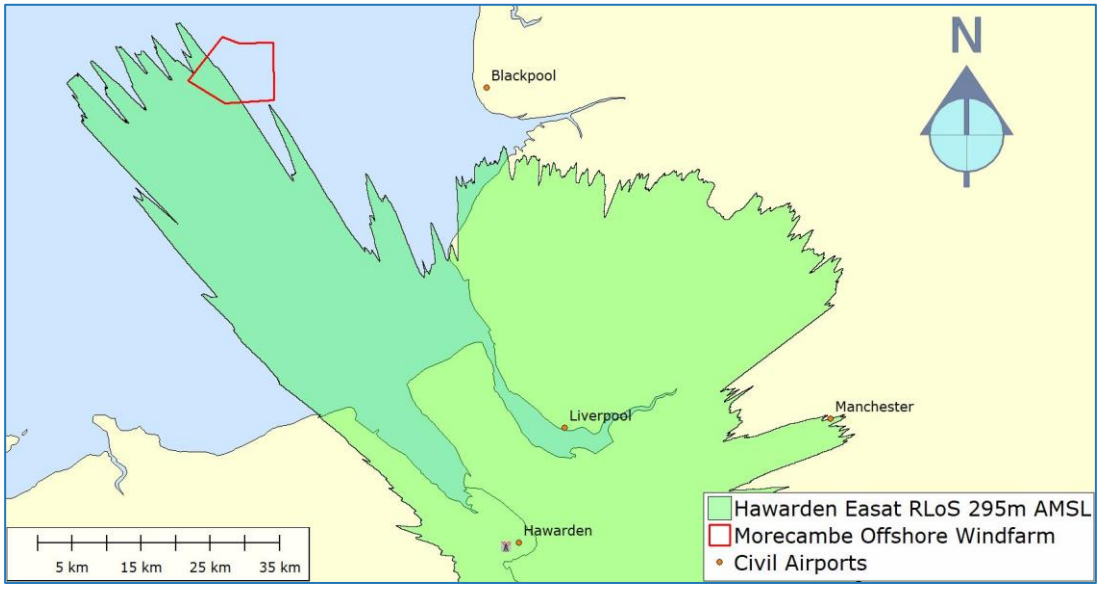

Figure 19: Hawarden Easat RLoS 295m AMSL

3.2.4.3. WTGs with a blade tip height of 315m AMSL will be in RLoS of the Easat PSR primarily in the south western extent of the windfarm site, and within a small area in the south eastern

extent. WTGs with a blade tip height of 295m AMSL will be in RLoS of the Easat PSR in the south western extent of the windfarm site.

3.2.4.4. Any WTGs in RLoS are very likely to be detected by the Easat PSR, however the airspace where the Easat PSR will be impacted is unlikely to be operationally significant for Hawarden Airport. This will be confirmed through consultation with the stakeholder.

3.2.4.5. Hawarden Terma RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 20 and Figure 21 respectively.

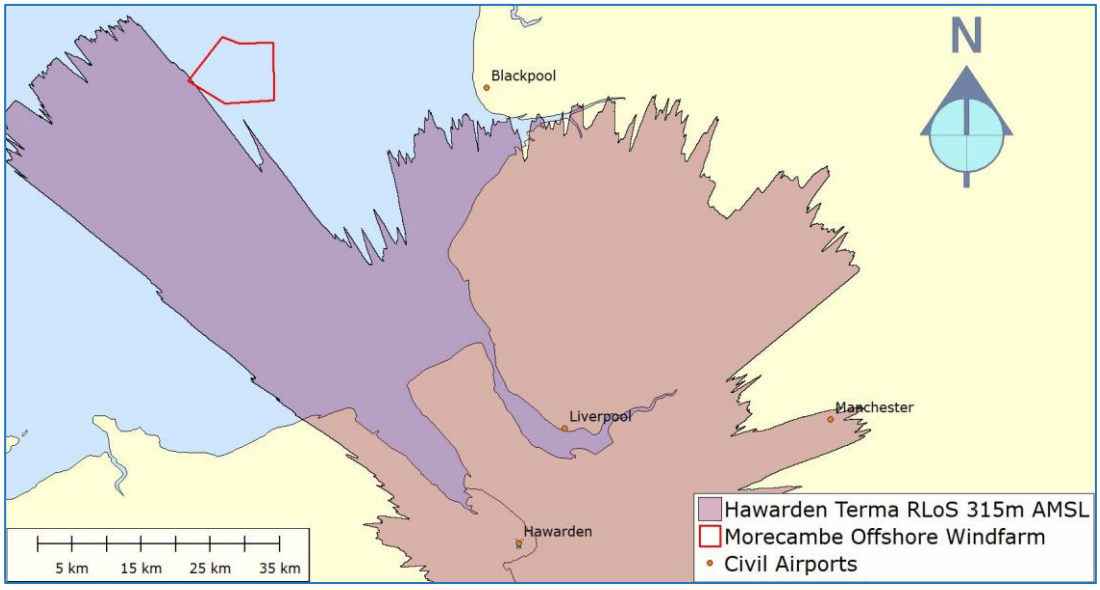

Figure 20: Hawarden Terma RLoS 315m AMSL

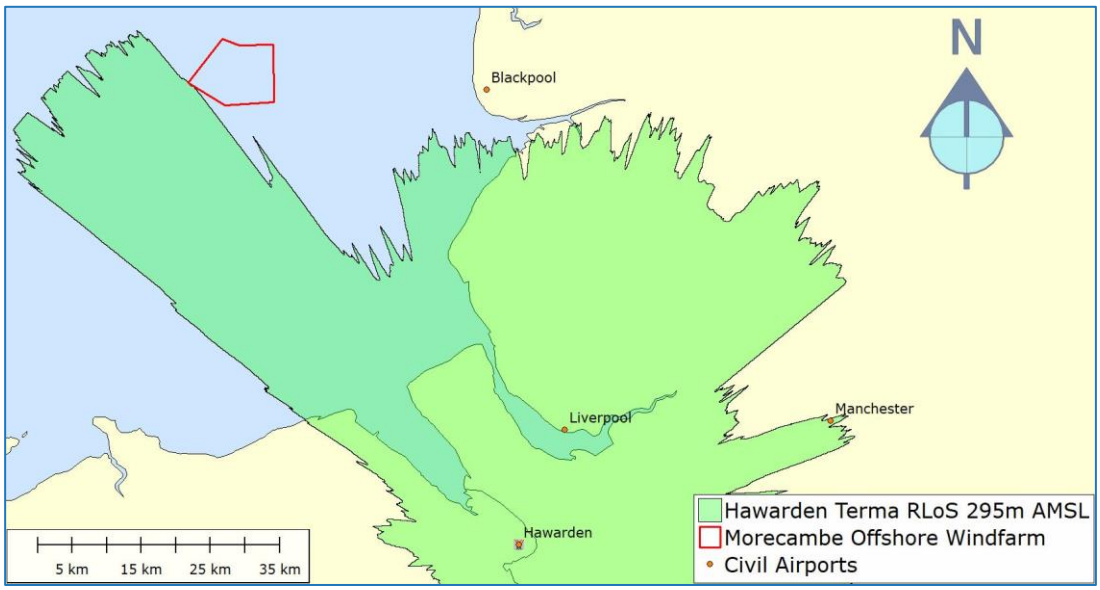

Figure 21: Hawarden Terma RLoS 295m AMSL

3.2.4.6. WTGs within the windfarm site with a blade tip height of 295m AMSL will not be in RLoS of the Terma PSR. For a blade tip height of 315m AMSL, a small area of the windfarm site is in

RLoS of the Terma PSR. However, it is not thought that the Terma PSR is used operationally for surveillance of the airspace in the vicinity of the windfarm site.

3.2.5. Manchester

3.2.5.1. Manchester RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 22 and Figure 23 respectively.

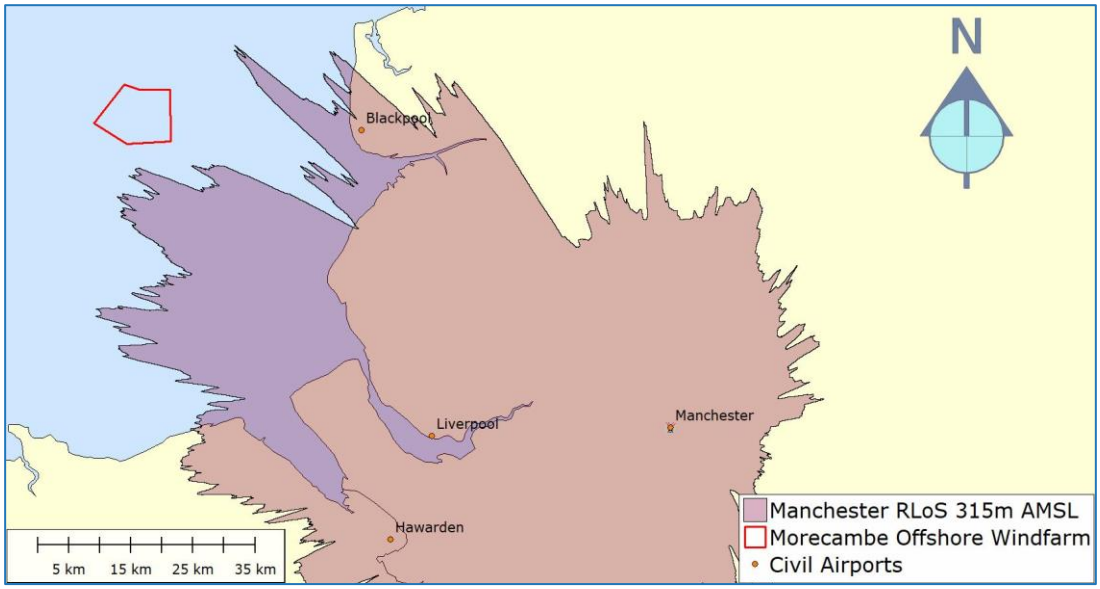

Figure 22: Manchester RLoS 315m AMSL

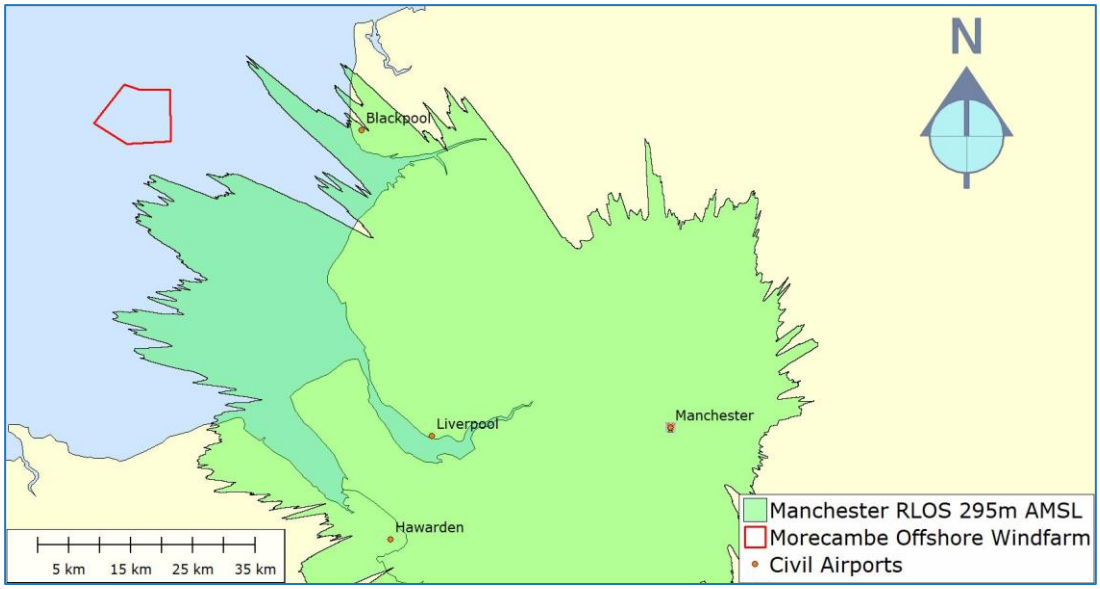

Figure 23: Manchester RLoS 295m AMSL

3.2.5.2. At blade tip heights of 295m and 315m AMSL, no WTGs within the windfarm site will be in RLoS of the Manchester ASR 10-SS PSR. WTGs within the windfarm site are unlikely to be detected by the Manchester PSR.

3.3. Military airfields with surveillance radar

3.3.1. Closest military airfields

3.3.1.1. The closest radar equipped military airfields to the windfarm site are Warton Aerodrome, 40km or 21nm to the east, and Royal Air Force Valley, 81km or 43nm to the south west. A PSR is also installed at MOD West Freugh, a weapons range that is 143km or 77nm north west of the windfarm site.

3.3.2. Warton

3.3.2.1. Warton RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 24 and Figure 25 respectively.

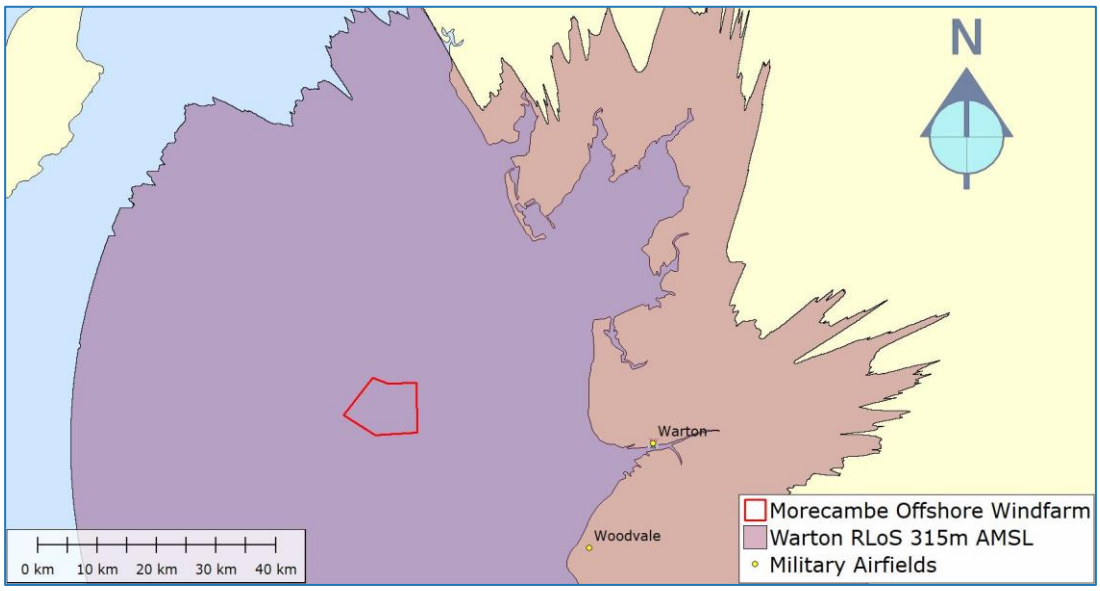

Figure 24: Warton RLoS 315m AMSL

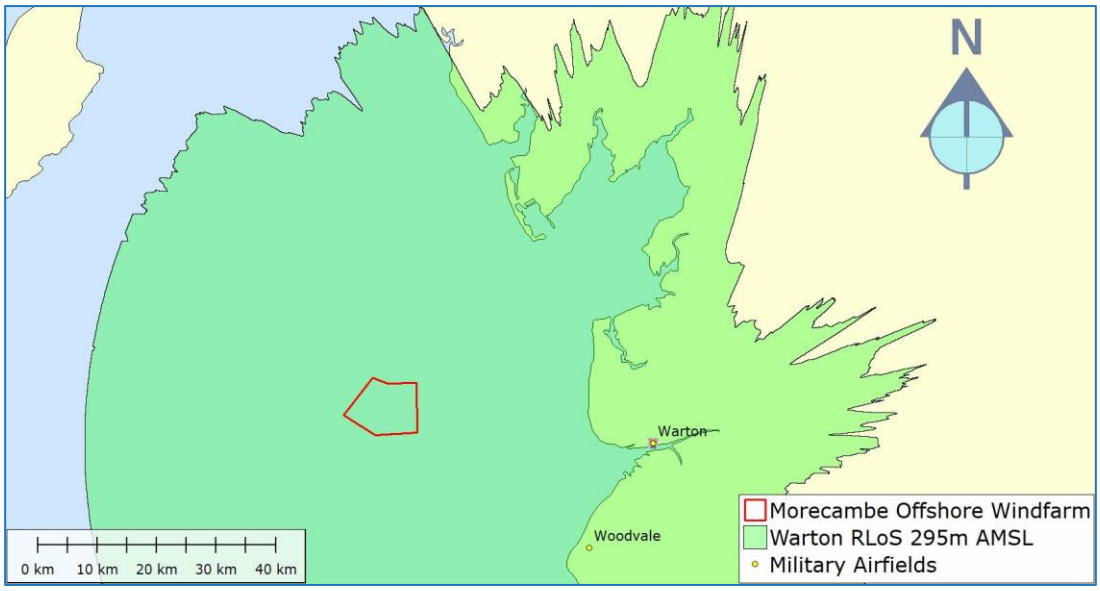

Figure 25: Warton RLoS 295m AMSL

3.3.2.2. All WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the Warton ATCR-44 S PSR and highly likely to be detected. The operational significance of the PSR impact will be confirmed through consultation with the airfield and the MOD.

3.3.3. Valley

3.3.3.1. Valley RLoS coverage for a blade tip height of 315m is shown in Figure 26.

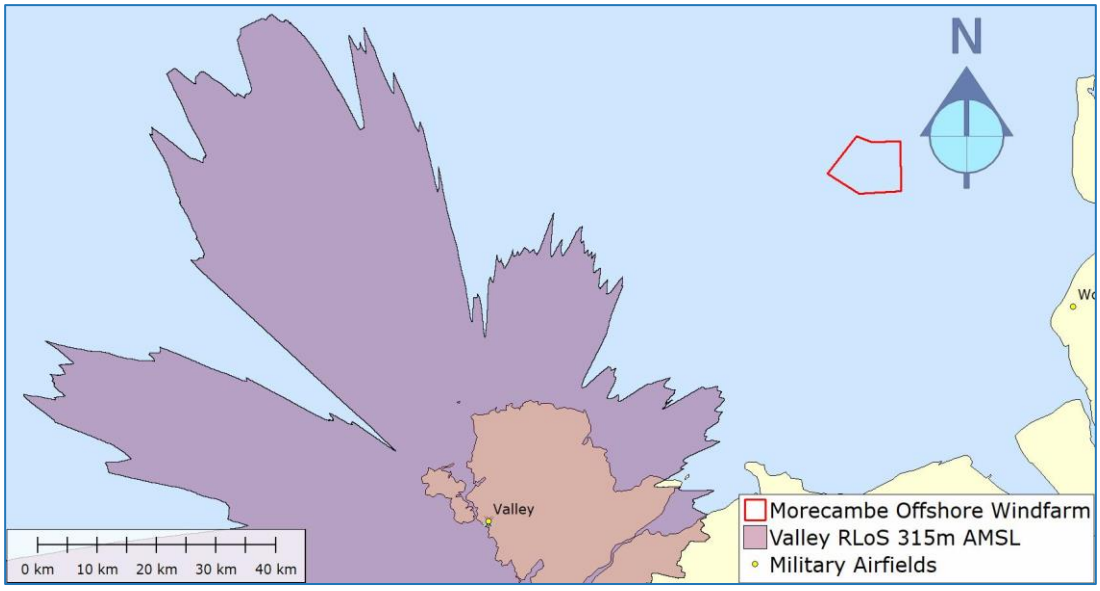

Figure 26: Valley RLoS 315m AMSL

3.3.3.2. No WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the Valley PSR. It is highly unlikely that WTGs with the maximum blade tip height of 315m AMSL will be detected by the Valley PSR.

3.3.4. West Freugh

3.3.4.1. West Freugh RLoS coverage for a blade tip height of 315m AMSL is shown in Figure 27.

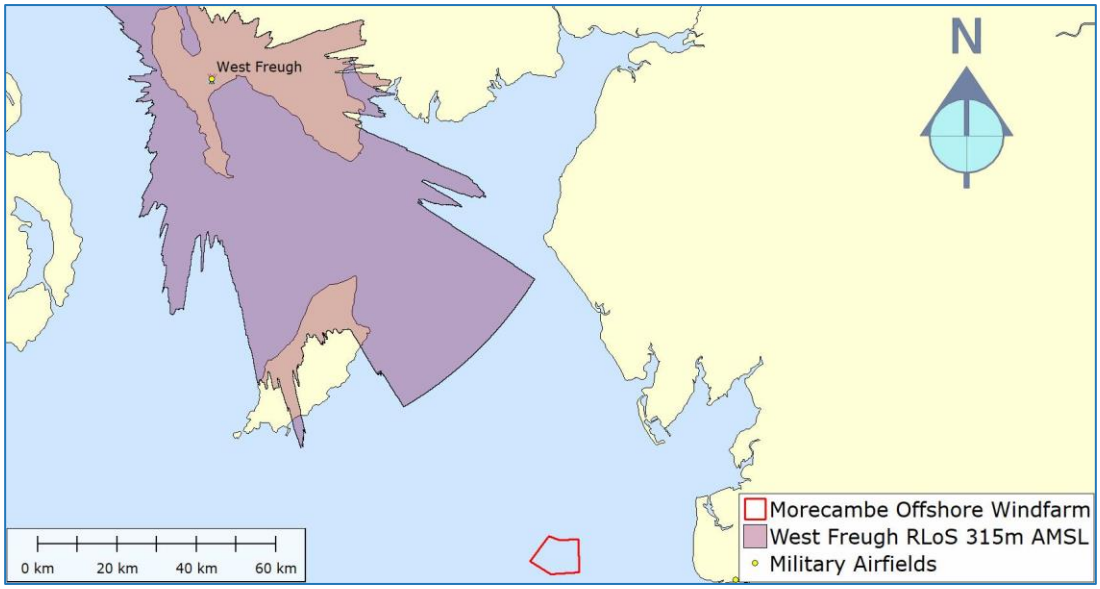

Figure 27: West Freugh RLoS 315m AMSL

3.3.4.2. No WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the West Freugh PSR. It is highly unlikely that WTGs with the maximum blade tip height of 315m AMSL will be detected by the West Freugh PSR.

3.4. NERL radars

3.4.1. Closest NERL radars

3.4.1.1. The closest NERL radars to the windfarm site are at St Annes, 33km or 18nm to the east, Great Dun Fell, 117km or 63nm to the north east, Clee Hill, 162km or 87nm to the south, and at Lowther Hill, 172km or 93nm to the north.

3.4.2. St Annes

3.4.2.1. St Annes RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 28 and Figure 29 respectively.

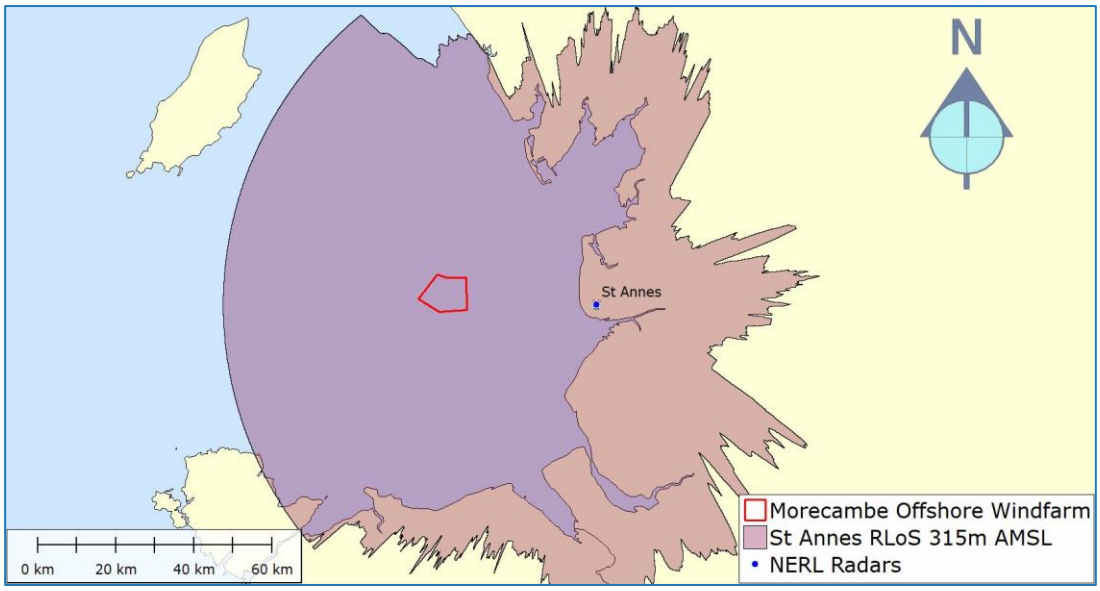

Figure 28: St Annes RLoS 315m AMSL

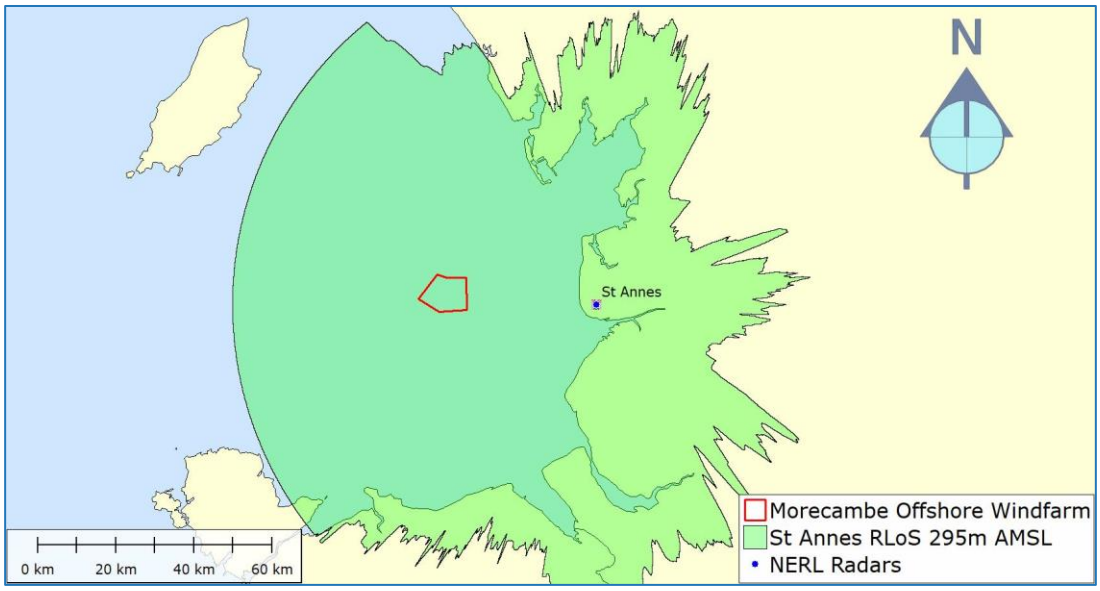

Figure 29: St Annes RLoS 295m AMSL

3.4.2.2. All WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the St Annes ASR-10SS PSR and highly likely to be detected. The impact on St Annes PSR is likely to be operationally significant, and a mitigation solution will need to be agreed in consultation with NATS.

3.4.3. Great Dun Fell

3.4.3.1. Great Dun Fell RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 30 and Figure 31 respectively.

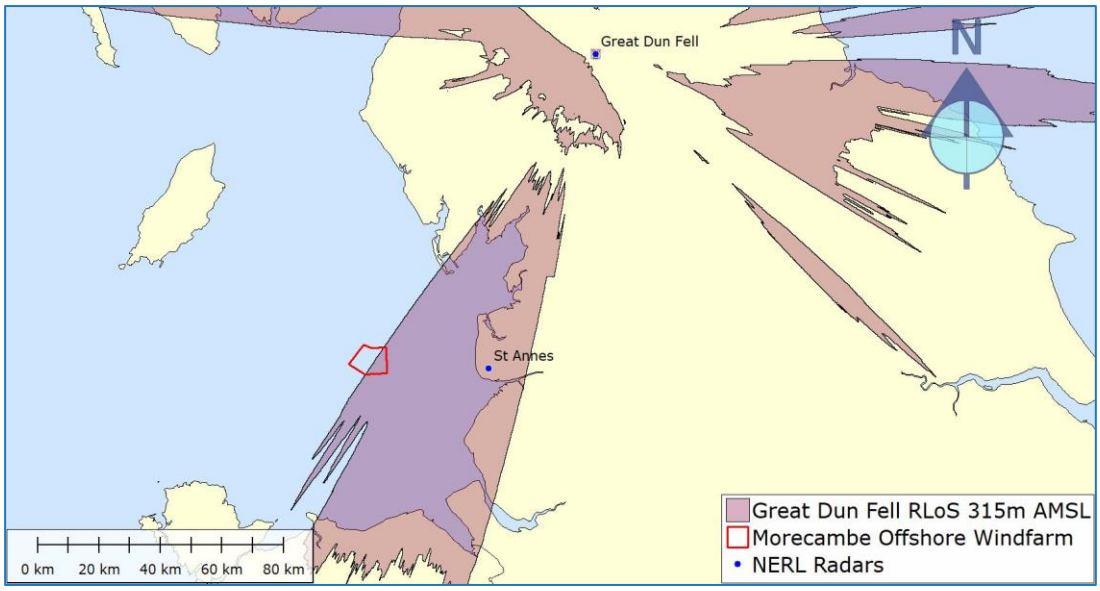

Figure 30: Great Dun Fell RLoS 315m AMSL

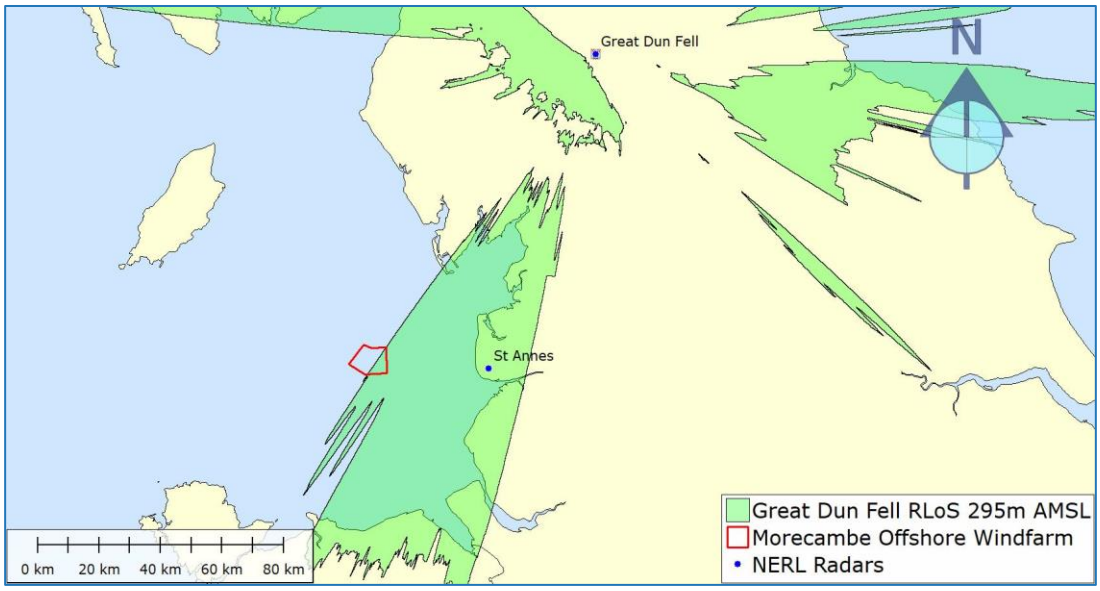

Figure 31: Great Dun Fell RLoS 295m AMSL

3.4.3.2. All WTGs within the south eastern extent of the windfarm site, irrespective of blade tip height, will be in RLoS of the Great Dun Fell ASR-23 PSR and highly likely to be detected. The impact on Great Dun Fell PSR is likely to be operationally significant, and a mitigation solution will need to be agreed in consultation with NATS.

3.4.4. Clee Hill

3.4.4.1. Clee Hill RLoS coverage for a blade tip height of 315m AMSL is shown in Figure 32.

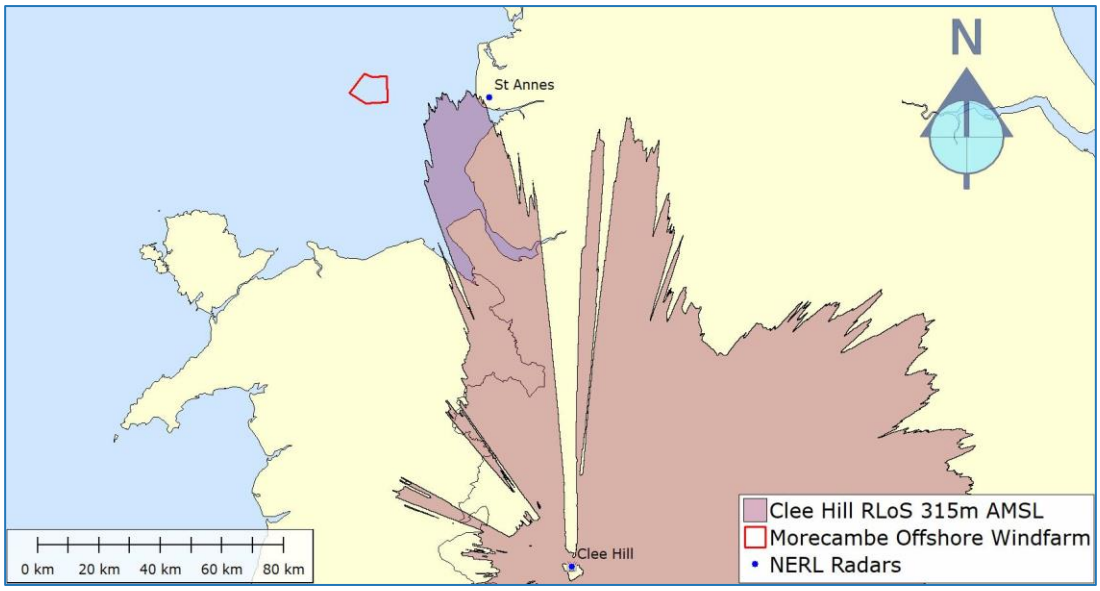

Figure 32: Clee Hill RLoS 315m AMSL

3.4.4.2. No WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of the Clee Hill PSR. It is highly unlikely that WTGs with the maximum blade tip height of 315m AMSL will be detected by the Clee Hill PSR.

3.4.5. Lowther Hill

3.4.5.1. Lowther Hill RLoS coverages for blade tip heights of 315m and 295m AMSL are shown in Figure 33 and Figure 34 respectively.

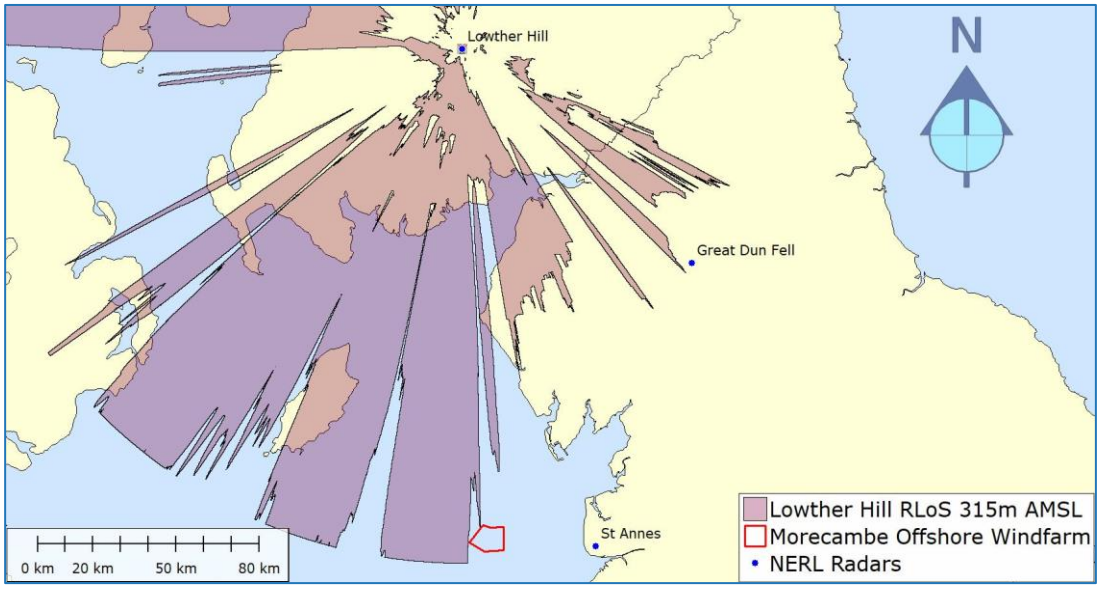

Figure 33: Lowther Hill RLoS 315m AMSL

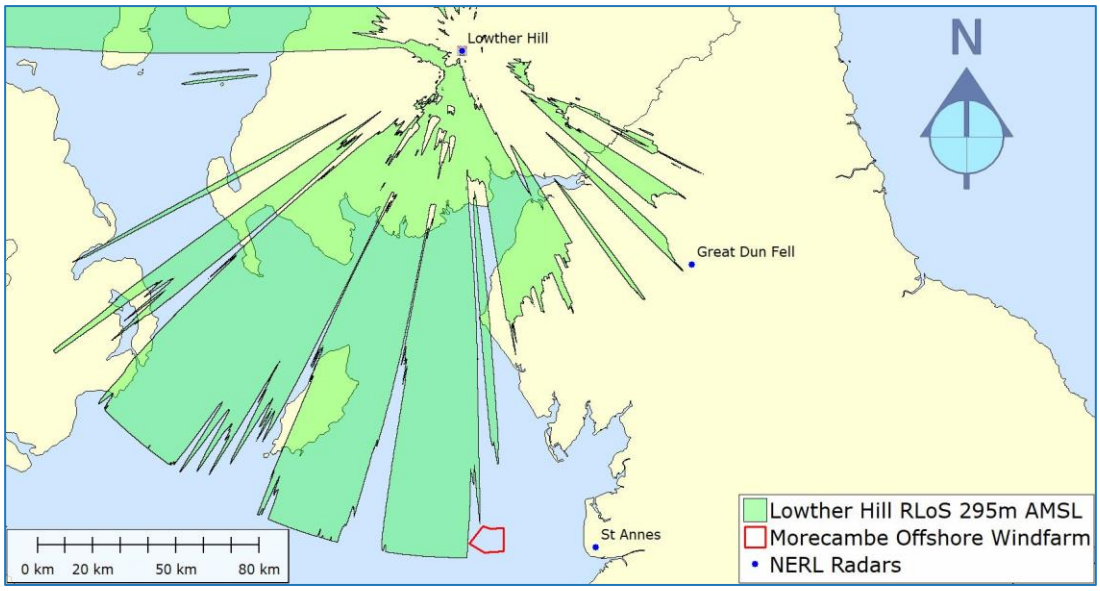

Figure 34: Lowther Hill RLoS 295m AMSL

3.4.5.2. WTGs with a blade tip height of 315m AMSL will be in RLoS of the Lowther Hill PSR in one very small area of the windfarm site, to the north west. WTGs within the windfarm site with a blade tip height of 295m AMSL will not be in RLoS of the Lowther Hill PSR.

3.4.5.3. Any WTGs in RLoS are highly likely to be detected by the Lowther Hill PSR, however the PSR is an advanced new Indra 3D radar that can use clutter mitigation techniques to filter out false returns from WTGs. Re-configuration of the PSR may allow the impact of any detected WTGs within the windfarm site to be mitigated.

3.5. MOD air defence radars

3.5.1. The closest air defence radars to the windfarm site are based at Remote Radar Head (RRH) Staxton Wold, 205km or 110nm to the east, RRH Brizlee Wood, 209km or 113nm to the north east, and at RRH Neatishead, 351km or 190nm to the south east.

3.5.2. RLoS coverages for a blade tip height of 315m AMSL are shown for all three air defence radars in Figure 35.

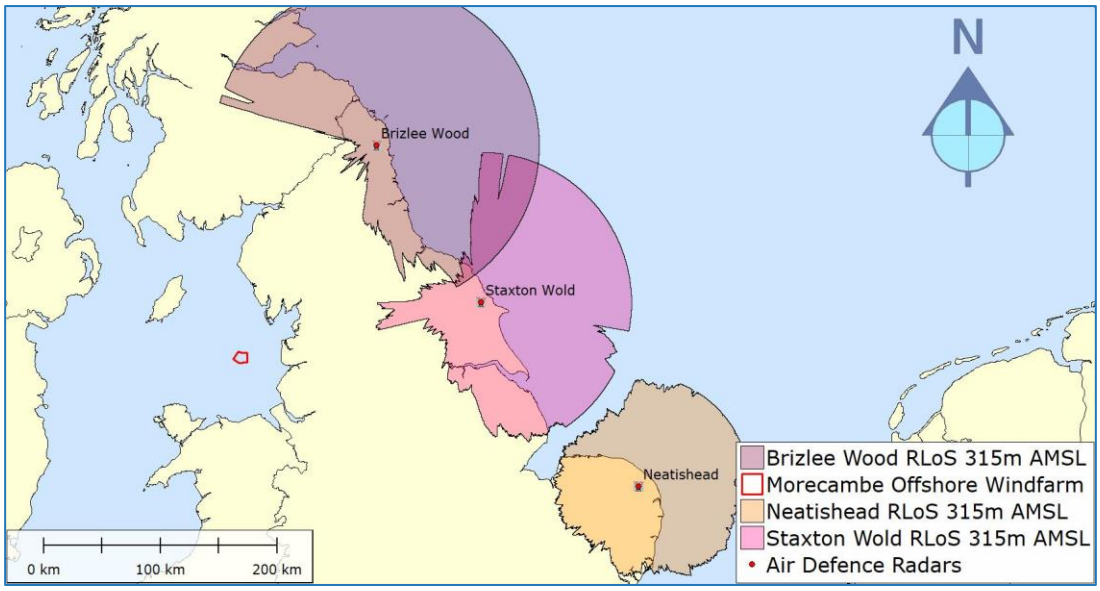

Figure 35: RLoS 315m AMSL for air defence radars

3.5.3. No WTGs within the windfarm site, irrespective of blade tip height, will be in RLoS of any air defence radars. WTGs with the maximum blade tip height of 315m AMSL will not be detected by any air defence radars.

3.6. Radar mitigation

3.6.1. Possible mitigation options for WTGs that are detected by PSRs include blanking of the radar in the impacted area, blanking combined with infill from an alternative radar feed that is not impacted by the WTGs, or blanking combined with the imposition of a TMZ.

3.6.2. A TMZ allows ATC to track an aircraft target using solely SSR within an area in which PSR clutter may otherwise have obscured the target.

3.6.3. NERL's network of radars feed their overlapping coverage data into a Multi Radar Tracking (MRT) system, producing an integrated radar picture for users at its control centres at Swanwick and Prestwick. As it has been shown that it is highly unlikely that Clee Hill PSR will detect WTGs within the windfarm site, this radar could potentially provide suitable infill data for the other impacted NERL PSRs.

3.7. Infill mitigation – Clee Hill PSR

3.7.1. Clee Hill RLoS coverage over the windfarm site is depicted in Figure 36 at altitudes of 4,000ft, 4,500ft and 5,000ft AMSL.

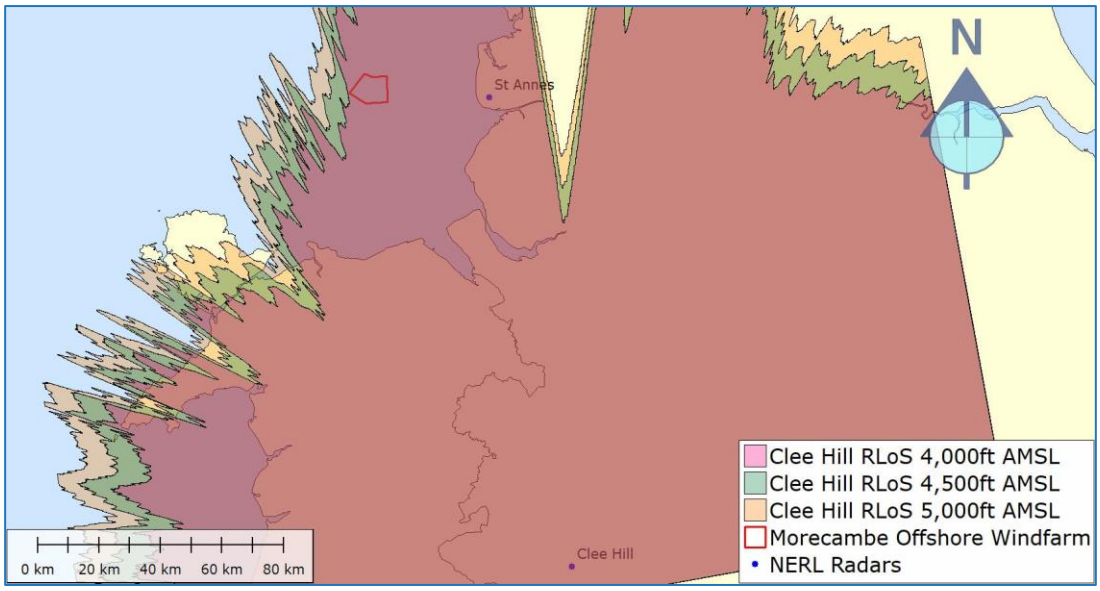

Figure 36: Clee Hill PSR RLoS coverage at 4,000ft, 4,500ft and 5,000ft AMSL

3.7.2. Clee Hill PSR has RLoS coverage down to 4,000ft AMSL over the entire windfarm site.

3.8. Infill mitigation – Lowther Hill PSR

3.8.1. Should re-configuration of Lowther Hill PSR to filter out WTG clutter be a viable mitigation for this facility, then data from Lowther Hill PSR could also be used as part of an infill solution.

3.8.2. Lowther Hill RLoS coverage over the windfarm site is depicted in Figure 37 at altitudes of 3,000ft, 3,500ft and 4,000ft AMSL.

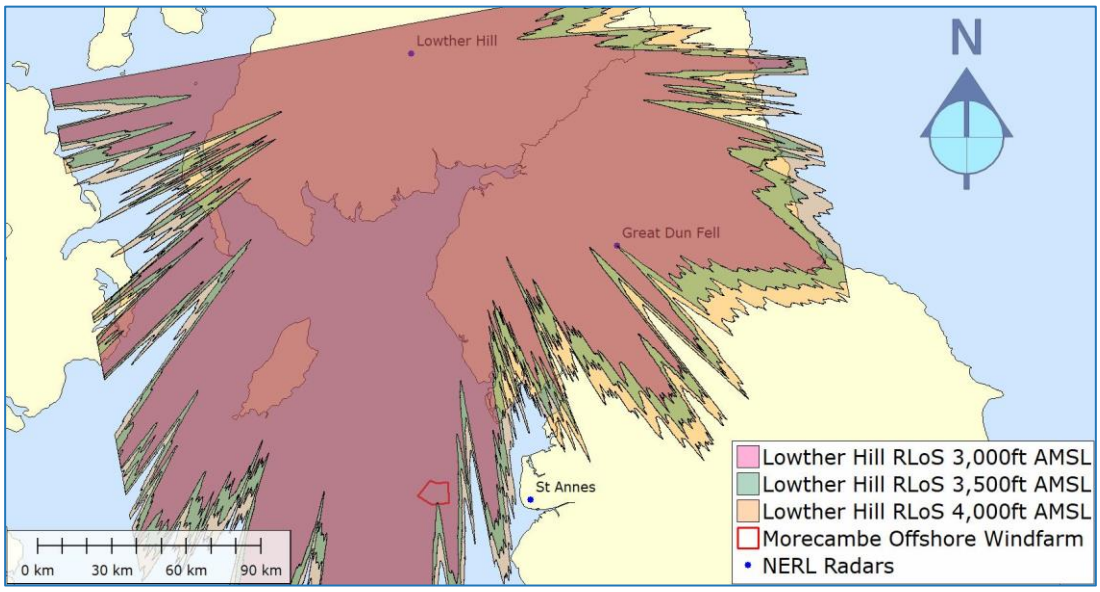

Figure 37: Lowther Hill PSR RLoS coverage at 3,000ft, 3,500ft and 4,000ft AMSL

3.8.3. Lowther Hill PSR has RLoS coverage down to 3,000ft AMSL over the windfarm site.

3.9. Consultation on mitigation

3.9.1. Potential mitigation measures will be consulted upon with stakeholders throughout the development of the Project design and will also reflect appropriate measures that are being discussed at an industry level.

References

[1] CAP 764 Policy and Guidelines on Wind Turbines (CAA, 2016)

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