

Environmental Impact Assessment

# Sandy Knowe Wind Farm Extension

## Chapter 13: Other Considerations

ERG UK Holding Ltd



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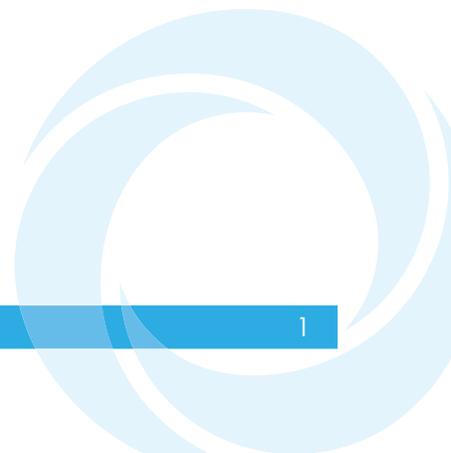
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### Glossary of Terms

Term	Definition
The Applicant	ERG UK Holding Limited
The Agent	Atmos Consulting Limited
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of carrying out, in a systematic way, an assessment of the likely significant environmental effects from a development.
Environmental Impact Assessment Regulations	The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (EIA Regulations)
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations
The Proposed Development	The Sandy Knowe Wind Farm Extension
The Proposed Development Site	The area within which the Proposed Development will be located

### List of Abbreviations

Abbreviation	Description
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ECU	Energy Consents Unit



## 13 Other Considerations

### 13.1 Introduction

This Chapter summarises the potential effect of the Proposed Development on aviation and telecommunications and the potential shadow flicker effects on sensitive receptors. Stakeholders have been consulted during the EIA process, and a summary of consultation responses is listed in Table 13-1.

### 13.2 Methodology and Approach

#### 13.2.1 Legislation, Planning Policy and Guidance

Planning policy at a national and local level and its relevance to environmental design and assessment is discussed in Chapter 4 of this EIAR. The key planning policies and guidance relevant to this Chapter are set out below along with other reference documentation related to each of the technical areas.

##### Planning Policy

- The National Planning Framework (NPF)3;
- Scottish Planning Policy (SPP);
- Scottish Government web-based Advice 'Onshore wind turbines: planning advice'; and
- Dumfries and Galloway Council Local Development Plan 2 (LDP2).

##### Aviation and Radar

- Civil Aviation Authority (CAA), 1:250,000 and 1:500,000 VFR Charts;
- Civil Aviation Publication (CAP) CAP 168 Licensing of Aerodromes, March 2019;
- CAP 493 Manual of Air Traffic Services Part 1, November 2017;
- CAP 670 ATS Safety Requirements, August 2019;
- CAP 738 Safeguarding of Aerodromes, December 2006;
- CAP 764 Policy and Guidance on Wind Turbines, February 2016;
- CAP 774 UK Flight Information Services, May 2017;
- CAP 793 Safe Operating Practices at Unlicensed Aerodromes, July 2010;
- Joint Ministry of Defence (MoD)/CAA Wind Farm Interim Guidelines;
- Low Flying Operations Squadron Wind Farm Assessment Criteria (Briefing Document 20071128 U TTA WF 2009/2011/2013);
- Military Aviation Authority Low Flying Manual, April 2019;
- Military Aviation Authority Manual of Aerodrome Design and Safeguarding, March 2019;
- Military Aviation Authority Traffic Management (3000 series) Instructions, October 2016;
- UK Aeronautical Information Publications (AIP); and
- UK Military Aeronautical Information Publication (MIL AIP).

## Telecommunications and Television

- Tall Structures and their Impact on Broadcast and other Wireless Services, 2009, Ofcom.

## Shadow Flicker

- Update of UK Shadow Flicker Evidence Base, 2010, Parsons Brinckerhoff (DECC, 2011); and
- Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014).

## 13.2.2 Consultation

The assessment process has been informed by consultation with the ECU including the Scoping Opinion (October 2021). A summary of the key consultation responses is described in Table 13-1.

Consultation and discussions with aviation stakeholders are ongoing and it is likely that the outcome of these discussions will be during the determination of the Proposed Development. Currently there are continuing discussions with Glasgow Prestwick Airport (GPA), NATS and Glasgow Airport.

**Table 13-1: EIA Consultation – Aviation and telecommunication**

Consultee	Scoping Comment	Applicant Response
Ministry of Defence	Subject to the conditions detailed in Appendix A of the MOD scoping response, the MOD has no concerns to the proposed development	Noted.
	The addition of turbines in this location has the potential to introduce a physical obstruction to low flying aircraft operating in the area. The MOD will request that Proposed Development turbines will be fitted with 25 candela omni-directional red lighting or infrared lighting with an optimised flash pattern of 60 flashes per minute of 200ms to 500ms duration at the highest practicable point.	A lighting scheme is already in place for Sandy Knowe Wind Farm. Since receipt of the Scoping Opinion the Applicant has engaged further with the MOD with regards to a potential lighting scheme for the Proposed Development in combination with Sandy Knowe Wind Farm.
Edinburgh Airport	Confirmed the location of this development falls out with their Aerodrome Safeguarding zone for Edinburgh Airport therefore they have no objection/comment.	No further action required.
Glasgow Airport (GA)	Site is outwith obstacle limitation surfaces for GA, outwith radar consultation area for GA and is within the Instrument Flight Procedure area for GA and may impact upon procedures. Engagement with GA recommended to fully assess potential impact. Final position confirmed upon full planning application.	The Applicant is engaging with Glasgow Airport to discuss the potential impacts on the Instrument Flight Procedure area. Glasgow Airport has confirmed that although the proposed development is within the area of their IFP's, the current locations and heights would not have any impact. They have also confirmed that no impacts are predicted on the OLS or their radar.
Glasgow Prestwick	Preliminary Line of Sight (LOS) analysis at the proposed turbine tip heights of 149.9m for the	Engagement with GPA is ongoing.

Consultee	Scoping Comment	Applicant Response
Airport (GPA)	Sandy Knowe Wind Farm Extension – indicates that all 6 turbines would be visible to the GPA primary radar(s), and GPA request the Developer engages with GPA on this matter – to allow a more detailed radar LOS modelling assessment to be undertaken to establish the visibility (or otherwise) of the proposed scheme to GPA's primary radars.	
	Given the tip height (149.9m) of the proposed turbines, we also request that the Developer engages with GPA to establish fully if the proposed development is likely to have any impact on our published Instrument Flight Procedures (IFP's) – both conventional and RNAV/RNP published IFP's as published in the UK Aeronautical Information Publication (AIP) for GPA (EGPK).	A review of all published Glasgow Prestwick Airport IFPs has been undertaken as requested by the airport safeguarding team. Nine specific procedures were identified within five nautical miles of the proposed turbines. The minimum vertical clearance between an aircraft on any of these procedures and the highest proposed turbine tip is approximately 2600 feet (792 metres). It is likely that the procedures could comfortably accommodate the wind farm. Engagement with GPA is ongoing.
	A preliminary ATC Operational Assessment indicates that this is an area of airspace where GPA provide an air traffic service, and as such if the turbines are visible to our primary radar then mitigation will be required.	Engagement with GPA is ongoing to identify mitigation requirements.
	Should this proposed development result in a full Section 36 Planning Application, it is likely GPA would object to the development until such times as the aviation safety matters detailed above were appropriately addressed.	Engagement with GPA is ongoing to address matters appropriately.
NATS	It has been determined that the terrain screening available will not adequately attenuate the signal for Lowther RADAR, and therefore this development is likely to cause false primary plots to be generated. A reduction in the RADAR's probability of detection, for real aircraft, is also anticipated.	Noted. Engagement with NATS is ongoing to identify potential mitigation opportunities.
	There is also an unacceptable impact anticipated on the Prestwick Centre Radar	Engagement with Glasgow Prestwick Airport is ongoing.
	NATS objects to the Proposed Development given the above comments	Noted. It is anticipated that technical mitigation is available to address the potential impacts.
BT	The Proposed Development should not cause interference to BT's current and presently planned radio network.	Noted.
JRC	This Proposed Development is cleared with respect to radio link infrastructure operated by Scottish Power and Scotia Gas Networks.	Noted.
Vodafone	Vodafone require 100m clearance from tip of any turbine blade to fixed link radio path	Previous engagement with Vodafone on 06 November 2020, noted a maximum

Consultee	Scoping Comment	Applicant Response
		<p>separation distance between the link and rotor distance of 'at least 50m from the first Fresnel Zone of each link in question'.</p> <p>Through further engagement with Vodafone following their scoping response, it was agreed on 09 September 2021 via email correspondence that a 50m buffer from the first Fresnel zone of each link in question can be acceptable. The final layout was subsequently sent to Vodafone for their consideration and on 02 February it was confirmed that the revised locations are suitable.</p>

### 13.2.3 Assessment Methodology and Significant Criteria

In order to predict and quantify the effects that will result from the Proposed Development on aviation, telecommunications and television, and the effects of shadow flicker on sensitive receptors, this assessment has considered:

- **Baseline Conditions** – a review of existing information in relation to existing public rights of way, telecommunication links, aviation, television reception, existing infrastructure on the Site and local area, and properties in the area that might be sensitive to shadow flicker effects.
- **Significance of Effects** – an assessment of the effect of the Proposed Development against the baseline conditions and assessment of the cumulative effect of the Proposed Development with other existing, consented or proposed wind turbine developments in the area.
- **Mitigation Measures** – details of the proposed mitigation measures to be incorporated into the Proposed Development that will be implemented to avoid significant effects.
- **Residual Effects** – an assessment of residual effects following the implementation of mitigation measures.

#### Aviation

##### Radar Line of Sight

Line of sight Analysis was used to determine the extent to which a planned wind development 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.

For the purpose of the EIA significance criteria, the effect is deemed 'Significant' if direct line of sight is expected.

Appendix 13-1 presents a detailed methodology.

### **Instrument Flight Procedures (IFPs)**

A high-level overview of potential IFP concerns without detailed modelling was undertaken to determine whether an impact upon IFPs is expected and whether further, more detailed analysis is required. Generally, if the horizontal clearance between any IFP and the closest wind turbine is greater than or equal to 5 nautical miles, and the vertical clearance is greater than or equal to 1000 feet, then no significant impacts are expected.

For the purpose of the EIA significance criteria, the effect is deemed 'Significant' if an impact is expected.

### **Limitations**

The turbines assessed as part of the Technical Note (Appendix 13-1) are the turbine locations from Design Chill. As noted in the evolution section of Chapter 3: Description of Development, the difference between design chill and design freeze are minimal microsighting movements and no turbine dimensions changed. Although locations of proposed turbines are not identical to the final layout, the assessments are considered to be valid due to the minor changes in coordinates.

### **Shadow Flicker**

There is no applicable legislation setting out any relevant rules or requirements for the assessment or control of shadow flicker.

The update of UK Shadow Flicker Evidence Base (DECC, 2011) reviews international legislation relating to the assessment of shadow flicker for wind turbine development and concludes that the area within 130 degrees either side of north from the turbine, and out to 10 rotor diameters, is considered acceptable as a study area for shadow flicker assessment.

The DECC study also concluded that there have not been extensive issues with shadow flicker in the UK and, in circumstances where the potential for significant shadow flicker issues effects have been identified, these have been resolved using standard mitigation.

This assessment also takes into consideration the Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014).

### **Study Area**

OS mapping was used to identify properties with potential susceptibility to shadow flicker, in line with the Parsons Brinckerhoff study Update of UK Shadow Flicker Evidence Base (2011). The candidate wind turbine modelled in the assessment has an indicative rotor diameter of 112m.

The area around the turbine location within a distance of 10 rotor diameters (1120m) and 130 degrees either side of north (the zone of potential shadow flicker) was mapped. There are four properties within potential shadow flicker impact distance of the proposed turbine (Figure 13-1).

### **Shadow Flicker Assessment Modelling – Worst Case Scenario**

In assessing the effect of shadow flicker, the commercial software Garrad Hassan Windfarmer was used to calculate the expected number of hours shadow flicker that could occur at each receptor.

The model takes into account the movement of the sun relative to the time of day and time of year and predicts the time and duration of expected shadow flicker at a window of an affected receptor. The input parameters used in the model are:

- The turbine location;
- The turbine dimensions; and
- The location of the receptors to be assessed.

The Garrad Hassan Windfarmer model is based upon a Digital Terrain Model (DTM) of 5m resolution.

Calculations were undertaken for predicted shadow hours at each of the receptors for two scenarios: a worst case and a realistic (climate adjusted) scenario. For the worst-case scenario the following assumptions were made:

- All receptors have a window facing directly towards the turbine;
- The turbine blades were assumed to be rotating for 365 days per year;
- There is a clear sky 365 days per year;
- The turbine blades are always orientated in a perpendicular direction between the receptor and the sun;
- The receptor is occupied at all times; and
- No screening is present.

These assumptions result in a highly conservative assessment. The modelling results are typically considered to be a theoretical worst-case estimation of the actual impacts experienced, which would not arise in practice given the assumptions listed above.

#### **Shadow Flicker Assessment Modelling – Climate Adjusted Scenario**

For much of the year weather conditions will be such that shadows will not be cast or will be weak and would therefore not give rise to shadow flicker effects. Garrad Hassan Windfarmer calculations most likely overestimate the duration of effects as outlined in the worst case scenario.

Other factors such as the potential for screening by vegetation or structures will also reduce or prevent flicker incidence in practice, including woodland blocks located between the proposed turbine locations and some shadow flicker receptors to the north of the Proposed Development.

To create a more realistic scenario for the potential impact of shadow flicker on receptors, it was necessary to identify the expected meteorological conditions at the Proposed Development Site.

This involved the following methodology:

- Use of the HadUK-Grid 1km resolution dataset (Met Office et al, 2018) to derive the average number of sunshine hours across a 20 year period. This value is then calculated on a monthly basis for the area covering the turbines generating potential shadow flicker at receptors;
- The monthly average of sunshine hours is compared to the maximum number of daylight hours to estimate the percentage of sunshine / cloud-free conditions in which Shadow Flicker is predicted to occur; and
- The bare earth shadow flicker model is updated to generate a climate-adjusted estimate of shadow flicker at each receptor, in a tabulated summary of hours per annum.

### Shadow Flicker Assessment Modelling - Cumulative sites

The nearest cumulative site that may have influence on the shadow flicker effects in combination with the Proposed Development is the Sandy Knowe Wind Farm within the Proposed Development Site. This has been considered as part of the cumulative assessment.

### Health and Safety

Given the nature and location of the Proposed Development, i.e. rural in nature and not within close proximity to settlements, it is considered that the likelihood and effect from potential accidents and disasters is minimal and therefore, excluded from detailed assessment.

Therefore, no significant effects are anticipated and it is considered this can be scoped out from further assessment.

Nevertheless, high standards of health and safety will be established and maintained throughout the project.

At all times activities will be undertaken in a manner compliant with applicable health and safety legislation and with relevant good practice as defined under applicable statutory approved codes of practice and guidance, including the Health and Safety at Work Act 1974, (HSE Executive, 1974) the Construction (Design and Management) Regulations 2015 (UK Government, 2015) the Work at Heights Regulations 2005 (as amended) etc, (UK Government, 2005); and Onshore Wind Health & Safety Guidelines (Renewable UK, 2015).

## 13.3 Baseline Conditions

### 13.3.1 Aviation and Radar

#### Glasgow Airport PSR

Glasgow Airport PSR is approximately 60km northwest of the Proposed Development and therefore outwith the radar consultation zone. The Proposed Development Footprint is also located outwith the obstacle limitation surfaces for Glasgow Airport.

#### Glasgow Prestwick Airport PSR

The Proposed Development is approximately 35km south east of GPA which is equipped with a primary surveillance radar and Terma Scanter 4002.

The Applicant has a mitigation agreement in place to take into consideration any visibility from Sandy Knowe Wind Farm.

#### NATS Lowther Hill PSR

The Proposed Development is located within a NATS Consultation Zone for Secondary Surveillance Radar. NATS En Route Ltd (NERL) operates a network of long-range ATC radars throughout the country in addition to other communications, navigation and surveillance systems. The closest radar is located at Lowther Hill, approximately 20km to the east of the Proposed Development.

This is equipped with primary and secondary surveillance radars which are used by controllers at Scottish Area Control (Prestwick) to provide air traffic services to aircraft in transit over Scotland and the north of England.

The Applicant has a mitigation agreement in place to take into consideration any visibility from Sandy Knowe Wind Farm.

### Deadwater Fell PSR and SSR

The closest military ATC radar is located at RAF Spadeadam, known as the Deadwater Fell radar. It is used to provide ATC services to aircraft operating in and around the Spadeadam Electronic Warfare Training Facility. Radar modelling was undertaken for Sandy Knowe Wind Farm and concluded that the turbines would not be detectable. The MOD did not raise any objections or concerns in their scoping consultation response.

It is anticipated that the Proposed Development will also not be detectable.

### High Priority Military Low Flying Zone

The Proposed Development lies within a high priority military low flying zone and in tactical training area (LFA 20T) where aircraft can fly as low as 100 feet for training purposes.

The Applicant has a mitigation agreement, including an agreed lighting scheme, in place to take into consideration any potential conflict from Sandy Knowe Wind Farm.

### Instrument Flight Procedures (IFPs)

As part of the EIA Scoping process, Glasgow Airport and Glasgow Prestwick Airport noted that the Proposed Development Footprint is within the Instrument Flight Procedure area for both airports and may impact upon procedures.

## 13.3.2 Telecommunication

Two telecommunication links intersect the Proposed Development in a north east to south west direction as illustrated in Figure 13-3.

Through desktop studies it was identified that these two links were owned and operated by Vodafone which serve the operational Hare Hill Wind Farm located to the south west of the Proposed Development site. Vodafone requested in November 2020 (and later confirmed in September 2021) that the wind turbines are designed around these two telecommunication links and that a buffer of 50m from the first Fresnel Zone<sup>1</sup> must be incorporated into the design parameters of the Proposed Development to avoid potential effects.

## 13.3.3 Shadow Flicker

Shadow flicker can arise from the passing of the moving shadow of a wind turbine rotor-blade over a narrow opening such as the window of a nearby residence. A similar

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<sup>1</sup> Buffer = 50m + Blade length (57.5m) + 1st Fresnel Zone (7.5m) = 115m

effect can also occur when the gloss blades of a rotating turbine reflect the sun causing a flashing light.

Shadow flicker happens only when a certain combination of conditions coincide at particular times of the day and year, mainly in the winter months when the sun is low in the sky (BERR 2009).

The occurrence of shadow flicker and the extent of its effects are dependent on a number of factors, namely:

- Distance from the wind turbine;
- Turbine hub height and rotor diameter;
- Speed of blade rotation;
- The proportion of sunny weather during the months when flicker can occur; and
- The size, shape and orientation of any windows or doors of neighbouring properties.

The flickering may have the potential to cause disturbance and annoyance to residents. It is, however, not possible for turbines to cause photosensitive epilepsy. People with photosensitive epilepsy are usually sensitive to flickering light between 16-25 Hertz (Hz), although some people may be sensitive to rates as low as 3 Hz and as high as 60 Hz (Epilepsy Action, 2018).

Modern wind turbines are designed to operate at a frequency of less than 1 Hz and are therefore well below the frequencies known to trigger photosensitive epilepsy (Epilepsy Action, 2018).

There are four residential properties within the study area with the potential to experience shadow flicker (See Figure 13-1), three of which are financially involved with the Proposed Development. These are Receptor IDs one to three (Table 13-2).

**Table 13-2: Shadow Flicker Receptors**

Receptor ID	Name	Approximate Grid Reference
1	High Cairn Cottage*	268611, 612167
2	High Cairn*	268749, 612363
3	Crockroy*	270454, 611947
4	Property north of Crockroy	270577, 612139

\*Property is financially involved with the Proposed Development

## 13.4 Assessment of Effects

### 13.4.1 Aviation and Radar

#### Glasgow Airport PSR

A radar line of sight assessment was completed for the Proposed Development – considering both the consented Sandy Knowe and the Proposed Development turbines (Appendix 13-1).

The analysis predicted that none of the consented and proposed turbines would be visible to the Glasgow Airport PSR.

### Glasgow Prestwick Airport PSR

A radar line of sight assessment was completed for the Proposed Development considering both the consented Sandy Knowe and the Proposed Development turbines (Appendix 13-1).

The analysis predicted that seven of the 24 consented turbines and four of the six Proposed Development turbines would be visible to the Glasgow Prestwick Airport PSR. The following turbines are expected to be visible by the GPA PSR:

- T25;
- T26;
- T27; and
- T28.

### NATS Lowther Hill PSR

A radar line of sight assessment was completed for the Proposed Development considering both the consented Sandy Knowe and the Proposed Development turbines (Appendix 13-1).

The analysis showed that all 24 of the consented turbines and all six of the proposed turbines would be visible to the NATS Lowther Hill PSR.

### High Priority Military Low Flying Zone

The Proposed Development has the potential to introduce a physical obstruction to low flying aircraft operating in the area.

### Instrument Flight Procedures (IFPs)

IFPs are typically designed so that there are vertical and horizontal safety margins between the specified trajectory and surrounding terrain and obstacles. Glasgow Airport has indicated that the proposed six-turbine extension is within their IFP area and therefore may impact upon procedures. Glasgow Prestwick Airport has requested an assessment of any likely impacts upon their published IFPs.

A high level assessment of potential IFP concerns without detailed modelling has been undertaken (Appendix 13-1). The purpose was to determine whether an impact upon IFPs is expected or whether further, more detailed analysis is required.

#### **Glasgow Airport IFP**

The Proposed Development is located outside of the Obstacle Limitation Surfaces (OLS) area for Glasgow Airport. It is likely that if an obstacle does not infringe the OLS, it will not adversely affect the IFP. Nonetheless, a review of all published Glasgow Airport IFPs has been undertaken.

The investigation determined that IFPs at Glasgow Airport are not expected to be affected by the Proposed Development because all proposed turbines are more than five nautical miles horizontally clear of aircraft flying the procedures.

Therefore, no significant effects are anticipated.

### Glasgow Prestwick Airport IFP

A review of all published Glasgow Prestwick Airport IFPs has been undertaken. Nine specific procedures were identified within five nautical miles of the Proposed Development.

The minimum vertical clearance between an aircraft on any of the procedures and the highest proposed turbine tip is approximately 2600 feet (792 metres). It is expected that the procedures could comfortably accommodate the Proposed Development.

Therefore, no significant effects are anticipated.

## 13.4.2 Telecommunication

The moving rotors of wind turbines have the potential to effect telecommunication and television signals by causing Electromagnetic Interference (EMI). Wind turbines cause EMI by reflection of signals from rotor blades so that a nearby receiver picks up both a direct and reflected signal.

The types of civilian and military communication signals which may be affected by EMI include TV and radio broadcasting, microwave and cellular radio communications and various navigational and air traffic control systems. A turbine located within, or near to, the communication link may interfere with the signal causing unwanted 'noise'.

The potential for negative effects on domestic television reception are greatly diminished post digital switchover, which was completed across the UK in 2012.

It has been confirmed through consultation with Vodafone that the employment of embedded mitigation noted in 12.3.2 has resulted in the turbines having no predicted effects to the links that cross the Proposed Development Site.

It has also been confirmed through Scoping consultation responses from BT and JRC that there are no potential effects on their assets.

As such no significant effects are anticipated.

## 13.4.3 Shadow Flicker

There are no UK statutory provisions setting out acceptable levels of shadow flicker. The DECC 2011 report identifies best practice guidelines across Europe and this assessment has adopted the Best Practice Guidance for Planning Policy Statement 18 'Renewable Energy' (Department of Environment Northern Ireland, 2009, pg. 29) provides an indication of what may be an acceptable duration of shadow flicker, stating that:

*"It is recommended that shadow flicker at neighbouring offices and dwelling...should not exceed 30 hours per year or 30 minutes per day"*

### Bare Earth (Worst Case) Effects

Following the calculation of a bare earth 'worst case scenario' for the Proposed Development (Table 13-3) annual shadow flicker predictions fall below the significance threshold levels for receptors 2 and 4. Receptor locations are shown on Figure 13-1 and Table 13-2 (See Section 13.3.3).

However, the receptors 1 and 3 exceed the 30 hours per year threshold that has been applied for this assessment and therefore further analysis has been undertaken.

**Table 13-3: Worst Case Scenario Results, Hours per Year**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
	<b>Total hours per year</b>			
January	9.8	5.4	14.0	9.1
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	4.3	1.2	9.3	4.8
December	16.4	12.7	12.7	10.8
<b>Totals</b>	<b>30.6</b>	<b>19.3</b>	<b>36.0</b>	<b>24.8</b>

\*Property is financially involved with the Proposed Development

In addition to the 30 hours per year threshold, receptors 1 and 3 also exceed 30 minutes on selected days in worst case scenarios, as outlined in Table 13-4.

**Table 13-4: Worst Case Scenario Results, Number of days exceeding 30 minutes**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
	<b>No. Days of exceedance</b>			
January	2	0	3	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	3	0
December	11	0	0	0
<b>Totals</b>	<b>13</b>	<b>0</b>	<b>6</b>	<b>0</b>

Climate Adjusted Scenario Effects

Table 13-5 shows the 'Climate Adjusted Scenario' following the methodology outlined in Section 13.2.3.

**Table 13-5: Climate Adjusted Scenario**

Month	Daytime Hours*	Site Sunshine Hours**	Sunshine %
January	241.2	32.4	13.4%
February	279.3	56.1	20.1%
March	368.1	80.6	21.9%
April	425.2	125.0	29.4%
May	503.1	175.5	34.9%
June	520.8	154.6	29.7%
July	520.8	155.7	29.9%
August	463.7	146.7	31.6%
September	381.9	112.1	29.3%
October	324.0	78.1	24.1%
November	250.9	46.9	18.7%
December	223.2	27.2	12.2%

\*based on Proposed Development Site latitude

\*\*HadUK-Grid 1km resolution dataset (Met Office et al, 2018) to derive the average number of sunshine hours across a 20 year period.

Following the calculation of a 'Climate Adjusted Scenario' (Table 13-5) for the Proposed Development (Table 13-6) shadow flicker predictions fall below the significance threshold levels for all residential receptors, thus it can be concluded that these properties are not predicted to receive significant effects from the Proposed development.

**Table 13-6: Climate Adjusted Scenario Results, Hours per Year**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
	<b>Total hours per year</b>			
January	1.3	0.7	1.9	1.2
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0.8	0.2	1.7	0.9
December	2.0	1.5	1.5	1.3
<b>Totals</b>	<b>8.1</b>	<b>5.1</b>	<b>9.5</b>	<b>6.5</b>

\*Property is financially involved with the Proposed Development

As the maximum number of minutes per day in the worst case scenario is 40 and the probability of cloud-free conditions in the months in which shadow flicker is predicted ranges from 12-19%, following the calculation of the 'Climate Adjusted Scenario' no receptors area predicted to have more than 30 minutes of shadow flicker on a single day.

In conclusion, whilst the climate adjusted scenario indicates that no receptors exceed the daily threshold, in specific conditions (see Section 13.3.3) there is the possibility of shadow flicker events exceeding 30 minutes per day threshold, the probability of this however is Low.

As such **no significant** effects are predicted.

## 13.5 Assessment of Cumulative Effects

### 13.5.1 Shadow Flicker

#### Bare Earth (Worst Case) Effects

Following the calculation of a bare earth 'worst case scenario' for the Proposed Development in combination with Sandy Knowe Wind Farm, total annual shadow flicker predictions increase at receptor 1 and 3 to 54 and 46 hours respectively (Table 13-7).

The remaining receptors are below the significance threshold of 30 hours per year.

**Table 13-7: Cumulative Worst Case Scenario Results, Hours per Year**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
	<b>Total hours per year</b>			
<b>January</b>	21.4	5.4	14.0	9.1
<b>February</b>	0	0	5.3	0
<b>March</b>	0	0	0	0
<b>April</b>	0	0	0	0
<b>May</b>	0	0	0	0
<b>June</b>	0	0	0	0
<b>July</b>	0	0	0	0
<b>August</b>	0	0	0	0
<b>September</b>	0	0	0	0
<b>October</b>	0	0	4.6	0
<b>November</b>	11.8	1.2	9.8	4.8
<b>December</b>	21.1	12.7	12.7	10.8
<b>Totals</b>	<b>54.3</b>	19.3	<b>46.4</b>	24.8

\*Property is financially involved with the Proposed Development

In addition to the 30 hours per year threshold, receptors 1 and 3 also exceed 30 minutes on selected days in worst case scenarios, as outlined in Table 13-8.

**Table 13-8: Cumulative Worst Case Scenario Results, Number of days exceeding 30 minutes**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
	<b>No. Days of exceedance</b>			
January	22	0	3	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	11	0	3	0
December	24	0	0	0
<b>Totals</b>	<b>57</b>	<b>0</b>	<b>6</b>	<b>0</b>

\*Property is financially involved with the Proposed Development

#### Climate Adjusted Scenario Effects

Following the calculation of a 'Climate Adjusted Scenario' (Table 13-5) for the Proposed Development in combination with Sandy Knowe Wind Farm (Table 13-9), annual shadow flicker predictions fall below the significance threshold levels for all residential receptors. Therefore, it can be concluded that these properties are not predicted to receive significant effects from the Proposed development.

As such **no significant** effects are predicted.

**Table 13-9: Cumulative Climate Adjusted Scenario Results, Hours per Year**

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
January	2.9	0.7	1.9	1.2
February	0	0	1.1	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	1.1	0
November	2.2	0.2	1.8	0.9
December	2.6	1.5	1.5	1.3

Month / Receptor ID	1 (High Cairn Cottage)*	2 (High Cairn)*	3 (Crockroy)*	4 (Property north of Crockroy)
<b>Totals</b>	14.4	5.1	12.3	6.5

\*Property is financially involved with the Proposed Development

As the cumulative maximum number of minutes per day in the worst case scenario is 60 and the probability of cloud-free conditions in the months in which shadow flicker is predicted ranges from 12-19%, following the calculation of the 'Climate Adjusted Scenario' no receptors area predicted to have more than 30 minutes of shadow flicker on a single day.

In conclusion, whilst the climate adjusted scenario indicates that no receptors exceed the daily threshold, in specific conditions (see Section 13.3.3) there is the possibility of shadow flicker events exceeding 30 minutes per day threshold, the probability of this however is Low.

As such **no significant** effects are predicted.

## 13.6 Mitigation Measures

### 13.6.1 Aviation and Radar

As noted in Section 13.3.1, the Applicant already has agreed mitigation in place with the MOD, NATS and GPA for the consented Sandy Knowe Wind Farm. The approach to the Proposed Development will be to enhance any existing mitigation to encompass the Proposed Development turbines where necessary.

Subject to the implementation of the mitigation, to the satisfaction of the MOD, NATS and GPA; the Proposed Development would not adversely affect aviation interests.

As there are no expected significant effects on IFPs, no mitigation is required.

### 13.6.2 Telecommunication

There are no necessary mitigation measures over and above embedded design mitigation already in place, and the potential effects from the Proposed Development are not significant.

### 13.6.3 Shadow Flicker

There are no mitigation measures required as the potential effects from the Proposed Development are not significant.

However, in the event that complaints of shadow flicker are received by the Applicant or Dumfries and Galloway Council, an appropriate investigation would be undertaken to confirm the occurrence, following which mitigation measures would be used to mitigate the re-occurrence if required.

This could involve the provision of screening planting, the installation of blinds within the affected property, or the programming of the wind turbines to automatically shut down at times when shadow flicker effects could occur. This could be secured through a planning condition. Application of these measures would ensure that potential effects are minimised or removed entirely.

## 13.7 Residual Effects

Following implementation of mitigation through design, best practice and guidance, it is considered that there will be **no significant** effects on telecommunications and television reception or in relation to shadow flicker as a result of the Proposed Development.

Following implementation of mitigation, it is considered that there will be **no significant** effects on aviation interests as a result of the Proposed Development.

## 13.8 Summary and Statement of Significance

### 13.8.1 Aviation

#### PSR

Radar line of sight assessments have been undertaken in relation to Glasgow Airport PSR, GPA PSR, and Lowther Hill PSR. No effects are considered for Glasgow Airport PSR and there is visibility expected from GPA PSR and Lowther Hill PSR.

Following implementation of mitigation, it is considered that there will be **no significant** effects on Glasgow Airport PSR, GPA PSR, and Lowther Hill PSR as a result of the Proposed Development.

#### High Priority Military Low Flying Zone

The Proposed Development has the potential to introduce a physical obstruction to low flying aircraft operating in the area.

Following implementation of mitigation, it is considered that there will be **no significant** effects on operations in relation to the High Priority Military Low Flying Zone as a result of the Proposed Development.

#### Instrument Flight Procedures (IFPs)

##### Glasgow Airport IFP

A review of all published Glasgow Airport IFPs has been undertaken. The investigation determined that IFPs at Glasgow Airport are not expected to be affected by the Proposed Development because all proposed turbines are more than five nautical miles horizontally clear of aircraft flying the procedures.

##### Glasgow Prestwick Airport IFP

A review of all published Glasgow Prestwick Airport IFPs has been undertaken. Nine specific procedures were identified within five nautical miles of the Proposed Development.

The minimum vertical clearance between an aircraft on any of the procedures and the highest proposed turbine tip is approximately 2600 feet (792 metres). It is expected that the procedures could comfortably accommodate the Proposed Development.

Therefore, **no significant** effects are anticipated on Glasgow Airport and GPA IFPs as a result of the Proposed Development.

### 13.8.2 Telecommunication

It has been confirmed through consultation with Vodafone that the employment of embedded mitigation noted in 12.3.2 has resulted in the turbines having no predicted effects to the links that cross the Proposed Development Site.

It has also been confirmed through Scoping consultation responses from BT and JRC that there are no potential effects on their assets.

As such **no significant** effects are anticipated on telecommunication assets as a result of the Proposed Development.

### 13.8.3 Shadow Flicker

Following the calculation of a 'Climate Adjusted Scenario' for the Proposed Development, and the Proposed Development in combination with Sandy Knowe Wind Farm, annual and daily shadow flicker predictions fall below the significance threshold levels for all residential receptors. Therefore, it can be concluded that these properties are not predicted to receive significant effects from the Proposed development.

As such **no significant** effects are anticipated on receptors from shadow flicker as a result of the Proposed Development.

## 13.9 References

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