Chapter 16: Other Considerations

Contents

16 Other Considerations

16.1 Introduction

16.1.1 This chapter assesses the potential effects of the Proposed Development in relation to:

- Shadow Flicker.
- Telecommunications and Broadcast Services.
- Ice Throw.
- Air Quality.
- Population and Human Health.
- Climate and Carbon Balance.
- Major Accidents and Disasters.
- Waste and Environmental Management.
- Public Access.

16.1.2 Elements relating to major accidents and disasters have also been addressed in the individual technical discipline chapters where relevant.

16.1.3 Impacts on population and human health have also been addressed in the individual EIA topic chapters where relevant.

16.1.4 This assessment has been undertaken by SLR Consulting.

16.1.5 The chapter is supported by **Figures 16.1** and **16.2**, and **Technical Appendix 16.1: Carbon Calculator** that are referenced in the text where appropriate.

16.2 Shadow Flicker

Introduction

16.2.1 This section of the chapter summarises the potential effect of shadow flicker associated with the Proposed Development.

16.2.2 Under certain combinations of geographical position and time of day, when the sun passes behind the rotors of a wind turbine and casts a shadow over neighbouring properties, as the blades rotate, the shadow may appear to flick on and off, when viewed through a narrow aperture such as a window. The phenomenon occurs only within buildings where shadows are cast across a window aperture, and the effects are typically considered to occur up to a maximum distance of 10 times the rotor diameter from each wind turbine[1]. This effect is known as shadow flicker.

Policy and Guidelines

16.2.3 The following policy and guidance documents have been referred to in undertaking the assessment:

- Scottish Government - National Planning Framework 4 (2023).
- Scottish Government - Onshore wind policy statement 2022 (and its predecessor Onshore wind turbines: planning advice).
- The Highland Council's (THC) Onshore Wind Energy Supplementary Guidance (2016).
- Northern Ireland, Planning Policy Statement 18: Renewable Energy (2009).
- Department of Energy & Climate Change (DECC) - Update of UK Shadow Flicker evidence base (2011).

16.2.4 A report on shadow flicker from the Department of Energy & Climate Change (DECC) indicates a general rule of ten rotor diameters should be used for separation distance from a wind turbine position to a dwelling. Scottish Government guidance advocates that beyond this distance there should be no adverse impact from shadow flicker.

16.2.5 However, THC's expectation is for wind energy developments to be located a minimum distance of 11 times the rotor diameter of the turbine(s) from any regularly occupied buildings not associated with the

[1] Note THC will require an assessment of Shadow Flicker for any receptors within a distance of 11 times the rotor diameter of turbines.

development. Within a distance less than 11 times the blade diameter, a shadow flicker assessment will be required. This is to account for the northern latitudes of the Highlands (THC, 2016).

Consultation

16.2.6 Consultation was undertaken through the EIA Scoping Report. No further consultation has been undertaken.

16.2.7 THC stated that "*Given that the final layout for the turbines and the candidate turbine is yet to be selected, a shadow flicker assessment should be undertaken as part of the EIAR. That said, if there are no properties within 11 rotor diameters the matter of shadow flicker will not require detailed assessment but should still be addressed in the EIAR".*

Assessment Methodology and Significance Criteria

Study Area

16.2.8 The update to Shadow Flicker Evidence Base (2011), published by the then DECC states that assessing shadow flicker effects within ten times the rotor diameter of wind turbines has been widely accepted across different European countries and is deemed to be an appropriate area. It also states that shadow flicker effects on receptors in the UK are generally restricted to 130 degrees either side of north of the turbine, based on a review of policy and guidance in place at the time the document was written.

16.2.9 The Scottish Government's Onshore wind turbines: planning advice (2014) document states that:

"Under certain combinations of geographical position, time of day and time of year, the sun may pass behind the rotor and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as 'shadow flicker'. It occurs only within buildings where the flicker appears through a narrow window opening. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the potential site.

16.2.10 Where this could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem. However, there is scope to vary layout/reduce the height of turbines in extreme cases".

16.2.11 Neither National Planning Framework 4 (NPF4) (2023) or the Scottish Government's Onshore Wind Policy Statement (2022) contain technical details regarding the assessment of shadow flicker.

16.2.12 THC's Onshore Wind Energy Supplementary Guidance (THC, 2016) states that:

"…the Council will expect wind energy developments to be located a minimum distance of 11 times the blade diameter of the turbine(s) from any regularly occupied buildings not associated with the development. Within a distance less than 11 times the blade diameter, a shadow flicker assessment will be required. The Council may support a scheme that relies on mitigation, where it is deemed to be effective. In such instances turbine shutdown systems will be the required mitigation. The increase in distance from the widely accepted 10 times rotor diameter to 11 is to account for the northern latitudes of Highland- this is in line with the conclusions of the DECC Update of UK Shadow Flicker Evidence Base, 2011".

16.2.13 The assessment was therefore carried out based on a study area of 11 rotor diameters for the candidate turbine V162 (plus 100m micrositing) giving an overall study area of 1,882m from the proposed turbines[2] (**See Figure 16.1**).

16.2.14 Shadow flicker effects are only considered during the operational phase of a wind farm development, and do not occur if the turbines are not rotating or if the sun is not shining.

Assessment Methodology

16.2.15 The shadow flicker assessment comprises numerical modelling of the proposed turbines and receptors within the defined study area. It is noted that whilst there are a number of computer models available, the DECC study (2011) confirms that there are limited differences between outputs of the various packages. For shadow flicker assessments, SLR Consulting use one of the industry standard software packages, ReSoft Wind Farm software (version 5.1.2.1).

16.2.16 The calculations from this assessment process assumes a worst-case scenario based on the sun shining during all daylight hours over the course of a year, no obscuring features (such as trees, hedges, other buildings) being present, the face of the rotor always being aligned towards the dwelling, and that the rotor is always turning (i.e. the wind is always blowing between 4 m/s and 25 m/s, and no account is taken of shut down periods for maintenance). This methodology yields a theoretical maximum indication

[2] Candidate turbine's rotor diameter is 162m, 11*162 = 1782m, plus 100m micrositing = 1,882m.

of potential shadow flicker incidence, together with the times of day, and dates during the year when potential incidence may occur.

16.2.17 The levels of shadow flicker at each receptor have been calculated based on a 'greenhouse' modelling approach, where the full length of each façade of a building is modelled as a window (and is therefore sensitive to shadow flicker). Each modelled window is assumed to have a mid-point height of 3 m. This approach has been taken in order to present a worst-case estimate of shadow flicker, in the absence of any detailed window location data. In reality, only the glazed area of each façade would be sensitive to shadow flicker effects, therefore modelling the full façade will result in higher predicted levels than will actually be possible.

16.2.18 The software performs calculations to determine the position of the sun throughout the year, and thus during what times of day it will theoretically cast a shadow across the windows of nearby houses within the defined study area (plus 100 m micrositing). Data input into the model where shadow flicker assessment is required is as follows:

- The locations of all properties within 1,882 m of the turbine locations (plus an allowance of 100 m for micrositing).
- The dimensions and orientations of windows facing the Proposed Development – for the purpose of this model, a window centre point height of 3 m has been assumed.
- The surrounding topography (Ordnance Survey Digital Terrain Model).
- The locations and dimensions of the turbines.

16.2.19 The following sources of information outlined in **Table 16-1** were used to inform this assessment.

Table 16-1 - Sources of Information

Topic	Sources of Information
Residential Properties Location in relation to the Proposed Development and identification of windows.	Ordnance Survey (OS) 1:25,000 Mapping
Topography Height data	OS 10m Digital Terrain Model (DTM) data

16.2.20 In practice, it is likely that shadow flicker effects would occur for considerably less time than the worst-case predictions, for the following reasons:

- In the UK, sunshine typically occurs for approximately 30% of daylight hours. At other times, the wind turbines are unlikely to cast shadows sufficiently pronounced to cause shadow flicker effects to occur.
- At times when the wind turbine rotor is not oriented directly towards the property, the duration of shadow flicker effects would be reduced due to the elliptical shape of the shadow cast.
- The assessment has been undertaken assuming a worst-case scenario which does not take into consideration the screening effect of anything located between the wind turbines (e.g., intervening structures or vegetation) and the property. The assessment also assumes that the property does have windows facing the wind turbines, which may not always be the case.

16.2.21 A "likely-case" scenario of shadow flicker effects has therefore also been included in the results section, based on the average sunshine hours experienced at the Proposed Development location.

16.2.22 Only those properties within 1,882 m of the proposed turbines have been included in the calculations. The model has been run using OS terrain 10 m DTM data which is the most accurate digital terrain data available for the site.

Limitations to Assessment

16.2.23 There are several additional factors that can influence the amount of shadow flicker actually experienced and these cannot be readily included in a computer-based assessment.

16.2.24 Climatic conditions dictate that the sun is not always shining. The closest Met Office location is Loch Glascarnoch, located approximately 18km from the Proposed Development. Historic Met Office data (over the period 1991 - 2020) gives actual sunshine hours for the Loch Glascarnoch Met Station to be on average 23.8%[3] of total daylight hours. Cloud cover during other times may obscure the sun and

[3] Average sunshine hours of 1,044.34 / total number of daylight hours 4,380 = 23.8%. Data from Met Office Climate Averages site available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gfk82sdb6

prevent shadow flicker occurrence. While some shadows may be cast under slightly overcast conditions, no shadow at all would be cast when heavy cloud cover prevails.

16.2.25 During calm periods, or very high winds, the wind turbine blades would not rotate, and shadow flicker would not occur. Turbines would also be periodically shut down for maintenance or repair work.

16.2.26 Wind turbines automatically orientate themselves to face the prevailing wind direction. This means that the turbine rotors would not always face directly towards the occupied buildings. Under some wind conditions, the proposed turbines would face ‘side-on’ to properties, and in these conditions only a very small area of blade movement would be visible.

16.2.27 Any screening provided by vegetation or structures has not been incorporated as the analysis has been run on bare ground terrain data as a worst-case scenario. The inclusion of a 100 m micrositing allowance has also been added to the worst-case nature of the assessment, as for some properties this means additional turbines are considered to cause shadow flicker if they moved 100 m towards the property.

Assessment of Potential Effect Significance

16.2.28 Whilst the time and duration of shadow flicker events can be predicted accurately, the level of the effect is difficult to quantify as this would depend on the location of windows within a property, the use of the rooms affected, the level of shading surrounding the property and how susceptible the receptor is to light flicker.

16.2.29 As confirmed by the DECC study (2011), there is no standard Scottish or UK guidance relating to a limit for shadow flicker, and this remains the case. The only guidance providing additional recommendations is the Northern Irish PPS 18 (2009) guidance which recommends that for properties within 500 m of the turbines, shadow flicker should not exceed 30 hours per year.

16.2.30 The assessment has therefore adopted a criterion of 30 hours of shadow flicker (under the likely-case assessment scenario outlined in paragraph 16.2.21) in one year as a significance threshold. Where less than 30 hours of shadow flicker is predicted to occur in one year at a particular property, this is considered to be a minor effect (not significant), with significance increasing in relation to the number of hours (over 30) of shadow flicker per year, in accordance with best practice guidance.

16.2.31 Whilst the distance between turbine and property does not affect the calculated shadow flicker exposure times, it does mean that the actual effect (i.e. the total exposure time and flicker intensity combined) of the Proposed Development would, in reality, be less than that calculated as a worst-case as a result of a reduction in shadow flicker intensity as the distance increases between a turbine and a receptor.

Requirements for Mitigation

16.2.32 Mitigation will be proposed to minimise or remove predicted effects, if levels of shadow flicker are deemed to be significant in practice in line with the Northern Irish PPS 18 (2009) guidance.

Cumulative Assessment

16.2.33 There are no existing, or in planning wind farms located in the local area such that potential cumulative shadow flicker effects would be experienced. Therefore, cumulative effects relating to shadow flicker are not considered further.

Baseline Conditions

16.2.34 Three residential properties have been identified which fall within the 1,882m study area. These properties could theoretically be affected by shadow flicker from the Proposed Development (**Figure 16.2).** Details of the properties are shown in **Table 16-2**. In addition, at the time of writing (March 2025) there are no proposed residential properties with planning consent within the study area[4] which would be affected by shadow flicker.

Table 16-2 - Receptors within the Study Area

Shadow Flicker Property ID	Receptor Name	Easting	Northing	Distance to Nearest Turbine (m)
1	Tigh Fiodha	240447	863843	1,764
2	Silverbridge Lodges	240392	863891	1,835
3	Tigh Fiodha Larder	240503	863795	1,692

[4] https://wam.highland.gov.uk/wam/

Receptors Brought Forward for Assessment

16.2.35 All properties within the Study Area and identified in **Table 16-2** have been brought forward for assessment.

Potential Effects

Construction and Decommissioning

16.2.36 Shadow flicker is an operational effect and so not considered during the construction or decommissioning phases.

Operation

16.2.37 **Figure 16.2** shows the results of the shadow flicker modelling. The results, set out in Table 16-3 below, show both the 'worst-case scenario', which assumes that the sun is always shining during daylight hours, the wind is always blowing, makes no allowance for any screening by vegetation, and includes the potential for micrositing leading to turbines being moved 100 m closer to these properties, and the likely case scenario, whereby the worst-case results are adjusted for likely annual sunshine hours.

16.2.38 Based on the predictive modelling technique outlined above, there is predicted to be the greatest shadow flicker effects of up to 8.2 hours per year at Tigh Fiodha Larder (shown in Table 16-3), assuming the worst-case scenario whereby the sun is always shining during daylight hours, the turbines are always turning, and there is no screening from vegetation. The last two columns of Table 16-3 provide an indication of the likely shadow flicker minutes per day and hours when the 23.8% average sunshine hours factor is used.

16.2.39 The other properties could also potentially receive shadow flicker effects but for fewer hours per year.

Table 16-3: Shadow Flicker Assessment Outputs From Computer Model

Shadow Flicker Property ID	Receptor Name	Days per Year Where Shadow Flicker Potentially Experienced	Turbine(s) Causing Effect	Max Minutes per Day Where Shadow Flicker Potentially experienced	Total Hours per Year When Shadow Flicker Potentially experienced	Likely Max Minutes per Day Where Shadow Flicker Potentially experienced*	Likely Expected Hours per Year When Shadow Flicker Potentially Experienced*
1	Tigh Fiodha	22	T6	24.2	7.2	5.8	1.7
2	Silverbridge Lodges	22	T6	23.7	7.0	5.6	1.7
3	Tigh Fiodha Larder	24	T6	25.4	8.2	6.0	2.0
* based on average sunshine hours of 23.8% being applied to the model as outlined in Limitations to Assessment section of this chapte							

Analysis of Results

16.2.40 The results confirm that none of the properties assessed could potentially experience over 30 hours of shadow flicker effect per year, based on the worst-case assessment criteria. Based on the assessment criteria the effects of shadow flicker on these properties would therefore be **not significant**.

16.2.41 These figures are an over-estimate of actual effects. Given the conservative nature of this assessment as set out in the limitations of assessment section, it is likely that in practice actual hours of shadow flicker would be considerably less than this due to the wind not always blowing and the sun not always shining, alongside assumptions previously set out earlier.

16.2.42 Likely expected hours of shadow flicker are provided in the final column of **Table 16-3**, adjusted for likely sunshine hours. The model does not take into account the proportion of time that the wind is blowing to a sufficient level to rotate turbine blades, any screening provided by vegetation, or the true size and orientation of dwelling windows due to the 'greenhouse' approach, and thereby the likely expected hours of shadow flicker represents a conservative assessment. Therefore, the shadow flicker hours will be even less than predicted. As like the worst case scenario, under these conservative assumptions, the annual hours of shadow flicker anticipated at all properties are under the 30 hours of significance threshold.

Mitigation

16.2.43 Based on the significance thresholds outlined previously, no significant shadow flicker effects are predicted to occur as a result of the Proposed Development.

16.2.44 Although shadow flicker levels are predicted to be well below the 30-hour per year significance threshold, the Applicant is nonetheless committed to promptly investigating any complaints of shadow flicker and taking appropriate action as required.

16.2.45 The Applicant proposes that prior to the operation of the first turbine, a Wind Farm Shadow Flicker Protocol would be submitted to and approved by THC. This would set out the protocol to be followed should a shadow flicker complaint be received from a receptor within the study area, and potential mitigation measures. Should a complaint be received these mitigation measures would include using the turbine's shadow flicker control module to be programmed to minimise impacts at the receptor(s). Operation of the Proposed Development would be undertaken in accordance with the Wind Farm Shadow Flicker Protocol.

16.2.46 If a complaint is made regarding shadow flicker, an investigation would take place which considers the weather conditions at the time of the alleged shadow flicker, to determine which turbines were, or were not, creating the effect and the extent of the shadow flicker created. If the investigation confirms a loss of residential amenity at any location, the technical mitigation measures built into these turbines would be activated.

16.2.47 Shadow flicker control modules, consisting of light sensors and specialised software, will be installed on the turbines that can prevent operation during periods when shadow flicker can be experienced at nearby properties. The installation of a programmable shadow flicker module will allow the control of turbines in order to eliminate shadow flicker. The correct operation of the installed shadow flicker control measures will ensure that there will be no impact from shadow flicker. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.

16.2.48 The shadow flicker control module consists of bespoke software, a clock, a timer, a switch, a wind direction sensor and a light sensor. The module can control a specific turbine (or turbines) which would be programmed to shut down on specific dates at specific times when the sun is bright enough, there is sufficient wind to rotate the blades and the wind direction is such that nuisance shadow flicker could occur. There is no specific UK guidance regarding what level of light is sufficient to cause a shadow flicker event. However, the actual light level that would trigger a turbine shut down can be manually configured on-site, following installation, to reflect local conditions.

16.2.49 It is proposed that a planning condition would provide an appropriate form of mitigation to ensure that any complaints would be investigated within a reasonable timescale and that the rectification of any substantiated shadow flicker issue would be implemented promptly and effectively. The DECC guidance (2011) states that *"Mitigation measures which have been employed to operational wind farms such as turbine shut down strategies, have proved very successful, to the extent that shadow flicker cannot be considered to be a major issue in the UK".*

Residual Effects

<u>Operation</u>

16.2.50 There will be no significant effects in relation to shadow flicker as a result of the Proposed Development.

Summary

16.2.51 Under conservative assumptions, the Proposed Development is predicted to potentially cause limited shadow flicker for the properties identified within the 1,882m study area, with no property predicted to experience shadow flicker levels in excess of 30 hours per year under either the worst case or likely sunshine hours assessment.

16.2.52 Should a shadow flicker complaint be raised, mitigation can be provided, including shutting down individual wind turbines during periods when shadow flicker is modelled to occur and the climactic conditions are such that shadow flicker can be experienced.

16.2.53 A planning condition would provide an appropriate form of mitigation to ensure that any complaints would be investigated within a reasonable timescale and that the rectification of any substantiated shadow flicker issue would be implemented promptly and effectively.

16.3 Television and Telecommunications

Introduction

16.3.1 This section of the chapter summarises the potential television and telecommunications effects associated with the Proposed Development.

Guidance

16.3.2 The Scottish Government's 'Onshore Wind Turbines: Planning Advice' provides guidance for assessing the impact of wind turbines with communications systems. (Scottish Government, 2014).

16.3.3 Tall structures such as wind turbines may cause interference of nearby television signal or telecommunications links. As such, any links in the vicinity of the Proposed Development must be identified and operators must be consulted.

16.3.4 The Ofcom Spectrum Information Portal (Ofcom, 2025) was used in the first instance to identify fixed telecommunications crossing or adjacent to the site.

16.3.5 A number of other telecommunications services in addition to fixed links may be present, however most of these services are generally only affected if wind turbines are located in the immediate vicinity. Furthermore, where other services are present, there is usually a supporting fixed link to allow onward signal transmission, which would be identified in this assessment. It is therefore considered that the search for fixed microwave links, and discussion with identified operators, also covers all other services.

Scope of Assessment

<u>Effects Scoped Out</u>

16.3.6 Effects on television and radio signal have been scoped out of detailed assessment for the following reasons:

- Operational effects on television: Wind turbines have the potential to adversely affect analogue television reception through either physical blocking of the transmitted signal or, more commonly, by introducing multi-path interference where some of the signal is reflected through different routes. The Proposed Development is located in an area which is served by a digital transmitter. Digital television is less likely to be affected by the atmospheric conditions that rendered analogue television unwatchable and does not suffer from reflection effects or ghosted image generation. In the unlikely event that television signals are affected by the Proposed Development, mitigation measures will be considered by the Applicant.
- Operational effects on radio broadcasting signals: radio broadcasting will not be affected by the Proposed Development once operational as the length of radio broadcast signal wavelengths are such that interference from wind turbines is unlikely and any interference to the radio signal is unlikely to noticeably affect the audio signal.

16.3.7 The assessment has therefore focused on microwave fixed links. Fixed links are direct line-of-sight communication links between transmitting and receiving dishes placed on masts generally located on hilltops that vary in length from a few kilometres to over 70 km. They are used for the transmission of information to broadcasting masts for television and radio and for the mobile telephone networks and other use-cases.

Asessment

16.3.8 Five fixed links were identified from the Ofcom Spectrum Information Portal as running through the site. The links meet at the telecoms mast in the west of the site. Two links extend in a westerly direction from the mast, whilst the other three extend in a south easterly direction. These links are shown on **Figure 2.2** and are operated by Vodafone and Airwave Solutions Limited.

16.3.9 A range of other major operators, including scanning telemetry operators, were still contacted as a matter of best practice.

16.3.10 Telecommunications and broadcasting network operators were consulted during the scoping exercise and again at design freeze.

16.3.11 **Table 16-4** summarises the consultation undertaken, and responses received from the link operators.

Table 16-4: Link Operators Responses

Link Operator	Date of Response	Response/Issue Raised	Actions
Arquiva	28/03/22	We have no objections to this development.	None
	21/10/24	Response by Arqiva : No Objection We refer to the above planning application and thank you for the opportunity to comment on the above development. Arqiva is responsible for providing the transmission network for the BBC & ITV along with the majority of the UK's radio companies and is responsible for ensuring the integrity of Re-Broadcast Links. Tall infrastructure such as wind turbines and other tall structures have the potential to block radio transmission links and rebroadcasting links (through direct blocking of radio signal or deflecting signal). Our radio transmission networks normally operate with a 100m buffer either side of a radio link, free from interference by a tall development. We have considered whether this development is likely to have an adverse effect on our operations and have concluded that we have no objection given the nearest Arqiva asset is located 7.8km West of the nearest broadcast site.	None
Atkins	29/03/22	We have NO OBJECTION to your proposal	None
	21/10/24	The above application has now been examined in relation to UHF Radio Scanning Telemetry and Microwave communications used by our Client in that region and we are happy to inform you that we have NO OBJECTION to your proposal.	None
BT	16/10/24	We have studied this proposal using the attached with respect to EMC and related problems to BT point-to-point microwave radio links. The conclusion is that the project indicated will not cause interference to BT's current and presently planned radio network. BT requires 100m minimum clearance from any structure to the radio link path. . If any changes are proposed to the information supplied, please let us know and we can reassess this for you.	None
Joint Radio Company	08/09/23	*We can recommend approval if the following conditions are met.* *Turbines 1-9 and 11-14 are cleared as detailed in your submission of 15th August 2023 with an assumed maximum Micrositing value of 50m however T10 must be limited to a maximum of 25 metre Micrositing to allow us to remove our objection and clear this turbine.*	Changes made to location of turbines that removed objection (see below).
Joint Radio Company	17/10/24	*This proposal is **cleared -** with respect to radio link infrastructure operated by the local energy networks.* *JRC analyses proposals for wind farms on behalf of the UK Fuel & Power Industry. This is to assess their potential to interfere with radio systems operated by utility companies in support of their regulatory operational requirements.* *In the case of this proposed wind energy development, JRC does not foresee any potential problems based on known interference scenarios and the data you have provided.*	None
MLL Telecom	24/07/23	There are no existing links within a 5km radius of your proposed development, so we therefore have no objection regarding the proposal.	Consulted again on 15/10/24 but no response as yet.

Link Operator	Date of Response	Response/Issue Raised	Actions
Motorola Airwave Solutions	11/05/23	From our preliminary assessment, T0 is few metres away from NOR194 and T3 is also few metres from our link and right on the fresnel zone. These two turbines will need to move.	Changes made to location of turbines that removed objection (see below).
	29/06/23	Motorola Airwave Solutions has no objections whatsoever to the proposed wind farm development at Carn Fearna with no further micro siting of the wind turbines.	None
	17/02/25	Motorola Airwave Solutions objects as Turbine 6 is interfering with the Airwave Network. A buffer of 200 m has been requested around the link. This is a result of a link that was not identified in previous consultation responses.	Further discussions were undertaken with Motorola Airwave Solutions.
	31/03/25	Airwave have no objection to the wind farm development at Carn Fearna (Design Freeze Layout)	None
National Grid	N/A	N/A	Consulted on 15/10/24 but no response as yet.
Vodafone	07/07/2022	Provided link locations but didn't clarify if any intersected with Proposed Development.	None
	15/10/2024	I can confirm that this windfarm development will not have any impact on any MW links.	None

Mitigation and Residual Effect

16.3.12 During the design process, appropriate constraints buffers were applied to the fixed links identified across the site. Further design changes ensured that all potential turbines were sited outwith these buffers, mitigating any potential effects to telecommunications links from the Proposed Development. As turbines have been sited outwith these buffers, and relevant operators have not objected, there is no residual effect on telecommunications links.

16.4 Air Quality

16.4.1 Construction activities can result in temporary effects from dust if un-managed. This can result in nuisance effects such as soiling of buildings and, if present over a long period of time, can affect human health. As the nearest property is over 500 m away from any substantial construction works (substation compound), effects associated with dust or vehicle emissions are considered to be unlikely, therefore the effects of dust and vehicle emissions from the construction, operation and decommissioning of the Proposed Development was scoped out of this assessment.

16.4.2 Dust Mitigation Measures are included within the outline CEMP (**Technical Appendix 3.1**) which sets out mitigation measures to be implemented on-site including for site activities and the movement of construction traffic along with regular monitoring activities to ensure that dust as a result of construction of the Proposed Development is adequately controlled.

16.5 Population and Human Health

16.5.1 Chapters 7 to 16 contain assessments which relate to the health and wellbeing of the local population. These chapters assess the effects of the Proposed Development, both positive and adverse, provide an analysis of the significance of these effects and also put forward measures to mitigate against adverse effects on people and their health. A summary of these assessments is provided in **Table 16-5**.

16.5.2 Chapter 17 provides an overview of the mitigation put forward as part of these assessments in order to reduce any adverse effects of the Proposed Development to an acceptable level.

16.5.3 Further to the topics covered in Chapters 7 to 16, including this chapter, it is not expected that the Proposed Development would have significant effects on population and human health.

Table 16-5: Summary of Potential Effects of the Proposed Development on Population and Human Health

Technical Discipline	Effect on Population and Human Health	Mitigation Required	Rationale
Landscape and Visual (Chapter 7)	**Not Significant**	None	The Proposed Development would result in some significant effects, including hours of darkness effects, on aspects of the landscape and visual resource, however, these effects **would not** lead to significant effects on Population and Human Health.
Residential Visual Amenity	**Not Significant**	None	The RVAA indicates that one of the four properties included is likely to experience a major and significant visual effect as a result of the Proposed

Technical Discipline	Effect on Population and Human Health	Mitigation Required	Rationale
(RVAA) (Technical Appendix 7.2)			Development. This is Property 1, which is financially involved with the Proposed Development. The remaining three properties will have a moderate-minor or moderate and not significant effect. In line with the Landscape Institute's guidance on RVAA, the finding is that none of the four properties would reach the Residential Visual Amenity Threshold, and therefore **would not lead to significant effects on Population and Human Health.**
Noise and Vibration (Chapter 12)	Not Significant	None	Noise resulting from the construction of the Proposed Development is expected to meet typical noise limits for activities of this type without requiring any specific mitigation. The operational noise assessment indicates that predicted turbine noise levels, based on the installation of an appropriate candidate turbine, can meet the requirements of ETSU-R-97 without the requirement for mitigation/curtailment. Therefore, **no significant effects on Population and Human Health** are anticipated due to noise emissions associated with the Proposed Development.
Site Access, Traffic and Transport (Chapter 13)	Not Significant	Mitigation would be achieved via the Construction Traffic Management Plan, which would include an update on the position regarding cumulative developments, and suggest appropriate mitigation measures if required.	The assessment predicted a likely significant effect of Fear and Intimidation of and by Road Users on the section of the A835 from the A832 Junction to the A834 Junction at Contin, but only if the peak months of traffic generation for the Proposed Development, Kirkan and Lochluichart Extension II developments coincide and all stone required is imported. Following the application of mitigation, it is considered that there would be **no significant residual effects on Population and Human Health** due to Fear and Intimidation of and by Road Users on the section of the A835 from the A832 Junction to the A834 Junction at Contin.
Socio-economics, Recreation, Tourism and Access (Chapter 14)	Not Significant	None	The assessment concludes that there are **no significant** adverse effects in terms of Socio-economics, Recreation, Tourism and Land Use, and therefore there would be **no significant effects on Population and Human Health** on these aspects due to the Proposed Development.
Shadow Flicker (Chapter 16)	Not Significant	Shadow Flicker Control Module	The assessment concludes that there are no signifiant adverse efffects in terms of Shadow Flicker and therefore there would be **no significant effects on Population and Human Health** from these aspects due to the Proposed Development.

16.6 Climate and Carbon Balance

16.6.1 This section of the chapter details the calculations to work out carbon dioxide (CO_2) emissions from the Proposed Development and is supported by **Technical Appendix 16.1**. In addition to generating electricity, the Scottish Government sees wind farms as an important mechanism for reducing the UK's CO_2 emissions. This section estimates the CO_2 emissions associated with the manufacture and construction of the Proposed Development as well as estimating the contribution the Proposed Development would make to reducing CO_2 emissions, to give an estimate of the whole life carbon balance of the Proposed Development. The assessment is based on a detailed baseline description of the Proposed Development and its location. All calculations are based on site specific data, where available. Where site specific data is not available, approved national/regional information has been used.

16.6.2 An assessment of the vulnerability of the Proposed Development to climate change has not been included, as it is considered that none of the identified climate change trends would affect the Proposed Development, with the exception of increased windstorms. Mitigation with regard to extreme weather events, including windstorms, is detailed in Section 16.7.

16.6.3 Each unit of wind generated electricity would displace a unit of conventionally generated electricity, therefore, contributing to the UK net zero targets by reducing CO_2 emissions associated with power generation. **Table 16-6** provides a breakdown of the estimated emissions displaced per annum and over the assumed lifespan of 50 years for the Proposed Development.

Carbon and Peatland

16.6.4 Renewable energy developments in upland areas may often be sited on peatlands which hold stocks of poorly protected carbon, and so have the potential to release carbon to the atmosphere in the form of CO_2 if disturbed. Scotland has the majority of peat soils in the UK and, therefore, has a responsibility to ensure stability of this carbon and to ensure that developments do not cause a significant loss of this carbon reservoir.

16.6.5 Peatland classification mapping shows that the majority of the Proposed Development lies within areas of Class 1 and Class 5 peatland with pockets of Class 2 peatland within the southern and south-western extent of the site.

16.6.6 The carbon balance assessment considers the implications of any parts of the Proposed Development which could lead to the additional release of CO_2 resulting from the disturbance of peat.

16.6.7 In order to minimise the requirement for the extraction of peat, the layout design process has avoided areas of deeper peat where practicable. The layout design process is described in Chapter 2. Specific details on the peat depth and probing surveys undertaken are included in **Technical Appendix 10.1** and **Technical Appendix 10.2**.

Characteristics of Peatland

16.6.8 The loss of carbon from the carbon fixing potential from plants and vegetation on peat land is small but is calculated for the area from which peat is removed and the area affected by drainage. The carbon stored in the peat itself represents a much larger potential source of carbon loss.

16.6.9 When flooded, peat soils emit less carbon dioxide but more methane than when they are drained. In flooded soils, carbon emissions are usually exceeded by plant fixation, so the net exchange of carbon with the atmosphere is negative and soil stocks increase. When soils are aerated, carbon emissions usually exceed plant fixation, so the net exchange of carbon with the atmosphere is positive.

16.6.10 To calculate the carbon emissions attributable to the removal or drainage of the peat, emissions occurring if the soil had remained in situ and undrained are subtracted from the emissions occurring after removal or drainage.

16.6.11 The indirect loss of CO_2 uptake (fixation) by plants originally on the surface of the site but eliminated by construction activity including the destruction of active bog plants on wet sites and felling, is calculated on site specific data collected as part of the EIA process and based on blanket bog.

16.6.12 Emissions due to the indirect, long-term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by construction of the site, can also be calculated from site specific data for the Proposed Development. This figure is a worst-case scenario, as the peat would be reused on-site to minimise carbon losses.

Carbon Payback Methodology

16.6.13 The assessment of the carbon payback is based on a detailed baseline description of the Proposed Development and its location. All calculations are based on site specific data, where available. Where site specific data is not available approved national/regional information has been used.

16.6.14 The methodology to calculate carbon emissions is based on ‘Calculating carbon savings from windfarms on Scottish peat lands - A New Approach’ (Nayak et al, 2008), prepared for the Scottish Government Science, Policy and Co-ordination Division. This was superseded in 2011 by the document ‘Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach’, (Nayak et al, 2008 and 2010) and (Smith et al, 2007). In terms of carbon footprint, the ‘carbon calculator’ is the Scottish Government’s tool provided to support the process of determining the carbon impact of wind farm developments in Scotland. At the time of writing, the online version of the ‘carbon calculator’ was unavailable due to a technical fault. In its absence, the Scottish Government has advised that an excel spreadsheet (for the purposes of development, testing and trialling) which mimics the online version should be used in lieu of the online tool to present the payback period of the wind farm.

Effects of Carbon Emissions from Construction

16.6.15 Emissions arising from the fabrication of the wind turbines and the associated components are based on a full life analysis of a typical wind turbine and include CO_2 emissions resulting from transportation, erection, operation, dismantling and removal of wind turbines and foundations and transmission grid connection equipment from the existing electricity grid system.

16.6.16 With respect to wind turbines, emissions from material production are the dominant source of CO_2. Emissions arising from construction (including transportation of components, quarrying, building foundations, access tracks and hardstands) and commissioning are also included in the calculations.

The assessment has used Nayak et al (2008) default values for 'turbine life' emissions, calculated with respect to installed capacity.

16.6.17 The Proposed Development is seeking consent with an operational lifespan of 50 years.

Input Parameters

16.6.18 To undertake this assessment, the following parameters were considered, which encompass a full life cycle analysis of the Proposed Development. These parameters include:

- Emissions arising from the fabrication of the wind turbines and all the associated components.
- Emissions arising from construction, (including transportation of components; quarrying; building foundations, access tracks and hardstands; and commissioning).
- The indirect loss of CO_2 uptake (fixation) by plants originally on the surface of the site but eliminated by construction activity (including the destruction of active bog plants on wet sites).
- Emissions due to the indirect, long-term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by construction.
- Loss of carbon due to drainage.

16.6.19 As part of their methodology, Nayak et al have provided a spreadsheet called 'Scottish Government Windfarm Carbon Assessment Tool' to calculate whole life carbon balance assessments for wind farms on peatlands. The calculation spreadsheet allows a range of data to be input in order to address expected, minimum and maximum values. However, if several parameters are varied together, this can have the effect of 'cancelling out' a single parameter change. For this reason, the approach for this assessment has been to include 'maximum values' as those values which would result in the longest (maximum) payback period; and 'minimum values' as those values which would result in the shortest (minimum) payback period.

16.6.20 This spreadsheet tool provides generic values for CO_2 emissions associated with some components (such as wind turbine manufacture) and requires site specific information for other components (such as habitat type, extent of peat disturbance and ground water levels).

16.6.21 This assessment draws on information detailed in Chapters 8 (Ecology) and 10 (Geology, Hydrology, Hydrogeology and Peat) of the EIA Report. For the purpose of this assessment, it is assumed that all the embedded good practice measures outlined in the aforementioned chapters would be employed.

16.6.22 The final wind turbine choice is not yet known but would likely be around 7.2 MW and the greenhouse gas savings and carbon payback are based on the input parameters of the proposed nine wind turbines. Figures are based on currently available wind turbines and assume a consistent supplier for all wind turbine locations (i.e. wind turbine types are chosen by manufacturer). Note that, within the calculation spreadsheet, the expected, maximum and minimum values have been adjusted to suit the input parameter.

16.6.23 The capacity factor used within the calculation spreadsheet is based a site-specific estimateed capacity factor of 31.7%.

16.6.24 The input parameters for the Scottish Government calculation spreadsheet are detailed in **Technical Appendix 16.1: Carbon Calculator**. The choice of methodology for calculating the emission factors uses the 'site specific methodology' defined within the calculation spreadsheet.

Results

16.6.25 This section presents a summary of the carbon assessment which has been undertaken in respect of the Proposed Development. The purpose of the 'carbon calculator' is to assess, in a comprehensive and consistent way, the carbon impact of wind energy developments. This is undertaken by comparing the carbon costs of manufacture and construction with the carbon savings attributable to a development through operation. An assessment has been undertaken to calculate the carbon emissions which would be generated in the construction and operation of the Proposed Development after an illustrative 50 years.

16.6.26 The carbon calculations spreadsheet is provided in **Technical Appendix 16.1**. A summary of the anticipated carbon emissions and carbon payback of the Proposed Development relative to the current

Digest of UK Energy Statistics (DUKES) published figures (Department for Energy Security and Net Zero) is provided in **Table 16-6**.

Table 16-6: CO_2 Emissions and Payback Time

Results	Exp.	Min.	Max.
Net emissions of carbon dioxide (t $CO_{2\,eq}$) (carbon losses minus carbon gains) per annum.	124,026	7,575	171,300
Carbon Payback Time			
…coal-fired electricity generation (years)	0.7	0.04	1.0
…grid-mix of electricity generation (years)	3.3	0.2	4.6
…fossil fuel – mix of electricity generation (years)	1.6	0.1	2.2
Ratio of CO_2 eq. emissions to power generation (g/kWh) (Target ratio by 2030 (electricity generation) <50 g/kWh)	14	1	19

Interpretation of Results

16.6.27 The calculations of total CO_2 emission savings and payback time for the Proposed Development indicates the overall payback period of a development with nine wind turbines with an average (expected) installed capacity of around 7.2 MW each would be approximately 1.6 years (19 months), when compared to the fossil fuel mix of electricity generation.

16.6.28 This means that the Proposed Development is expected to take around 19 months to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of the wind turbines; the Proposed Development would in effect be in a net gain situation following this time period and would contribute to national CO_2 reduction targets.

16.6.29 The potential savings in CO_2 emissions due to the Proposed Development replacing other electricity sources over the lifetime of the wind turbines (assumed to be 50 years for the purpose of the carbon calculator) are approximately:

- 170,047 tonnes of CO_2 per year over coal-fired electricity;
- 37,248 tonnes of CO_2 per year over grid-mix of electricity; and
- 76,296 tonnes of CO_2 per year over a fossil fuel mix of electricity.

16.7 Major Accidents and Disasters

16.7.1 The vulnerability of the Proposed Development to major accidents and natural disasters, such as flooding, sea level rise, or earthquakes, is considered to be low due to its geographical location. A summary of Major Accidents scoped in / out is provided in **Chapter 6: Scoping, Table 6.2**.

16.7.2 In addition, the nature of the Proposed Development and location of the site means there would be negligible risks on the factors identified by the EIA Regulations. For example:

- Population and human health – the site is away from major population centres with low population density and the required safety clearances around turbines has been a key consideration throughout the design process.
- Biodiversity – receptors and resources would be unaffected as there would be little risk of polluting substances released or loss of habitat in a turbine failure scenario (highly unlikely).
- Land, soil, water, air and climate – there would be little risk of polluting substances released or loss of habitat in a turbine failure scenario (highly unlikely).
- Material assets, cultural heritage and the landscape – there would be no adverse effects on these features in a turbine failure scenario (highly unlikely).

<u>Public Safety and Access</u>

16.7.3 The Renewable UK Onshore Wind Health and Safety Guidelines (RenewableUK, 2015) note that wind farm development and operation can give rise to a range of risks to public safety including:

- Traffic (especially lorries during construction, and abnormal loads for the transport of wind turbine components; including beyond the site boundary).
- Construction site hazards (particularly to any people entering the site without the knowledge or consent of the site management).
- Effects of catastrophic wind turbine failures, which may on rare occasions result in blade throw, tower topple or fire.
- Ice throw, if the wind turbine is operated with ice build-up on the blades.

16.7.4 The RenewableUK guidance states that "*Developers should ensure that risks to public safety are considered and managed effectively over the project lifecycle, and should be prepared to share their plans for managing these risks with stakeholders and regulators; effective engagement can both build trust, and help to reduce the level of public safety risk by taking account of local knowledge*".

16.7.5 Site security and access during the construction period would be governed under the Health and Safety at Work Act 1974 and associated legislation. Public access to the site including the existing tracks would remain in place as far as possible during construction (subject to temporary health and safety restrictions during certain construction activities) and would re-open to the public fully once construction of the Proposed Development is complete.Appropriate warning signs would be installed concerning restricted areas of the site such as the substation compound, switchgear and metering systems. All on-site electrical cables would be buried underground with relevant signage.

Traffic

16.7.6 Accident data for the roads within the study area has been reviewed and is presented in Chapter 13. An assessment of the potential effects on road safety has been undertaken. In summary, the Proposed Development would create an increase to HGV traffic levels within the study area during construction, but these levels would remain well within the design capacity of the local road network.

Construction

16.7.7 With regard to risks and accidents during the construction phase, the construction works for the Proposed Development would be undertaken in accordance with primary health and safety legislation, including the Health and Safety at Work Act 1974 and the Construction (Design and Management) (CDM) Regulations 2015 which will include a requirement to produce emergency procedures in a Construction Phase (Health & Safety) Plan in accordance with the Regulations.

16.7.8 Nonetheless, the risk of accidents is covered where relevant in individual topic chapters, for instance, the potential for environmental incidents and accidents such as spillages and flood risk are considered in Chapter 10. Good practice measures to prevent incidents and spillages are set out in the outline CEMP (**Technical Appendix 3.1**).

Extreme Weather

16.7.9 As far as the risk of turbine failure during high winds is concerned, the turbines would cut-out and automatically stop as a safety precaution in wind speeds over 25 m/s.

16.7.10 Wind turbines can be susceptible to lightning strike due to their height and appropriate measures are taken into account in the design of turbines to conduct lightning strikes down to earth and minimise the risk of damage to turbines. Occasionally however, lightning can strike and damage a wind turbine blade. Modern wind turbine blades are manufactured from a glass-fibre or wood-epoxy composite in a mould, such that the reinforcement runs predominantly along the length of the blade. This means that blades will usually stay attached to the turbine if damaged by lightning and in all cases, turbines will automatically shut down if damaged by lightning.

16.7.11 Ice build-up on blade surfaces occurs in cold weather conditions. Wind turbines can continue to operate with a very thin accumulation of snow or ice but will shut down automatically as soon as there is a sufficient build up to cause aerodynamic or physical imbalance of the rotor assembly. Potential icing conditions affecting turbines can be expected two to seven days per year (light icing) in Scotland (WECO, 1999). In the event that a turbine is shut down during conditions suitable for ice formation, there is potential for ice throw to occur after start-up. There are monitoring systems and protocols in place to ensure that turbines that have been stationary during icing conditions are re-started in a controlled manner to ensure public safety. The risk to public safety is considered to be very low due to the few likely occurrences of these conditions along with the particular circumstances that can cause ice throw.

Turbine Failure

16.7.12 The leading cause of turbine failure is blade failure, followed by fires – with extreme weather, as discussed above, the most likely cause of both. Additional causes of blade failure, beyond those listed above, include blade strikes, manufacturing defects and fires. Extreme weather is the most common cause of turbine fires, however; electrical malfunctions and the overheating of mechanical components are also potential risk factors.

Seismic Activity

16.7.13 No geological fault lines are present on or in the immediate vicinity of the site, and there are no records of any earthquakes occurring in the vicinity of the site within the last 15 years (Earthquake Track[5]).

[5] https://earthquaketrack.com/gb-sct-inverness/recent

Earthquakes in Scotland are typically no greater than 3 on the Richter Scale and, therefore, minor and unlikely to cause significant damage to buildings and infrastructure.

16.7.14 It is very unlikely that an earthquake would occur in the vicinity of the site resulting in any damage to the Proposed Development. Should a wind turbine be damaged, the risk to public safety is considered to be negligible due to the remote location and careful design layout of the infrastructure.

16.8 Waste and Environmental Management

16.8.1 This topic is covered in the outline CEMP (Appendix 3.1).

16.9 Conclusion

16.9.1 This chapter has assessed the potential impacts of the Proposed Development on a number of other consideration topics.

16.9.2 A shadow flicker assessment has been conducted which concluded that the annual hours of shadow flicker anticipated at all properties are under the significance threshold of 30 hours.

16.9.3 Although shadow flicker levels are likely to fall to below the 30-hour per annum significance threshold, both for the worst-case scenario, and when the average sunshine hours expected at the site are applied, the Applicant is nonetheless committed to promptly investigating any complaints of shadow flicker and taking appropriate action as required. The Applicant proposes that prior to the operation of the first turbine, a Wind Farm Shadow Flicker Protocol will be developed which will set out the protocol to be followed should a shadow flicker complaint be received from a receptor within the study area.

16.9.4 A carbon assessment for the Proposed Development has also been undertaken. The calculations of total carbon dioxide emission savings and payback time for the Proposed Development indicates the overall payback period of a development with nine wind turbines with an average (expected) installed capacity of around 7.2 MW each would be approximately 1.6 years (19 months), when compared to the fossil fuel mix of electricity generation.

16.9.5 This means that the Proposed Development is expected to take around 19 months to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of the wind turbines; the Proposed Development would in effect be in a net gain situation following this time period and would contribute to national CO_2 reduction targets.

16.9.6 Assessment of the effects of the Proposed Development on television and telecommunications effects concludes no significant effects as a result of the Proposed Development.

16.10 References

THC (2016). Onshore Wind Energy Supplementary Guidance 2016.

Department of Energy and Climate Change. (2011). *Update of UK Shadow Flicker Evidence Base.* Available at https://www.gov.uk/government/news/update-of-uk-shadow-flicker-evidence-base Accessed on: 20 March 2025.

Nayak et al; (2008 and 2010) and Smith et al; (2011), *Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach*. Available at: (http://www.gov.scot/Publications/2008/06/25114657/0 Accessed on: 20 March 2025.

Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., (2010), *Calculating carbon budgets of wind farms on Scottish peatland. Mires and Peat 4: Art. 9.* Available at: http://mires-and-peat.net/pages/volumes/map04/map0409.php Accessed on: 20 March 2025

Northern Ireland Department of the Environment. (2009). *Best Practice Guidance to Planning Policy Statement 18 (PPS 18) Renewable Energy*. Available at: https://www.infrastructure-ni.gov.uk/publications/best-practice-guidance-pps-18-renewable-energy Accessed on: 20 March 2025.

Ofcom. (2025). *Spectrum Information Portal*. Available at: https://www.ofcom.org.uk/spectrum/frequencies/spectrum-information-portal/ Accessed on: 20 March 2025

RenewableUK (2015) *Onshore Wind Health & Safety Guidelines.*

Scottish Government (2014). *Onshore wind turbines: planning advice.* Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ Accessed on: 20 March 2025.

Scottish Government. (2022). *Onshore Wind Policy Statement*. Available at https://www.gov.scot/publications/onshore-wind-policy-statement-2022/ Accessed on: 20 March 2025.