CONTENTS

INTRODUCTION

15.1 This Chapter considers any remaining environmental topics that are within the scope of the Environmental Impact Assessment (EIA), but do not warrant full assessment and are therefore not considered elsewhere in the EIA Report. These topics include:

- Shadow flicker;
- Climate and carbon balance;
- Risk of accidents and other disasters;
- Population and human health;
- Air quality;
- Aviation;
- Telecommunications and other infrastructure;
- Television reception; and
- Waste and environmental management.

15.2 This Chapter is accompanied by **Technical Appendix 15.1: Carbon Calculator**. This Chapter is also supported by **Figure 15.1: Potential Zone of Shadow Flicker Influence**.

15.3 Planning policies of relevance to this assessment are provided in **Technical Appendix 4.1: Legislation, Planning Policy and Guidance.**

SHADOW FLICKER

15.4 This chapter assesses the potential effects that may arise from shadow flicker as a result of the operation of the proposed development. It should be read with reference to the scheme description in **Chapter 3: Description of Development**.

15.5 Shadow flicker may occur 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 flicks on and off, an effect known as shadow flicker. The effect can only occur inside buildings, where the flicker appears through a window opening.

15.6 The likelihood and duration of the effect depends upon:

- The direction and aspect of the property relative to the turbine(s): in the UK, only properties within 130 degrees either side of north, relative to the turbines, can be affected, as turbines do not cast long shadows on their southern side;

- distance from turbine(s): the further the building is from the turbine, the less pronounced the effect would be, given the shadow fades with distance. Flicker effects are known to be strongest and most likely to have the potential to cause significant effects within eleven rotor diameters (rather than 10, due to how far north the proposed development is) of a turbine (refer to **Technical Appendix 4.1: Legislation, Planning Policy and Guidance** for further detail);
- turbine height and rotor diameter;
- time of year and day; and
- weather conditions (i.e. cloudy days reduce the likelihood of effects occurring).

15.7 If shadow flicker cannot be avoided through layout changes, then technical mitigation solutions are available, such as shutting down the turbines which cause the effect when certain conditions prevail.

15.8 Shadow flicker effects are only considered during the operational phase of a wind farm development.

Study Area

15.9 In line with the best practice guidance (refer to **Technical Appendix 4.1**), a study area based on a distance of 11 rotor diameters from the proposed wind turbines has been employed to determine the zone of potential shadow flicker incidence of a proposed development. The turbines for the proposed wind turbines have a rotor diameter of 133m, this gives a study area of 1,463m from the turbines. In addition to this a further 25m area was added to the 11 rotor diameter distance in order to account for potential micrositing should the proposed development receive consent (total study area distance = 1,488m from proposed wind turbine locations).

15.10 The maximum study area for the proposed development was mapped using GIS software. This was then refined to include only the areas within 130 degrees of north of proposed wind turbine locations. Properties within 11 rotor diameters (1,463m) plus 25m for the reasons outlined above (1,488m) and the 130^{o} area were identified from OS AddressBase data. 5 properties were identified within the shadow flicker study area. **Figure 15.1** shows the location of these properties.

Methodology

15.11 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).

15.12 The calculations from this assessment process assume 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 4m/s and

25m/s, and no account is taken of shut down periods for maintenance). This methodology yields a theoretical maximum indication of potential shadow flicker incidence, together with the times of day, and dates during the year when potential incidence may occur.

15.13 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 11 rotor diameters (plus 25m micrositing). Data input into the model where shadow flicker assessment is required is as follows:

- The locations of all properties within 11 times the rotor diameter (including an allowance of 25m for micrositing) and 130 degrees either side of north of any turbine;
- The dimensions and orientations of windows facing the proposed development;
- The surrounding topography (Ordnance Survey Digital Terrain Model); and
- The locations and dimensions of the turbines.

15.14 The following sources of information outlined in **Table 15-1** were used to inform this assessment.

Table 15-1: Sources of Information

Topic	Source of Information
Residential properties Location in relation to proposed development and identification of windows.	Ordnance Survey (OS) 1:25,000 Mapping Google Earth Street View Bing Maps Birds Eye View
Topography Height data	OS 5m DTM data

15.15 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; and
- 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.

15.16 Only those properties within 1,488m of the proposed turbines have been included in the calculations. The model has been run using OS terrain 5 DTM data which is the most accurate digital terrain data available for the site.

15.17 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 and the property and as such the actual effect would likely be even less.

Limitations to the Assessment

15.18 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.

15.19 Climatic conditions dictate that the sun is not always shining. The closest Met Office location is Strathy East, located approximately 5.9km from the development Site.

15.20 Historic Met Office data (over the period 1991–2020) gives actual sunshine hours for the Strathy East Met Station to be on average 28.8% of total daylight hours (average sunshine hours of 1,262 / total number of daylight hours 4,380 = 35.4%). Cloud cover during other times may obscure the sun and 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.

15.21 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.

15.22 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.

15.23 Any screening provided by vegetation or structures has not been incorporated as the analysis has been run on bare ground terrain data.

Assessment of Significance

15.24 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.

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

15.26 The assessment has therefore adopted a criterion of 30 hours of shadow flicker 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.

15.27 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.

Baseline Conditions

15.28 A number of residential properties have been identified which fall within the 1,488m study area. These properties could theoretically be affected by shadow flicker from the proposed development (**Figure 15.1**). Details of these properties are identified in **Table 15-2.**

Table 15-2: Properties and Shadow Flicker Zone of Influence

No.	Property	Use	Grid Reference (E, N)	Distance from Nearest Proposed Turbine (m)	Within Shadow Flicker Zone of Influence?
1	Kirkton Cottage	Residential	288977, 962044	1,430	Yes
2	Kirkton Farm House*	Residential	289026, 961917	1,365	Yes
3	Ar Dachaidh*	Residential	289018, 961690	1,221	Yes
4	Achiemore	Residential	289514, 957985	1,590	No
5	Cornmill Bunkhouse	Residential	289535, 957691	1,615	No
6	27 Upper Bighouse*	Residential	288880, 957488	1,047	Yes
7	Craigfillan	Residential	289470, 957372	1,636	No
8	25 Upper Bighouse*	Residential	288888, 957156	1,230	Yes
9	Laidhan*	Residential	288872, 956625	1,590	No
10	Smigel	Residential	289402, 957678	1,486	Yes

* Property / Owner is financially involved with the proposed development

Assessment of Effects

15.29 **Figure 15.1** shows the potential zone of shadow flicker effects. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 14.6 hours per year at Ar Dachaidh (show in **Table 15-3**) assuming the worst-case scenario. In addition, three other properties could also potentially receive shadow flicker effects but of fewer hours.

15.30 The results shown in **Table 15-3** are based on the 'worst-case scenario', which includes the potential for micrositing leading to turbines being moved 25m closer to these properties.

Table 15-3: Shadow Flicker Assessment Outputs

No.	Property	Days per Year Where Shadow Flicker Potentially Experienced	Turbine(s) Causing Effect	Max Hours per Day Where Shadow Flicker Potentially experienced	Max Minutes per Day Where Shadow Flicker Potentially experienced	Total Hours per Year When Shadow Flicker Potentially Experienced
1	Kirkton Cottage	24	1	0.41	24.6	6.4
2	Kirkton Farm House*	38	1	0.43	25.8	12.7
3	Ar Dachaidh*	40	1	0.47	28.2	14.6
6	27 Upper Bighouse*	0	11	0	0	0
8	25 Upper Bighouse*	0	11	0	0	0
10	Smigel	32	11	0.39	18	9.7

* Property / Owner is financially involved with the proposed development

15.31 The results confirm that the properties assessed would not experience over 30 hours of shadow flicker in a year, and with a maximum of 14.6 hours predicted at any one property, that the predicted shadow flicker hours would be below the 30 hour limit and are therefore considered to be not significant.

15.32 Given the additional rationale in paragraph 15.15, it is likely 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.

Mitigation

15.33 Although no mitigation is currently required for the operational phase of the proposed development as no significant shadow flicker effects are predicted to occur, the applicant is committed to installing shadow flicker impact control modules prior to operation to Turbines 1 and 11.

15.34 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.

15.35 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 onsite, following installation, to reflect local conditions.

15.36 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. As noted in 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".*

CLIMATE AND CARBON BALANCE

15.37 This section of the chapter details the calculations to work out CO_2 emissions from the proposed development. In addition to generating electricity, the Scottish Government sees wind farms as an important mechanism for reducing the UK's carbon dioxide (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.

15.38 Each unit of wind generated electricity would displace a unit of conventionally generated electricity, therefore, saving power station emissions. **Table 15-4** provides a breakdown of the estimated emissions displaced per annum and over the assumed lifespan of 30 years for the proposed development.

Carbon and Peatland

15.39 Wind farms in upland areas tend to be sited on peatlands which hold stocks of carbon and so have the potential to release carbon into the atmosphere in the form of CO_2 if disturbed. The proposed development is located predominantly in an area of Class 1 and Class 2 Priority Peatland Habitat (SNH, 2016).

15.40 In order to minimise the requirement for the extraction of peat, the site design process (described in **Chapter 2: Site Description and Design Evolution**) has avoided areas of deeper peat. Peat probing was carried out onsite and peat depth mapped, as shown in **Figure 10.1.5** and **Figure 10.1.6** of **Technical Appendix 10.1: Peat Landslide and Hazard Risk Assessment**. This enabled wind turbines and associated infrastructure to be located in areas of shallower peat where possible. Where it has not been possible to avoid deeper areas of peat, floated track (446.95m) has been proposed as part of the site layout.

15.41 Paragraphs 15.42 to 15.58 detail how the whole life carbon balance assessment for wind farms on peatlands is calculated. Including the input of emissions due to liberation of CO_2 from carbon stored in peat as a result of construction.

Effects of Carbon Emissions from Construction

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

15.43 With respect to 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 hard standings) 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.

15.44 A number of technical papers (detailed in Nayak et al, 2008) have reported a wide range of emissions values from wind farms, these being between 6 and 34 tonnes CO_2 GWh-1. From this a calculation of additional CO_2 payback time due to production, transportation, erection and operation of the proposed development that this represents can be compared. The additional CO_2 payback time for the best case scenario of 6t CO_2 GWh-1 would be approximately 8 months (0.7 year) assuming replacement of coal fired power generation and approximately 18 months (1.5 years) assuming a replacement of grid mix (the combination of electricity suppliers, including coal, gas and oil generation, used for grid balancing and the type of power generation most likely to be replaced by wind generated power). For the worst-case scenario (34t CO_2 GWh-1), this would increase to 10 months (0.8 years) and 36 months (3.0 years) additional CO_2 payback respectively.

15.45 These increases are considerable and so it is essential that they are taken into account for the calculation of CO_2 payback time for a proposed development. However, it should be noted that this may still compare very favourably with the life cycle analysis of other means of non fossil fuel based power generation, such as nuclear, particularly when the full energy costs of construction, operation, maintenance and decommissioning, uranium mining and transportation and long term waste management are taken into account.

Characteristics of Peatland

15.46 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.

15.47 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.

15.48 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.

15.49 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.

15.50 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 re-used onsite to minimise carbon losses.

15.51 Data from turbine manufacturers and the construction related activity is included as part of the assessment to address payback periods, however the two previous sources (from peat and the losses from loss of plant uptake) are a much more significant contributor to CO_2 emissions and the overall CO_2 debt where peat is disturbed onsite.

Methodology

15.52 The methodology to calculate carbon emissions generated in the construction, operation and decommissioning of a wind farm 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, 2011). 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.

Input Parameters

15.53 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 turbines and all the associated components;
- emissions arising from construction, (including transportation of components; quarrying; building foundations, access tracks and hard standings; and commissioning);
- the indirect loss of CO_2 uptake (fixation) by plants originally on surface of the site but eliminated by construction activity (including the destruction of active bog plants on wet sites) and felling;
- 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; and
- loss of carbon due to drainage and from forestry clearance.

15.54 As part of their methodology, Nayak et al have provided a spreadsheet 'Scottish Government Windfarm Carbon Assessment Tool' to calculate whole life carbon balance assessments for windfarms on peat lands. The calculation spreadsheet (Version 1.6.1 and online version LKIV-O3H2-15KW v5) 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.

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

15.56 This assessment draws on information detailed in the EIA Report, **Chapter 8: Ecology** and **Chapter 10: Hydrology, Hydrogeology, Geology and Soils**. For the purpose of this assessment, it is assumed that all the embedded good practice measures outlined in **Chapter 8: Ecology**, and **Chapter 10: Hydrology, Hydrogeology, Geology and Soils**, would be employed.

15.57 The final wind turbine choice is not yet known, but would likely be at minimum a 4.8MW machine, and the proposed development would consist of 11 turbines. The greenhouse gas savings and carbon payback are based on these input parameters. Figures are based on currently available turbines and assume a consistent supplier for all turbine locations (i.e. 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.

15.58 The recommended capacity factor within the calculation spreadsheet is 39.8%. This is based on the collection of onsite wind data.

Results

15.59 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 farm developments. This is undertaken by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm. An assessment has been undertaken to calculate the carbon emissions which would be generated in the construction, operation and decommissioning of the proposed development.

15.60 The carbon calculations spreadsheet is provided in **Technical Appendix 15.1: Carbon Calculator**. A summary of the anticipated carbon emissions and carbon payback of the proposed development are provided in **Table 15-4**.

Table 15-4: Anticipated Carbon Emissions

Results	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	125,832	115,032	139,374
Carbon payback time			
Coal-fired electricity generation (years)	0.7	0.7	0.8
Grid-mix of electricity generation (years)	2.7	2.4	3.0
Fossil fuel - mix of electricity generation (years)	1.5	1.4	1.7
Ratio of CO2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	22.78	20.57	25.43

Interpretation of Results

15.61 The calculations of total carbon dioxide emission savings and payback time for the proposed development indicates the overall payback period of a wind farm with 11 turbines with an average (expected) installed capacity of 4.8MW each would be approximately 1.5 years, when compared to the fossil fuel mix of electricity generation.

15.62 The proposed development is expected to take around 18 months (1.5 years) to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of a wind farm; the site would in effect be in a net gain situation following this time period and can then claim to contribute to national objectives.

15.63 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 30 years for the purpose of the carbon calculator) are approximately:

- 169,359 tonnes of CO_2 per year over coal-fired electricity (approximately 5.1 million tonnes assuming a 30 year lifetime for the purposes of the carbon calculator);
- 46,681 tonnes of CO_2 per year over grid-mix of electricity (approximately 1.4 million tonnes assuming a 30 year lifetime for the purposes of the carbon calculator); and
- 82,839 tonnes of CO_2 per year over a fossil fuel mix of electricity (2.49 million tonnes assuming a 30 year lifetime for the purposes of the carbon calculator).

RISK OF ACCIDENTS AND OTHER DISASTERS

15.64 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 and the fact that its purpose is to ameliorate some of these issues.

15.65 In addition, the nature of the proposals and remoteness 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 remote 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); and
- material assets, cultural heritage and the landscape – there would be no adverse effects on these features in a turbine failure scenario (highly unlikely).

15.66 Despite the risk of major accidents and natural disasters being considered as low, the vegetation and openness of the site does present a potential, albeit remote, fire risk. **Technical Appendix 3.1: Outline CEMP** contains measures for reducing the risk of fires occurring during the construction of the proposed development and these are considered to be appropriate to the level of potential risk.

Public Safety and Access

15.67 The Renewable UK Onshore Wind Health and Safety Guidelines (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; and
- ice throw, if the wind turbine is operated with ice build-up on the blades.

15.68 The RenewableUK guidance (2015) 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"*.

15.69 Site security and access during the construction period would be governed under Health and Safety at Work Act 1974 and associated legislation. Public access along the Kirkton Farm road would remain in place as far as possible during construction, and would reopen to the public fully once construction of the proposed development is complete. No public access would be permitted along new access track to the site during construction. However, the Land Reform (Scotland) Act 2003 which came into effect in February 2005 establishes statutory rights of responsible access on and over most land. The legislation offers a general framework of responsible conduct for both those exercising rights of access and for landowners. Once the construction period and commissioning of the proposed development is complete, no special restriction on access are proposed.

15.70 Informal recreational access would benefit from the presence of the turbines within the site by providing a means to readily access the hill. Appropriate warning signs would be installed concerning restricted areas such as the substation compound, switchgear and metering systems. All onsite electrical cables would be buried underground with relevant signage.

Traffic

15.71 Accident data for the A836 (local road near to the site which the majority of construction traffic will be using) has been reviewed and is presented in **Chapter 12: Site Access, Traffic and Transport**. 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 but these levels would remain well within the design capacity of the local road network. The accident records for the study area show there were 14 accidents occurring over the five year study period. It would appear as though there were no accidents on the A836 in the vicinity of the junction of the Kirkton Farm road with the A836, with the closest accident recorded 2.2km east along the A836. The study area does not have a significant safety issue and the number of accidents recorded in the vicinity of the site are not high. Therefore, the level of effect is considered to be minor adverse and not significant.

Construction

15.72 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.

15.73 Nonetheless, the risk of accidents and other disasters is covered where relevant in individual topic Chapters, for instance, the potential for environmental incidents and accidents such as spillages are considered in **Chapter 8: Ecology**, **Chapter 9: Ornithology** and **Chapter 10: Hydrology, Hydrogeology, Geology and Soils**. Flood risk is also assessed with **Chapter 10**.

Extreme Weather

15.74 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.

15.75 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.

15.76 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). The potential for ice throw to occur after start up following a turbine shut down during conditions suitable for ice formation is high. There are monitoring systems and protocols in place to ensure that turbines that have been stationary during icing conditions are restarted 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.

Seismic Activity

15.77 No 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 47 years (Earthquake Track). 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.

15.78 It is very unlikely that an earthquake would occur on 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.

POPULATION AND HUMAN HEALTH

15.79 **Chapter 7: Landscape and Visual**, **Chapter 10: Hydrology, Hydrogeology, Geology and Soils**, **Chapter 12: Site Access, Traffic and Transport**, **Chapter 13: Noise** and **Chapter 14: Socio-economics and Land Use** 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 negative, provide an analysis of the significance of these effects and also put forward measures to mitigate against negative effects on people and their health.

15.80 **Chapter 16: Schedule of Commitments**, provides an overview of the mitigation put forward as part of these assessments in order to reduce any negative effects of the proposed development to an acceptable level.

15.81 Further to the topics covered in **Chapters 7 – 16**, including this chapter, it is not expected that there will be any other effects from the proposed development which would have significant effects on population and human health.

AIR QUALITY

15.82 Construction activities can result in temporary effects from dust if unmanaged. 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 500m away from any substantial construction works, effects associated with dust or vehicle emissions are considered to be unlikely, therefore the effects of dust and vehicle emissions from the construction and operation of the proposed development was scoped out of this assessment.

AVIATION

15.83 Wind farm developments can affect airports and aerodromes, predominantly by presenting a collision risk to approaching and departing aircraft, or by interfering with radar or other navigation aids. Further to this is the potential risk to any low flying aircraft, such as military aircraft during training exercises. For wind farm development, the standard approach is to avoid any negative effects on aviation infrastructure where possible, and to find suitable solutions (technical mitigation) where this cannot be achieved.

15.84 An assessment has been carried out to understand the potential impact of the proposed development on aviation related infrastructure.

Radar Visibility

15.85 The assessment looked at radar Line of Site (LoS) for radars that may potentially be affected by the proposed development (technical impacts only). Four radar were considered as part of the assessment:

- Lossiemouth PSR;
- Saxa Vord ADR;
- Alanshill PSR; and
- Wick Airfield.

15.86 The proposed development was deemed to be not visible to the above extant radar (diffraction effects have not been included in the LoS assessment). The proposed development is not assessed as having any significant effects with regards to aviation radar.

Military Low Flying

15.87 The proposed development site is within Low Flying Area 14, where military aircraft are permitted to fly down to 250 feet above ground level and obstacles.

15.88 The proposed development site lies just outside the high priority low flying training area denoted ‘Tactical Training Area – 14T’.

15.89 The proposed wind turbines would be fitted with infrared lighting in order to mitigate against physical obstruction to low flying aircraft operating in the area.

15.90 The proposed development is not assessed as having any significant effects on low flying military aircraft.

Scoping Responses

15.91 Consultation with the relevant aviation stakeholders was undertaken via Scoping and the Scoping Addendum process. **Table 15-5** outlines the responses of each of the relevant consultees.

Table 15-5: Consultation Responses

Consultee and Response Date	Stage	Summary of Response
Defence Infrastructure Organisation (23/07/21)	Scoping/Scoping Addendum	The Defence Infrastructure Organisation (DIO) Safeguarding Team represents the MOD as a consultee in UK planning and energy consenting systems to ensure that development does not compromise or degrade the operation of defence sites such as aerodromes, explosives storage sites, air weapon ranges, and technical sites or training resources such as the Military Low Flying System. The MOD requests the perimeter turbines are 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. Subject to the provision of appropriate lighting, the MOD has no objection in relation to this application.
NATS Safeguarding (21/04/21 & 20/07/21)	Scoping/Scoping Addendum	The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal. However, please be aware that this response applies specifically to the above consultation and only reflects the position of NATS (that is responsible for the management of en route air traffic) based on the information supplied at the time of this application.
Highlands and Islands Airports Ltd (20/04/21 & 14/07/21)	Scoping/Scoping Addendum	With reference to the above proposed development, it is confirmed that our calculations show that, for the scoping configuration, this development would not impact the safeguarding criteria for Wick Airport. Therefore, Highlands and Islands Airports Limited would have no objections to the proposal. It should be noted that this development lies within the protection area for the Instrument Flight Procedures (IFPs) for Wick Airport. Any significant height increase of the development (AMSL) could result in

Consultee and Response Date	Stage	Summary of Response
		an unacceptable impact on the IFPs
Civil Aviation Authority	Scoping / Scoping Addendum	No response received.

TELECOMMUNICATIONS AND OTHER INFRASTRUCTURE

15.92 Wind turbines can potentially cause interference to telecommunication links through reflection and shadowing to electro-magnetically propagated signals including terrestrial fixed microwave links managed by telecommunications operators.

15.93 Early constraints mapping (pre Scoping) identified the presence of three fixed links running north – south through the site. Telecommunications operators were consulted at Scoping stage and information requested for telecommunications links within close proximity of the site. Only generic / high level responses were received at Scoping and so the decision was made to contact the link operators directly in order to understand any requirement for stand off distances between the proposed turbines and the fixed link paths. In addition to this, a Telecommunications Impact Assessment was carried out by consultant Pager Power.

15.94 Pager Power's Telecommunications Impact Assessment identified the three link operators as Telefonica, MBNL and Vodafone. Each of these link operators was contacted regarding the proposed development (and provided the Scoping Addendum turbine coordinates). Telefonica advised that they had no objection as the turbine coordinates were in excess of 95m from their fixed link (2nd Fresnel zone clearance of 20m plus blade length). MBNL advised that they had concerns regarding the locations of Turbines 1, 8, 11 and 13 as they required a clearance of 100m from blade tip to fixed link (166.5m). Vodafone also advised that they had concerns regarding the locations of Turbines 1, 8, 11 and 13, and also required a clearance of 100m from blade tip to fixed link (166.5m). The MBNL and Vodafone responses did not take into account any 2nd Fresnel zone calculations which may allow for reduced separation distances.

15.95 Following the outcome of Pager Power's Telecommunications Impact Assessment, MBNL and Vodafone were contacted again in order to discuss the turbine coordinates and required separation distances in more detail.

15.96 On 8th of September 2021, Vodafone confirmed (via email) that the separation distances between Turbines 1 and 13 (Scoping Addendum layout) and their fixed telecoms link was acceptable. However, they advised that Turbine 8 may be an issue for the fixed telecoms link due to it being 73.5m from blade tip to fixed link. The final proposed layout has progressed from the version assessed by Vodafone, with Turbine 8 being moved south and west, away from the fixed link. In the proposed development, the separation distance between the closest proposed turbine (T1) and the Vodafone fixed link is approximately 178.7m (112.2m from blade tip to fixed link).

15.97 Following discussion with MBNL in October 2021, the site layout was updated in order to move the wind turbines further away from their fixed telecoms link. On 20th October 2021, MBNL confirmed (via email) that the separation distances between the closest proposed turbines (T1 and T11) and their fixed telecoms link was acceptable. The final proposed layout has progressed from the version assessed by MBNL, with the separation distance between the closest proposed turbine (T1) and the MBNL fixed link increasing.

15.98 No turbine forming part of the proposed development is within 166.5m of either the MBNL, Vodafone or Telefonica fixed links that run north-south through the site. All turbines forming part of the proposed development maintain in excess of 100m separation distance from blade tip to either the MBNL or Vodafone fixed links. Therefore, the proposed development is not assessed as having any significant effects with regards to telecommunications.

Consultation Responses

15.99 Consultation with the relevant telecoms stakeholders was undertaken via Scoping and the Scoping Addendum process. Further to this direct consultation with relevant telecoms stakeholders (fixed link operators) was also carried out post Scoping. **Table 15-6** outlines the responses of each of the relevant consultees.

Table 15-6: Consultation Responses

Consultee and Response Date	Stage	Summary of Response
Atkins (30/04/21 & 31/07/31)	Scoping/Scoping Addendum	The above application has now been examined in relation to UHF Radio Scanning Telemetry communications used by our Client in that region and we are happy to inform you that we have NO OBJECTION to your proposal. Please note that this is not in relation to any Microwave Links operated by Scottish Water
British Telecom (23/04/21 & 16/07/21))	Scoping/Scoping Addendum	We have studied this Windfarm proposal with respect to EMC and related problems to BT point-to-point microwave radio links. The conclusion is that the 12 Turbine Locations provided should not cause interference to BT's current and presently planned radio network. The conclusion is that, using the co-ordinates supplied in the Scoping Addendum, the extra turbines T13 and T14 should not cause interference to BT's current and presently planned radio network.
Joint Radio Company (16/04/21 & 14/07/21)	Scoping/Scoping Addendum	This proposal cleared with respect to radio link infrastructure operated by: The Local Utility Company.
Ofcom (14/04/21 & 08/07/21)	Scoping/Scoping Addendum	The windfarm coordination activity is no longer provided by Ofcom. For further information and how to access fixed link licence data, please see Ofcom's Website here <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/fixedterrestrial-links> under the sub-heading 'Windfarm and Wireless Services'

Consultee and Response Date	Stage	Summary of Response
Vodafone (08/09/21)	Post Scoping	Using the co-ordinates given I think turbine 13 and 1 should be ok as I have those approximately 167mtrs and 180mts. Turbine 8 is approximately 140mts so may be an issue.
Telefonica (15/09/21)	Post Scoping - Pager Power (Telecoms Impact Assessment)	We have a 7.5 GHz microwave in the path of where you are planning to install these turbines. We require full 2nd Fresnel zone clearance which is around 20 meters. Radius of the blade is 75m, therefore we would need a minimum of 95 meters from any turbine to the centre point of the link. As it stands none of the turbines would interfere. However, T8 and T11 are rather close and you would need to ensure that they are not moving, T8 to the East or T11 to the West. The same applies to T1 and T13 although these two are slightly further away.
MBNL (20/10/21)	Post Scoping	With the latest coordinates you have supplied below, there are minor infringement issues with Turbines 1 & 11 which should not be a problem for the EE/3UK mobile microwave network, so the application is approved. Please note though that any movement of the turbines through micrositing etc. towards the link will have to be re-analysed.

TELEVISION RECEPTION

15.100 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.

15.101 The proposed development is located in an area which is now served by a digital transmitter and, therefore, television reception is unlikely to be affected by the proposed development as digital signals are rarely affected. In the unlikely event that television signals are affected by the proposed development, reasonable mitigation measures would be considered by the applicant.

WASTE AND ENVIRONEMTNAL MANGEMENT

15.102 **Chapters 7** to **15** put forward suggestions on how to mitigate any negative impacts from the proposed development with regards to waste and environmental management. These are summarised in **Chapter 16: Schedule of Commitments**.

15.103 The outline CEMP (**Technical Appendix 3.1**) provides a general overview on how waste and other environmental issues would be managed during the construction phase. **Technical Appendix 10.2: Peat Management Plan** also details how excavated peat is controlled, stored, re-used and disposed of during the construction phase of the proposed development.

15.104 It is expected that a site specific waste management plan for the control and disposal of waste generated onsite would be required by condition, should the proposed development receive consent.

REFERENCES

Department of Energy and Climate Change, 2011. Update of UK Shadow Flicker Evidence Base. [Online]. Available at https://www.gov.uk/government/news/update-of-uk-shadow-flicker-evidence-base [accessed 08/04/2022].

Highland Council Local Development Plan. Available at https://www.highland.gov.uk/info/178/local_and_statutory_development_plans/199/highland-wide_local_development_plan [accessed 08/04/2022].