Chapter 15

Other issues

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Chapter 15
Other issues

15.1 Introduction

1. This Chapter assesses the potential effects of the construction and operation of the proposed Development on the following issues:

- infrastructure;
- telecommunications;
- television reception;
- shadow flicker;
- climate and carbon balance;
- air quality;
- aviation;
- population and human health; and
- waste and environmental management.

15.2 Infrastructure

2. Overhead power lines operated by ScottishPower Energy Networks (SPEN) cross the north of the Site from east to west. These power lines emanate from the existing Arecleoch Windfarm substation, which is also located within the application boundary. These overhead power lines were given a buffer of 220 m during the design process, and as such no turbines are proposed to be built within 220 m of these overhead power lines. No effects on these power lines, as a result of the proposed Development, is anticipated and so they are not considered further.

3. A public road and a railway line cross the Site, from north east to south west. The public road and the railway line were given a buffer of 220 m during the design process, and as such no turbines are proposed to be built within 220 m of the public road or railway line. No effects on these routes are predicted as a result of the proposed Development and they are not considered further. Chapter 7: Landscape and Visual, assesses the visual effects of the proposed Development from public roads and railways.

15.3 Telecommunications

4. 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.

5. Telecommunications operators were consulted and information requested for telecommunications links within close proximity of the Site. A summary of consultation is provided in **Table 15.1**.

Consultee	Summary of consultation	Comment / action taken
British Telecommunications (BT)	Email dated 01/11/18 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 Project indicated should not cause interference to BT's current and presently planned radio network.	No further action required
Joint Radio Company (JRC)	Email dated 06/11/18 This proposal cleared with respect to radio link infrastructure operated by: Scottish Power and Scotia Gas Networks	No further action required
Ofcom	No response	N/A

Table 15.1: Consultee responses

7. From the consultation responses received, it is apparent that there is no indication that the proposed Development would interfere with telecommunications links. The turbines have not increased in height through the design process, nor have they spread beyond the requested consultation radius of 1500 m from the turbine locations provided at the scoping consultation stage and therefore this is not considered further.

15.4 Television reception

8. 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.

9. 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.

15.5 Shadow flicker

15.5.1 Introduction

10. 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

11. The likelihood and duration of the effect depends upon:

- 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 ten rotor diameters 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).

12. 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.

13. Shadow flicker effects are only considered during the operational phase of a windfarm development.

15.5.2 Methodology

14. As noted in **Chapter 2: Site Description and Design Evolution**, the location of the proposed turbines has been carefully considered with respect to distance from residential properties.

15. An assessment has been carried out to identify whether shadow flicker would be likely to occur at properties neighbouring the proposed Development, and if so the predicted times of year, and the time and duration of these potential effects.

16. Shadow flicker is calculated based on the worst-case condition assuming the sun is always shining, there are no screening features such as trees, no accounting for periods of turbine shut down and also that the wind is always blowing at sufficient velocity to spin the blades and in a direction which results in the blades being perpendicular to the property (maximum shadow flicker or worst-case).

15.5.2.1 Limitations to the assessment

17. Sunlight and wind data have not been correlated for the purposes of this assessment and specific window type (i.e. the use and level of occupation for each room) has not been incorporated into the model. Window and door opening sizes and orientations have been estimated.

18. The assumption is that large apertures through which the shadow flicker could occur are present at each property, in reality windows may be smaller than this, though this is not considered a factor in the accuracy of the assessment as it means that the modelling has been done on a worst-case scenario for window size.

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

15.5.2.2 Study area

20. In line with the best practice guidance (refer to **Technical Appendix 4.1**), a study area based on a distance of 10 rotor diameters from the proposed wind turbines is normally 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 150 m, this gives a study area of 1,500 m from the turbines. In addition to this a further 50 m area was added to the 10 rotor diameter distance in order to account for micrositing should the proposed Development receive consent.

21. 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 10 rotor diameters (1,500 m) plus 100 m for the reasons outlined above (1,550 m) and the 130º area were identified from OS AddressBase data. Three properties were identified within the shadow flicker study area. **Figure 15.1** shows the location of these properties.

15.5.2.3 Modelling

22. The potential dates, times and durations of shadow flicker events have been predicted using ReSoft WindFarm software. This software creates a mathematical model of the proposed wind turbines, the surrounding area and the location of properties. The following factors are taken into account in the calculation:

- turbine location, rotor diameter and hub height;
- topography (using OS Terrain 5 digital terrain data); and
- locations of houses / buildings.

23. The software calculates the dates and times when the shadow of a wind turbine's rotor could fall onto a window. The following worst-case assumptions are made throughout the calculation:

- weather conditions are such that shadows are always cast (i.e. bright/clear/sunny at all times of day and throughout the year);
- the wind is always blowing at sufficient velocity to spin the blades;
- the turbine rotors are facing directly towards the property at all times, therefore the shadow is always at its maximum possible size and circularity, rather than elliptical as would be the case if the turbine rotor were oriented at an angle to the property; and
- The property has a window directly facing the wind turbines.

24. Rather than modelling individual windows within the software, each façade of the receptors that contain windows facing the proposed windfarm have been modelled as 'windows'. This technique provides conservative results and a reduction in the amount of data, simplifying the assessment process and aiding comprehension.

25. 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; and
- the turbines are located within a forest of dense, predominantly coniferous tree cover. During the winter months, early mornings and late evenings, these trees could potentially provide some screening to properties from the effects of shadow flicker. However, it cannot be assumed that these trees would all be present for the full lifetime of the windfarm.

26. Only those properties within 1,550 m 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.

27. 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.

15.5.2.4 Assessment of significance

28. No published significance criteria exist for the assessment of shadow flicker effects and there is no UK statutory limit or guidance to stipulate acceptable levels of shadow flicker.

29. Although there are no local or national UK mandatory requirements or criteria in regard to shadow effects caused by wind turbines, the Onshore Wind Energy Planning Conditions Guidance Note (Predac, 2004) observes that the amount of shadow flicker should be calculated in hours per year.

30. A review of the evidence base for shadow flicker by Parsons Brinckerhoff for the Department of Energy and Climate Change (Parsons Brinckerhoff for DECC, 2011) suggests that a maximum of 30 hours of shadow flicker in a calendar year is a threshold for consideration, ideally with no longer than 30 minutes on any single occasion.

31. The assessment has 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.

32. The criteria set out in paragraph 29 have been used in this assessment to represent the longest amount of time that shadow flicker effects can reasonably occur before causing what can be considered an unacceptable nuisance and therefore requiring mitigation.

33. 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.

15.5.3 Baseline conditions

34. The defined study area includes three properties, Glenour and Kilrenzie which could theoretically be affected by shadow flicker from the proposed Development (**Figure 15.1**). Wheeb is located just outside the shadow flicker zone of influence but the model has generated data for this property as part of a precautionary, conservative approach. Details of these properties are identified in **Table 15.2**.

No.	Property	Use	Grid reference	Distance from nearest proposed turbine (m)	Within shadow flicker zone of influence?
1	Glenour	Residential (currently derelict / 'very poor condition' on buildings at risk register)[1]	217278, 583112	1,130 from Turbine 4	Yes
2	Kilrenzie	Residential	217822, 583456	1,220 from Turbine 4	Yes
3	Wheeb	Residential	217246, 583602	1,590 from Turbine 4	No – just outside

Table 15.2: Properties and shadow flicker zone of influence

15.5.4 Assessment of effects

36. **Figure 15.1** shows the potential zone of shadow flicker influence. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 24.2 hours per year at Glenour (show in **Table 15.3**) assuming the worst-case scenario.

37. The results shown in **Table 15.3** are based on the 'worst-case scenario', which includes the potential for micrositing leading to Turbine 4 being moved 50 m closer to these properties.

No.	Property	Grid reference	Days per year where shadow flicker potentially experienced	Max hours per day where shadow flicker potentially experienced	Total hours per year when shadow flicker potentially experienced
1	Glenour	217278, 583112	58	0.57	24.2
2	Kilrenzie	217822, 583456	0	0	0
3	Wheeb	217246, 583602	0	0	0

Table 15.3: Shadow flicker assessment outputs

39. The results confirm that the properties assessed would not experience over 30 hours of shadow flicker in a year and with a maximum of 24.2 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 acceptable.

40. The model does predict that Glenour may occasionally experience up to 35 minutes of shadow flicker on certain days throughout the year, which is more than the 30 minutes per day which is suggested by the guidance as a maximum. This is not considered to be significant under the threshold applied for this assessment, the results of which are based on the maximum theoretical basis which means that the effects are likely to be materially below the maximum assessed. The Environmental Clerk of Works will also observe for any potential change in use of the property at Glenour during the Site commissioning process, given its derelict status.

41. No cumulative shadow flicker effects have been identified as the properties assessed in this study is located more than 10 rotor diameters in distance from all other nearby existing or proposed windfarm developments.

[1] https://www.buildingsatrisk.org.uk/search/keyword/glenour/event_id/892963/building_name/glenour-colmonell [accessed 15/05/19]

15.5.5 Mitigation

42. No mitigation is currently required for the operational phase of the proposed Development as no significant shadow flicker effects are predicted to occur.

15.6 Climate and carbon balance

15.6.1 Introduction

43. This section of this Chapter details the calculations to work out CO_2 emissions from the proposed Development. In addition to generating electricity, the Scottish Government sees windfarms as an important mechanism for reducing the UK's carbon dioxide (CO_2) emissions. This Chapter 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.

44. 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 for the proposed Development. The proposed Development is seeking consent without a limit to operational lifetime, however in order to ensure a meaningful result from the application of the calculator, an operational lifespan of 40 years has been assumed.

15.6.2 Carbon and peatland

45. Windfarms in upland areas tend to be sited on peatlands which hold stocks of carbon that have been affected by commercial forestry and so have the potential to release carbon into the atmosphere in the form of CO_2 if further disturbed.

46. In order to minimise the requirement for the extraction of peat, the Site design process has avoided areas of deeper peat. The Site design process is described in **Chapter 3: Site Selection and Design Evolution**. Specific details on the peat depth are included in the Peat Landslide and Hazard Risk Assessment, **Technical Appendix 10.1.**

15.6.3 Effects of carbon emissions from construction

47. 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.

48. 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.

49. A number of technical papers (detailed in Nayak et al, 2008) have reported a wide range of emissions values from windfarms, 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 12 months (1 year) assuming replacement of coal fired power generation and 38.4 months (3.2 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 14.4 months (1.2 years) and 49.2 months (4.1 years) additional CO_2 payback respectively.

50. 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.

15.6.4 Characteristics of peatland

51. 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

52. 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.

53. 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.

54. 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.

55. 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.

56. 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.

15.6.5 Methodology

57. The methodology to calculate carbon emissions generated in the construction, operation and decommissioning of a windfarm 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.

15.6.5.1 Input parameters

58. 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.

59. 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 2.9.1 and online version AEIL-O3DM-Y1WS v4) 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.

60. 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).

61. 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.

62. The final wind turbine choice is not yet known, but would likely be a 5.6 MW machine, and the proposed Development would consist of 13 turbines and 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.

63. The recommended capacity factor within the calculation spreadsheet is based on an average of between 31 – 36%.

64. The input parameters for the Scottish Government calculation spreadsheet are detailed in **Technical Appendix 15.1**. The choice of methodology for calculating the emission factors uses the 'Site Specific methodology' defined within the calculation spreadsheet.

15.6.6 Results

65. 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.

66. The carbon calculations spreadsheet is provided in **Technical Appendix 15.1.** A summary of the anticipated carbon emissions and carbon payback of the proposed Development are provided in **Table 15.4.**

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO_2 eq.)	216223	206174	226454
Carbon payback time			
Coal-fired electricity generation (years)	1.1	1.0	1.2
Grid-mix of electricity generation (years)	3.7	3.2	4.1
Fossil fuel - mix of electricity generation (years	2.2	2.0	2.5
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	25.7	22.4	28.6

Table 15.4: Anticipated carbon emissions

15.6.7 Interpretation of results

67. 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 13 turbines with an average (expected) installed capacity of 5.6 MW each would be approximately 2.2 years, when compared to the fossil fuel mix of electricity generation.

68. The proposed Development is expected to take around 26 months (2.2 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.

69. The potential savings in CO_2 emissions due to the proposed Development replacing other electricity sources over the lifetime of the windfarm (assumed to be 40 years for the purpose of the carbon calculator) are approximately:

- 187,000 tonnes of CO_2 per year over coal-fired electricity (7.48 million tonnes assuming a 40 year lifetime for the purposes of the carbon calculator);
- 57,000 tonnes of CO_2 per year over grid-mix of electricity (2.28 million tonnes assuming a 40 year lifetime for the purposes of the carbon calculator); or
- 94,000 tonnes of CO_2 per year over a fossil fuel mix of electricity (3.76 million tonnes assuming a 40 year lifetime for the purposes of the carbon calculator).

15.7 Air quality

70. 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 1 km away from the Site, 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.

15.8 Aviation and defence

71. The potential impacts of wind turbines on aviation interests have been widely publicised. There are two dominant scenarios:

- physical obstruction: turbines can present a physical obstruction at, or close to, an aerodrome or other aviation activity site; and
- radar / Air Traffic Services: turbines can produce spurious / false returns known as "clutter", particularly from primary surveillance radar (PSR). Turbine clutter appearing on a radar display can affect the safe and efficient provision of air traffic services as it can mask unidentified aircraft from the air traffic controller and / or prevent him from accurately identifying aircraft under his control and / or cause the track of the aircraft under control to be incorrectly reported. In some cases, radar reflections from the turbines can affect the performance of the radar itself.

15.8.1 Baseline conditions

72. The Site is approximately 45 km south west of Glasgow Prestwick Airport and over 87km south west of Glasgow Airport, the two major airports in the west of Scotland. From previous assessments it has been established that the proposed Development is not within radar line of sight of either airport's PSR and out with both airports' wind turbine consultation zones.

73. Relying on NATS published radar line of sight safeguarding maps, the Site is not visible to any NATS (En Route) plc (NERL) radar (e.g. Lowther Hill) and does not conflict with NERL safeguarding criteria. NERL's scoping response confirmed this conclusion.

74. The proposed Development's turbines are located within a Ministry of Defence (MoD) "blue" low flying area, namely a relatively low concern area. The MoD was consulted during the Site design phase and at the Scoping stage and no objection was raised. There have been no previous objections from the MoD in regards to the West Freugh Test & Evaluation (T&E) Range (operated by QinetiQ) in the case of the operational Kilgallioch or Arecleoch Windfarms and the proposed Development is out with the range's radar cover

75. As the proposed turbines would be in excess of 150m to blade tip, they would be required to be lit pursuant to Article 222 of the UK Air Navigation Order (ANO) 2016, with medium intensity (2000 candela) steady red aviation warning lights. It is acknowledged that the Site is in the Transition Zone to the Galloway Dark Sky Park so consideration is required to minimise lighting impacts.

76. The Civil Aviation Authority (CAA) Policy Statement on *Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m Above Ground Level* (CAA, June 2017) modifies the strict application of Article 222 to allow the lights to operate in a lower intensity mode "*if the horizontal meteorological visibility in all directions from every wind turbine generator in a group is more than 5 km*". In these circumstances the 2000 candela lights could be operated at "not less than 10% of the minimum peak intensity specified for a light of this type" (200 candela). It is therefore proposed that visibility sensors are installed at the proposed Development and if visibility is restricted to 5 km or less the lights would operate at 2000 candela. The 2017 CAA Policy Statement further modifies Article 222 to permit only one level of intermediate lights, halfway up the tower, and at reduced intensity (32 candela rather than 2000 candela). At least three (to provide 360 degree coverage) low-intensity (32 candela) red lights should be provided at an intermediate level of half the nacelle height on the tower.

77. In addition, it is proposed to explore the possibility of using 'smart' aviation lighting (aviation obstruction lighting detection system) whereby the lights would only be switched on when low altitude aircraft approach them. The CAA is in the process of consulting on a new policy statement on En-Route Aviation Detection Systems for Wind Turbine Obstruction Lighting Operation. SPR has had an opportunity to review the CAA's proposal as part of an industry working group considering this guidance. It is expected that this guidance will be finalised and released during 2019. The draft guidance would allow the aviation lights only to be illuminated when an aircraft is detected by a radar entering a volume bounded by 4 km (horizontal distance) from the perimeter group of turbines and 300m above the highest turbine tip of the Site. SPR calculations estimate that the upper boundary of this volume would be around 2,500 ft above ground level[2]. The aviation lighting would not be activated when commercial airlines pass over the Site as such aircraft ordinarily operate in Controlled Airspace (CAS), the base of which CAS over the Site being 5,000 ft and above.

78. Given the lights are only required for general aviators flying at night in the vicinity of the Site at altitudes of up to 2500 ft, it is anticipated that the lights will be rarely on in this quiet airspace. The widest transit across proposed Development t is circa 4 km (approx. north to south between turbine 4 and turbine 13), then the horizontal coverage volume would be 12km (4+4+4). At 250 knots the lights would be on for approximately 2 minutes, provided the radar can track the aircraft across the windfarm.

79. If radar activated lighting is required, this would require a separate planning application, radar licencing and relevant CAA approvals. Optimally, any such radar deployment could benefit multiple windfarms in the South Ayrshire or Dumfries and Galloway regions.

80. Periphery lights would also be lit with infra-red lighting to meet the MoD's low flying requirements (to be agreed with the MoD prior to turbine instalment)

81. The relevant aviation stakeholders were consulted regarding the potential effects of the proposed Development as part of the scoping process. A summary of consultation is provided in **Table 15.5.**

Consultee	Summary of consultation	Comment/Action taken
Defence Infrastructure Organisation	Email dated 07/11/18 The MOD has no objection to the proposal. In the interests of air safety, the MOD will request that the development should be fitted aviation lighting in accordance with the Civil Aviation Authority.	Appropriate aviation lighting in accordance with CAA requirements will be included as part of the proposed Development.

[2] In terms of the maximum height of the coverage volume, this is calculated as follows (300m above the highest part of the turbine or group of turbines). The highest height above sea level within the proposed Development is turbine 2 (see Figure 3.1) located at 220 m (rounded up to the nearest 10m contour). With 200 m turbines and 300 m above the highest part of the turbine, the maximum height of the radar coverage required would be 720 m or 2362 ft, rounded up to 2500 ft.

NATS Safeguarding	Email dated 06/11/18 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.	No further action required
Civil Aviation Authority	No response	N/A

Table 15.5: Consultee responses

15.8.2 Assessment of effects

83. From the consultation it is concluded that the proposed Development, would not have an effect on aviation, from either physical obstruction or radar interference. Therefore, aviation is not considered further.

15.9 Population and human health

84. **Chapter 7: Landscape and Visual Amenity**, **Chapter 10: Hydrology, Hydrogeology, Geology and Soils**, **Chapter 12: Access, Traffic and Transport**, **Chapter 13: Noise** and **Chapter 14: Land Use and Socio-Economics**, 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.

85. **Chapter 16: Summary of Mitigation**, 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.

86. 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.

15.10 Risk of accidents and other disasters

15.10.1 Introduction

87. 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.

88. 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).

15.10.2 Public Safety and Access

89. The RenewableUK Onshore Wind Health and Safety Guidelines (2015) note that windfarm 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.

90. 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.*"

91. Site security and access during the construction period would be governed under Health and Safety at Work Act 1974 and associated legislation. There would be no public access 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 windfarm is complete, no special restriction on access is proposed.

92. Informal recreational access would benefit from the presence of the turbines within the Site by providing a feature of interest. Appropriate warning signs would be installed concerning restricted areas such as the substation compound, transformers, switchgear and metering systems. All onsite electrical cables would be buried underground with relevant signage.

15.10.3 Traffic

93. Accident data for the roads local to the Site (A714 between the junction with the B734 and the A75) has been reviewed and is presented in **Chapter 12: Traffic, Transport and Access**. 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 are low, with only 21 accidents occurring over the five year study period. Therefore the level of effect is considered to be minor adverse and not significant.

15.10.4 Construction

94. 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.

95. 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: Geology, Hydrology and Hydrogeology**. Flood risk is also assessed with Chapter 10.

15.10.5 Extreme weather

96. 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.

97. 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.

98. 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.

15.10.6 Seismic activity

99. No fault lines are present on or in the immediate vicinity of the Site (Figure 10.4), and there are no records of any earthquakes occurring in the vicinity of the Site within the last 39 years (Earthquake Track, 2017). 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.

100. 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.

15.11 Waste and environmental management

101. Chapters 7 to 14 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: Summary of Mitigation**.

102. The outline CEMP provides a general overview on how waste and other environmental issues would be managed during the construction phase. The peat management plan also details how excavated peat is controlled, stored, re-used and disposed of during the construction phase of the proposed Development.

103. 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.

15.12 References

Civil Aviation Authority Statement (June 2017). *Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m Above Ground Level*. Available at: https://publicapps.caa.co.uk/docs/33/DAP01062017_LightingWindTurbinesOnshoreAbove150mAGL.pdf [Accessed 07/05/19]

Parsons Brinckerhoff Consultants on behalf of DECC (2010). *Update of UK Shadow Flicker Evidence Base*. Available at: http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/ored_news/ored_news/uk_shad_flick/uk_shad_flick.aspx [Accessed 30 May 2019].

Nayak *et al*; (2008 and 2010) and Smith *et al* (2011).*Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach.*

Nayak et al (2008). http://www.gov.scot/Publications/2008/06/25114657/0 [Accessed 30 May 2019].

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-andpeat.net/pages/volumes/map04/map0409.php [Accessed 30 May 2019].

Scottish Government (2019). Windfarm Carbon Assessment Tool (Version 2.9.1 and online version AEIL-O3DM-Y1WS v4.

Scottish Government (2014). *Onshore Wind Turbines: Planning Advice*. Last updated May 2014. Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ [Accessed 30 May 2019].

RenewableUK (2015). Onshore Wind Health and Safety Guidelines. Available at https://cdn.ymaws.com/www.renewableuk.com/resource/collection/AE19ECA8-5B2B-4AB5-96C7-ECF3F0462F75/OnshoreWind_HealthSafety_Guidelines.pdf [Accessed 30 May 2019].

RenewableUK (2018). Statistics Explained. Available at: https://www.renewableuk.com/page/UKWEDExplained [Accessed 30 May 2019].

The Air Navigation Order 2016.