

# Appendix 6.4 Visual Assessment of Turbine Lighting

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# Appendix 6.4 Visual Assessment of Turbine Lighting

## ***Introduction***

1. This Appendix presents an assessment of landscape and visual effects arising from the visible lighting of the Proposed Development. The written assessment is supported by a Zone of Theoretical Visibility (ZTV) plan of the visible turbine lighting and visualisations which illustrate the proposed turbine lighting from three viewpoints in the surrounding landscape.
2. Consultation on the scope and methodology of the LVIA has also been carried out with the relevant statutory bodies. The three proposed viewpoints, as listed below, based on a selection from the daytime viewpoint locations, were agreed to be suitable for the assessment of night time visual effects.
  - Viewpoint 1 – Coalburn
  - Viewpoint 4 - Minor Road, North Brackenridge
  - Viewpoint 13 – Victory Park, Muirkirk

## ***Description of the Proposed Turbine Lighting***

3. There are 21 turbines proposed which would be greater than 150 m to tip and therefore a number of the turbines would have to be lit as required by the Civil Aviation Authority. The following lighting solution is proposed to accord with CAA requirements:
  - **2000 candela steady state red aviation light on the top of the nacelle of 17 turbines (all turbines except T9, T11, T13 and T15) and;**
  - **32 candela steady red aviation lights (likely to be 3) at an intermediate level of half the nacelle height of the same turbines.**

### **Embedded Mitigation**

4. It is proposed to reduce the intensity of lighting in certain atmospheric conditions by reducing the intensity and attenuating the amount of vertical downwards lighting in order to reduce the visual impact experienced by receptors below the lights.
5. Reduced intensity: Visibility sensors will be installed on relevant turbines to measure the prevailing atmospheric conditions and visibility range. Should atmospheric conditions mean that visibility from the turbines within the site is greater than 5 km from the Proposed Development, CAA policy permits lights to operate in a lower intensity mode, being a minimum of 10% of their capable illumination. Therefore, the 2000 candela (cd) steady state lights would operate at 200 cd. However, if visibility is restricted to 5 km or less, the lights would operate at 2,000 cd.
6. Directional intensity: Additionally, the inherent directional intensity of 2,000 cd lights can be used to reduce vertical downwards lighting impacts at elevations less than -1° degree vertical angle from the horizontal plane from the aviation light. By ensuring the lights installed comply with the ICAO recommendations, it is possible to attenuate the vertical downwards light to a level that reduces the visual impact from receptors at ground levels below the lights. Implementing the ICAO recommendations, at -1 degrees the aviation lights should only be 1,125 cd and at -10 degrees should only be 75cd, when visibility is greater 5 km.

7. These measures are proposed as embedded mitigation. They are likely to reduce the magnitude of landscape and visual effects particularly for distant receptors, however this feature will not remove visibility of aviation lighting completely for any nearby receptors.
8. This embedded mitigation has been considered within the assessment within this appendix.

## ***Scope of the Assessment***

9. The primary source of best practice for Landscape and Visual Impact Assessment (LVIA) in the UK is '*The Guidelines for Landscape and Visual Impact Assessment*', 3rd Edition (GLVIA3) (Landscape Institute and the Institute for Environmental Management and Assessment, 2013). The assessment criteria adopted to inform the assessment of effects arising from the visible lighting has been developed in accordance with the principles established in this best practice document. It should however be acknowledged that GLVIA3 establishes guidelines not a specific methodology. The preface to GLVIA3 states:
 

*'This edition concentrates on principles and processes. It does not provide a detailed or formulaic 'recipe' that can be followed in every situation – it remains the responsibility of the professional to ensure that the approach and methodology adopted are appropriate to the task in hand.'*
10. The assessment criteria set out in Annex 1 have therefore been developed specifically for this appraisal to ensure that the methodology is fit for purpose.
11. The purpose of an LVIA when undertaken in the context of an Environmental Impact Assessment (EIA) is to identify any likely significant landscape and visual effects arising as a result of the proposals. An LVIA should consider both:
  - effects on the landscape as a resource in its own right (the landscape effects); and
  - effects on specific views and visual amenity more generally (the visual effects).
12. It is recognised that in some circumstances, it may be possible for turbine lighting to result in a significant effect on the character of the surrounding landscape. For example, if the proposed wind energy development is located within, or in close proximity to, a designated dark sky area, or is remote from existing sources of visible lighting, such as residential areas, commercial or industrial sites, or major roads.
13. For wind energy developments which are not located in such areas, it is considered that there would be no potential for significant effects on landscape character to arise from visible turbine lighting of the type proposed. This is because in these areas the character of the landscape during low natural light levels is already in part characterised by the presence of artificial lighting. Therefore, the addition of turbine lighting would not have the potential bring about a fundamental change to the characteristics of the landscape.
14. In considering the likelihood of significant effects within the 20 km study area, the Proposed Development is located within a landscape context which already contains some sources of artificial light, particularly those located within the surrounding settlements, industrial complexes and along the highways passing through the near landscape. The Proposed Development is not located near to a recognised Dark Sky Area, and nor is such a Dark Sky Area present within the 20 km study area.
15. With reference to the ZTV of the proposed lit turbines, as shown on Figure 1 of this Appendix, it is clear that there would be theoretical visibility of the lit turbines across much of the 20 km initial study area. Beyond 10 km, and up to 20 km from the proposed lit turbines, theoretical ZTV coverage is generally limited to particular parts of the landscape, such as the valley in which the A70 runs between Muirkirk and Cumnock, the M74 corridor north of Kirkmuirhill, the landscape north of Strathaven, and the landscape in the vicinity of Lanark, as shown on Figure 1. These areas already experience an element of night time lighting either through street lights within urban areas, or lighting along the road networks. The proposed turbine lighting would not be noticeable at such distances greater than 10 km in the

presence of existing baseline lighting in the local landscape and thus significant effects are unlikely to occur.

16. It is acknowledged that there are more remote areas of the landscape between 10 km and 20 km from the site, in which the proposed lit turbines would be theoretically visible, such as high points within the Lowther Hills to the south-east and the Tinto Hills to the east. However, the majority of these landscapes are located beyond 15 km from the Proposed Development. The likelihood of other sources of night time lighting within the nearer landscapes to these hill masses would reduce the impact of the lights associated with the Proposed Development and significant effects are unlikely to occur.
17. Taking into account the above findings, it is considered that a 10 km detailed study area would be most appropriate and proportionate to assess the potential effects of the night time lighting of the Proposed Development. A plan illustrating the ZTV of the proposed lit turbines across this detailed 10 km study area is included as Figure 2 of this Appendix. It is also considered that, in terms of the assessment of cumulative effects, an assessment should firstly be set out against the 'future baseline' in which other consented wind farms which will include aviation lighting (at Douglas West, Hagshaw Hill Repowering, Dalquhandy (Revised scheme) and Cumberhead (Revised scheme). In addition, further consideration should then be given to the application stage schemes at Douglas West Extension and Hare Craig.
18. In order to facilitate the assessment of night time lighting effects, a set of criteria and an appropriate methodology has been developed and this is set out in Annex 1, allowing for the assessment of both landscape character and visual effects. The character effects are based on the extent to which there would be a change to the perceived characteristics of the landscape during low light levels. The visual effects are based on the change to the view which would be experienced by visual receptors within the landscape, particularly those people taking in the view from their properties, moving in and around residential areas and using the local road network (again during the changing periods of low light levels experienced during dusk and after sunset).
19. The assessment considers all the daily low light periods when the turbine lighting would be visible to receptors in the surrounding landscape. On any given day these may include the early morning, evening and night-time periods. On occasion this may also include periods during the day, should natural light levels be particularly low, due to adverse weather conditions. It is understood that the primary period which an assessment of visual effects should consider, is the period just before official sunset, when sufficient daylight remains for the landform of the landscape on which the wind farm is proposed, to remain partially visible. This time period is known commonly as 'dusk', and whilst it is acknowledged that the formal astronomical period of dusk actually occurs after sunset, immediately prior to night, the wider time period of low light as the sun is setting and immediately after sunset is referred to hereafter in this methodology as the 'dusk period'.
20. The timing of official sunset changes depending on the location being considered, and the date of any assessment, but is astronomically predictable. However, this does not mean that the light levels in the period just prior to official sunset are equally predictable, or consistent. In practice, these will vary due to weather conditions and also the site specific effects of surrounding topography, vegetation and built form, including existing light sources in the landscape.
21. In order to ensure consistency across the assessment work undertaken and particularly in relation to the visualisations produced, photographs were collected at regular intervals as the light levels decreased across the period prior to and shortly after sunset. In particular, photographs were gathered, and assessments undertaken during the period where street lighting and other light sources of visible light in the baseline have been illuminated, but the landform remained partially visible. The ambient light conditions were recorded during each round of photography using a light meter, to seek as far as possible consistency across the visualisations prepared and assessment judgements made.

22. The starting point for determining the scope for the assessment was a consideration of the assessment viewpoints located within 20 km of the Proposed Development which are set out within the main daytime period LVIA. Following a consideration of each of these viewpoints, and with regard to the need to ensure a proportionate assessment was undertaken, the following viewpoints were selected for detailed assessment:
- VP 1 – Coalburn
  - VP 4 - Minor Road, North Brackenridge
  - VP13 – Muirkirk
23. Each of the representative viewpoints were visited several times during periods of low natural light to better understand the likely sensitivity of the viewpoint receptors and to better inform judgements on the likely visual effects arising from the turbine lighting. Furthermore, the extent of the detailed 10 km study area was visited to understand the extent of existing visible light sources and to appreciate the visibility of the development that would arise as receptors move through the landscape.
24. As noted above, it is also relevant to consider the ‘future-baseline’ that will be in place following the planning consent awarded to the wind farm schemes at Hagshaw Hill Repowering, Dalquhandy (revised scheme), Cumberhead (revised scheme) and Douglas West. In all cases a planning condition was set out which requires the inclusion of visible aviation as part of the schemes. In the case of Douglas West and Dalquhandy (revised scheme) this required lighting of 25 cd notwithstanding that they are developments with turbines of less than 150 m to blade tip. Although none of these conditions to our knowledge have yet been discharged, a specialist aviation consultant working for the Applicant has established what is likely to be put forward as a reasonable response to addressing these conditions. A plan illustrating the likely lit turbines associated with the three schemes is included as Figure 2 of this Appendix. It has therefore been deemed appropriate to include a ‘future-baseline’ photomontage illustrating this lighting, alongside the actual night-time photography which was gathered for each viewpoint. This allows a judgement to be made as to the likely impact of the Proposed Development turbines when compared with the expected baseline scenario. Figure 2 also shows the likely lit turbine scenario for the Hare Craig and Douglas West Extension proposals that are currently in planning. The lit turbines associated with these proposals has also been included in Sheet D of each visualisation to present a cumulative photomontage.
25. For each viewpoint a written assessment is provided. In line with the assessment criteria set out at Annex 1, the relative significance or level of effect on visual amenity is determined by considering in tandem the nature (sensitivity) of the visual receptor with the nature (magnitude) of change.
26. The assessment firstly considers the current baseline lighting environment during low light periods, particularly the dusk period, and the sensitivity of the receptors represented by the viewpoint. The assessment then describes the degree to which the lighting from the Proposed Development would be visible and the magnitude of change in views in the low light period which would result from the turbine lighting. Finally, a professional judgement is made as to the level of effect which would result from the identified change and whether or not the effect is considered to be significant in terms of the EIA Regulations. The reasoning behind these judgements is set out in the assessment. Notwithstanding the embedded mitigation described above, the assessment of the effects of turbine lighting has been undertaken on a worst case basis i.e. when the 2000 cd lighting is operating at full intensity and not at a reduced intensity.
27. It is recognised that the viewpoints only form individual representative locations from a small selection of the places within the study area from where the turbine lighting will be visible. Therefore, the viewpoints are used as the starting point to inform a wider consideration of the potential for visual effects on the key visual receptors within 10 km of the site. These receptors include settlements (principally

Coalburn, Muirkirk and parts of Lesmahagow) and users of the M74 and the minor road network to the north-east of the site and associated properties.

28. The assessment of effects is supported by a Zone of Theoretical Visibility (ZTV) plan illustrating the locations from which the turbine lights would be visible during the low light period. The assessment is also supported by photomontages prepared for the three assessment viewpoints. The methodology for the production of the ZTV Plan and the Photomontages is discussed separately in Annex 1 to this Appendix. However, it should be noted that the visual representation of light in a two dimensional printed photomontage is inherently difficult, as the manner in which light is seen and interpreted by the eye, especially in low light conditions, is a complex and varied matter. It is also important to note that the photomontages illustrate the 2000 cd lighting operating at full intensity and not at a reduced intensity.
29. The photomontages which accompany this assessment have been prepared in line with best practice guidance for the collection of photography for wind farm visualisations and using specialist software for the representation of turbine aviation lighting. However, notwithstanding this, and as with all photomontages, the images provided are simply a tool to assist in the assessment of effects and should be viewed and used in this context. It was established during the field work undertaken for this study that dusk period photographs of visible lighting do not always capture the extent to which the eye perceives light sources during the dusk period. Often photography will appear to show the lighting to be more recessive than it was perceived in the field. The photomontages therefore do not seek to replicate the manner in which a dusk period photograph would capture the aviation lighting, rather they seek to replicate the manner in which the lighting is perceived when it is viewed in the field. The assessment of visual effects does not rely solely on the photomontages however, and it is ultimately professional judgement which is used to evaluate the significance of effects. In the case this judgement has been 'ground-truthed' through site work to review and appraise the effects of existing visible red aviation lighting in the landscape using a number of locations in the Scottish landscape, as close to the site as was practicable.
30. On several occasions, Pegasus has visited the Middleton Wind Farm, East Renfrewshire, an operational wind farm with aviation lighting similar to that proposed. This enabled consideration and photography of existing visible aviation lighting in comparable low light levels, during the dusk period, for use as context and an aid to the work undertaken, providing a useful control for the assessment. Part of this additional site work also sought to consider if there would be any potential for surface illumination of the turbine blades, tower or nacelle as a result of the aviation lighting to be visible in the wider landscape surrounding a wind farm. A Photographic Record of images of the Middleton Wind Farm during low light conditions is set out at Annex 2, along with a further supporting record of images of the Emley Moor Transmitter station (a 300 m concrete tower and mast lit with 2,000 cd lights close to the Pegasus Office in Leeds), which has also been used as a convenient control and test location to 'ground truth' judgements. This matter is discussed subsequently in this assessment.

### ***Analysis of Aviation Lighting at Middleton Wind Farm***

31. In order to help inform the judgements made in this assessment a site visit was undertaken to the Middleton Wind Farm, East Renfrewshire, an operational commercial scale wind farm with aviation lighting similar to that proposed. This enabled consideration of aviation lighting in comparable low light levels, during the dusk period, for use as context and an aid to the work undertaken. A Photographic Record of images of the Middleton Wind Farm during low light conditions is set out at Annex 2, along with a further supporting record of images of the Emley Moor Transmitter mast, which has also been used as a guide.
32. Part of this additional site work also sought to consider if there would be any potential for surface illumination of the turbine blades, tower or nacelle as a result of the aviation lighting to be visible in the

wider landscape surrounding a wind farm. There was no clear visibility of such phenomena in the wider landscape during the site work undertaken, however it is understood that such events may be possible in close proximity to lit turbines in locations with very low natural light. It is therefore acknowledged as part of the judgements made within this assessment that such occurrences may be possible as a worse-case scenario but that they would not be typical of the general experience of the lighting when seen from the landscape.

33. A separate phenomenon which was experienced during the site visit to Middleton was the manner in which the turbine blades passing in front of the turbine lighting serve to cause a temporary dimming and brightening of the lights. This is something which only occurs when the turbines are viewed with the blades in front of the nacelle and therefore is dependent on the prevailing wind direction on any given day. The minor dimming and brightening effect serves to increase the noticeability of the turbines within the view and to some degree increases their visual effect. It is therefore acknowledged as part of the judgements made within this assessment that such occurrences would periodically occur in relation to the proposed turbines (the occurrence being most likely for locations to the south-west of the turbines).

### ***Assessment of Effects on Landscape Character***

34. The proposed turbines lie within the LCST 7A – Rolling Moorland Forestry character type as defined in the South Lanarkshire Landscape Character Assessment. The daytime period assessment work undertaken for the proposals set out in the main LVIA Chapter, identified that there would be a significant effect on the character of this area and a number of the surrounding character areas within 10 km of the site.
35. The key characteristics of the landscape character areas which lie in the area surrounding the site are set out in published landscape character assessments. However, a consideration of the potential for effects on landscape character during the low-light period requires an understanding not just of those characteristics which are apparent during the daylight, but also the degree to which artificial light sources are present in the landscape during low-light conditions.
36. Often there is a correlation between the daytime characteristics and the low-light characteristics, with primarily urban areas being identified as having a separate character from the surrounding rural landscape, both during daylight when buildings are visible and during low-light considerations when residential and street lighting is visible. However, this correlation is not always definitive as there are examples of landscapes which may appear rural and intimate during the daylight, but which may be characterised strongly by the artificial lighting of agricultural buildings during low-light. Similarly, there are landscapes which despite not being especially attractive or rural during daylight, can have very low levels of artificial lighting during low-light, giving a greater degree of intimacy and peacefulness to the landscape.
37. A review of the published character types within 10 km of the site was undertaken and each was considered in the field during low-light conditions, where accessible, as well as during daylight. From this review it was apparent that the only landscape which had baseline conditions during the low-light period where artificial light was not a characteristic element of the experience from within or looking out from the area was the Plateau Moorlands of East Ayrshire. This is not to say that artificial light sources are not present within, and visible from, this landscape, rather that views of such lighting are more infrequent and often towards sources at distance. The notable exception to this being the lighting associated with the mining industry which operates in some sections of the landscape.
38. The area of the landscape in which there would be the potential for effects on landscape character to occur from the visible aviation lighting is illustrated on the Zone of Theoretical Visibility (ZTV) Plan set out at Figure 1 of this Appendix.



39. During the period in which there was sufficient daylight to clearly see the turbines any effect on landscape character would be brought about primarily by the turbines themselves, rather than the associated lighting. However, as the daylight levels decrease, the visibility of the turbines decreases, and the turbine lighting becomes a more notable element. Eventually a point is reached at which it is the turbine lighting which brings about the greater degree of visual effect and indeed later in the darkest light conditions, it is only the lighting which brings about an effect as the turbines themselves are no longer visible.
40. It is accepted that within the Proposed Development site itself, and its immediate landscape context within the Rolling Moorland Forestry and wider Rolling Moorland, the presence of the visible aviation lighting would bring about a notable change during the low-light period. This being the change from a landscape which was primarily characterised by its absence of visible artificial light, to a landscape where artificial light (i.e. the lit turbines) became a primary characteristic. However, within a relatively short distance from the turbines the overriding characteristics of the landscape would remain those of an expansive, generally open rural and unlit landscape, with the turbine lighting forming a noticeable, but not a dominant feature.
41. In terms of an EIA judgement of significance it is considered that with regard to the current baseline situation that the landscape character types in the vicinity of the site are of high sensitivity to change during low-light conditions, as a consequence of the relatively low visibility of existing artificial lighting outside of the settlements. However, in the future baseline scenario, this would change, with a number of other wind energy developments already having aviation lighting in the vicinity of the site such that it would become a recognised part of the character of the night-time landscape.
42. With regard to the magnitude of the change, it is considered that against the current baseline, within the Proposed Development site itself and its immediate landscape context, the change would be high, resulting in a **major** and significant effect. Beyond a distance of approximately 4 km from the site the magnitude of effect would reduce to medium with the resulting level of effect being **moderate**, but not significant, on the basis that at this point the lighting would not be a defining characteristic of the overall experience of the landscape. In terms of the future baseline, where aviation lighting was already a recognised element of the night-time landscape, the potential for the Proposed Development to bring about a change to the character of the landscape would be reduced. The assessment would however remain as significant for up to 4 km from the site.
43. It is recognised that the overall totality of the effect on landscape character from the Proposed Development, plus all other operational and consented schemes would be greater and collectively the presence of aviation lighting would become a notable characteristic of the landscape in the immediate vicinity of the overall cluster of wind energy development in this part of the landscape. However, it is understood that these effects would not be such as to become a dominant or defining characteristic of the night-time landscape and that the clustering of the developments would restrict the overall influence of aviation lighting to a relatively localised part of the landscape.

## ***Assessment of Visual Effects***

44. The initial area in which the potential for visual effects from the visible aviation lighting was considered is illustrated on the Zone of Theoretical Visibility (ZTV) Plan set out at Figure 1 of this Appendix. As previously discussed, following analysis of theoretical visibility across the 20 km study area, it was considered appropriate and proportionate to consider a detailed 10 km study area as the likelihood of significant visual effects occurring beyond such distance is very low.
45. The assessment of visual effects begins with a consideration of three of the LVIA Assessment viewpoints which are located within the ZTV of the visible lighting and which are representative of key receptors within the 10 km study area. Each of these assessment viewpoints are illustrated on Figure 2 of this Appendix.

## LVIA Viewpoints

46. It was agreed that three of the viewpoints included in the LVIA should be considered as part of the assessment of visual effects arising from the visible turbine lighting (VPs 1, 4 and 13). Each of these viewpoints is discussed in turn below. Each of these viewpoints have also been used as the locations for the production of visualisations illustrating the visible aviation lighting. Reference is given to these visualisations where appropriate within the discussion of the viewpoints.

### VP1 – Muirburn Place, Coalburn

Viewpoint Location	281160, 635512
Distance to nearest lit turbine	4.7 km (T20)
Daytime Visualisations Figure Reference	Volume 4, Figure 6.37
LVIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline - <b>Moderate (significant)</b> Assessment against Future Baseline – Moderate (not significant)

47. This viewpoint is representative of the views of some residents in the northern part of Coalburn, as well as those experienced by road users travelling along the Coalburn Road between Lesmahagow to the north and Coalburn which have open views orientated in a westerly direction. The closest lit turbine within the Proposed Development is located to the west of the viewpoint at a distance of 4,694 m.
48. The nature of the existing baseline daylight view is one which looks across a remediated colliery landscape which has been restored to a semi-natural state and includes areas of rough grassland and newly planted coniferous trees. In the distance, large blocks of plantation forestry and existing wind turbine development at Nutberry can be seen.
49. The nature of the existing baseline dusk-period view is one where street lighting and lights within properties in Coalburn can be seen in the foreground, whilst the view westwards towards the Proposed Development site is currently darker in nature. However, once the future baseline is considered this view changes, with red aviation lighting being visible on a number of the consented Dalquhandy and Cumberhead turbines extending across the same part of the view as the properties in the northern part of the settlement.
50. The visualisations for Viewpoint 1 illustrate that whilst there are no lit turbines visible in the baseline view (sheet A), there would be a number turbine lights visible in the dusk and night time sky in the future baseline scenario (sheet B). The introduction of the Proposed Development would result in a further 17 lit turbines to the view. It should be noted however that the Proposed Development turbines would be seen much further away than the lit Dalquhandy turbines, and adjacent to the lit Cumberhead turbines. The visible turbine lights on the Proposed Development would be seen above the horizon at dusk and in low level light conditions in the sky above the overall simple landform.
51. The introduction of the lit turbines into the baseline view would result in a medium magnitude of change, giving rise to a **moderate** effect which would be significant due to the absence of similar lighting in the view. The lighting would be clearly notable in the view during periods of good, clear weather conditions and would form an easily identifiable component in the view. However, the introduction of the lit turbines to the dusk and night time future baseline view which was already in part characterised by the presence of existing aviation lighting, as seen from Viewpoint 1, would result in a medium magnitude of change in the view that is considered **moderate** but no longer significant. The lighting would be visibly notable but

would not form a strong influence upon the wider view available relative to the existing level of lighting seen in the broader landscape associated with the consented wind farms.

VP4 – Minor Road, North Brackenridge

Viewpoint Location	276584, 639685
Distance to nearest lit turbine	3.7 km (T19)
Daytime Visualisations Figure Reference	Volume 4, Figure 6.40
L VIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline – <b>Major/Moderate (significant)</b>  Assessment against Future Baseline – <b>Major/Moderate (significant)</b>

52. The viewpoint is located on a minor road located to the north-east of the site. The closest lit turbine within the Proposed Development is located at a distance of 3,674 m from the viewpoint.
53. The nature of the baseline daylight view is one which looks across the undulating plateau farmland and rolling moorland landscape in which the existing wind farm at Auchrobert is a prominent element in the foreground, with further schemes at Nutberry and Hagshaw Hill also visible.
54. In low light periods, there is little existing visible lighting visible from this part of the landscape. Once the future baseline is considered however this view changes, with red aviation lighting being visible on the consented turbines at Cumberhead, Hagshaw Hill Repowering, Dalquhandy and Douglas West, as they extend across the distant panorama of the view.
55. The visualisations for Viewpoint 4 illustrate that the Proposed Development would introduce new lit turbines to the dusk and night time view of the existing baseline landscape, in the middle distance of the view. It is acknowledged that they would form a notable element of the view from the viewpoint location and as such it is considered that there would be a high magnitude of change in the view which would result in a **major/moderate** effect that is significant due to the existing unlit baseline context.
56. However, when assessed against the future baseline scenario, in which numerous other existing lit wind turbines were present, the magnitude of change brought about by the introduction of the lighting associated with the Proposed Development would reduce to medium, resulting in a **moderate**, significant effect, as the additional lit would in part serve to further reinforce an existing characteristic of the dusk and night time view.
57. However, in the context of the existing baseline and future baseline views, it is considered that the additional lighting would not be an overly dominant feature upon the experience of visual receptors at this viewpoint location.

VP13 - Victory Park, Muirkirk

Viewpoint Location	269388, 627320
Distance to nearest lit turbine	6.9 km (T1)
Daytime Visualisations Figure Reference	Volume 4, Figure 6.49
L VIA Assessment of daylight period Visual Effect	Minor

58. This viewpoint is located on the western edge of Victory Park in Muirkirk, to allow for views beyond the immediate built form towards the site. The closest lit turbine within the Proposed Development is located to the north-east of the viewpoint at a distance of 6,868 m.
59. The nature of the baseline daylight view is one which comprises the public open space in the immediate foreground with dwellings located on Glasgow Road, Park Avenue and Burns Avenue located beyond. The existing turbines of the Galawhistle Wind Farm occupy the horizon in the direction of the view towards the site and form notable vertical features in the view. Further Galawhistle turbines are also seen slightly set down in the landscape beyond the horizon.
60. In low light periods, the existing lighting associated with residential properties and street lights is visible in the immediate context of the view, however beyond this there are currently no visible lights associated with the Galawhistle turbines close to where the Proposed Development is located.
61. The visualisations for Viewpoint 13 illustrate that whilst there would be no visible turbine lighting in the baseline view, there is already night time lighting within the urban environment that has a degree of influence. The introduction of the Proposed Development to the wider landscape would theoretically introduce four visible lit turbines to the dusk and night time view, as seen from Viewpoint 13, however in reality, as illustrated in the photomontage at Sheet C, all but one of these would be screened by intervening buildings or trees.
62. This turbine would be located just above the horizon in the same part of the view as the existing urban lighting and would not be visibly prominent in the baseline context. Overall, it is considered that there would be no greater than a low magnitude of change in the view.
63. In the future baseline scenario, there would be lit turbines within the Hagshaw Hill Repowering schemes which were visible in the distant view, sitting just above the horizon in the same direction as other light sources in the town. The addition of the lit turbines associated with the Proposed Development would therefore marginally increase the presence of aviation lighting which was already an element of the view.
64. In the context of both the existing baseline and future baseline views, it is considered that the additional lighting would not be a dominant feature upon the experience of visual receptors in this part of Muirkirk.
65. As a result of the introduction of aviation lighting to the view to the east there would be a worst case **minor** visual effect at Viewpoint 13, which is not considered to be significant. In the future baseline scenario, the lit turbine associated with the consented Hagshaw Hill Repowering would already form a feature in the night time view. In this context, the impact of the addition of the lit turbines of the Proposed Development would be reduced and still give rise to no greater than a **minor** effect. The cumulative effects of the introduction of the proposed Hare Craig scheme are discussed separately later in this Appendix.

### Settlements

66. In addition to the individual viewpoints, consideration has also been given to the potential visual effects on the nearest settlements to the site within the 10 km detailed study area. An assessment of the effects on Coalburn, Muirkirk and Lesmahagow is set out below, with reference given where relevant to the individual viewpoints discussed previously where these are located within or in close proximity to the settlements. Douglas has not been considered within this assessment as it lies outwith ZTV coverage of the proposed lit turbines. Similarly, Strathaven lies on the very edge of the 10 km detailed study area and with reference to the daytime assessment, which highlights only very limited potential visibility of turbine hubs from within the settlement, it is considered there would be no potential for significant effects to arise. This is further evidenced with regard to the daytime visualisations for VP11, which show only 6 hubs visible from the monument which located at a much greater elevation than the remainder of the town, which would therefore have far less visibility.

### Coalburn

Distance from settlement edge to nearest lit turbine	4-5 km
L VIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline - <b>Moderate (significant)</b> Assessment against Future Baseline – Moderate (not significant)

67. The linked settlements of Coalburn, Braehead, and Bellfield are situated to the east of the site with the majority of the properties falling between 4.5 km and 5 km of the Proposed Development. The daytime assessment identified the potential for moderate and significant effects to arise for those parts of the settlement from which a view of the Proposed Development was available, in the scenario whereby the existing baseline is considered, reducing to a moderate but non-significant effect in the future baseline scenario once the consented turbines are considered to form part the baseline view.
68. Viewpoint 1, discussed above, represents the view from the northern part of Coalburn, where it was identified that the introduction of lit turbines to the existing baseline dusk and night time view would result in a medium magnitude of change and a significant **moderate** visual effect during the low light period. However, once the future baseline is considered, other wind farm lighting would already be visible in the view from Coalburn, such that the introduction of the lights associated with the Proposed development would bring about less of a change to the character of the night time landscape in which lighting was already an existing feature. The effects would therefore reduce to moderate, but not significant.
69. Viewpoint 1 serves as a useful ‘worst case’ illustration of the view from those parts of Coalburn which would have an open view towards the Proposed Development. However, in reality for the majority of the settlement there would be no view of the lighting associated with the Proposed Development due to the screening effects of other properties or vegetation.
70. Overall, in the context of the existing visible turbine lighting which would be located in the foreground of the view from the settlement, it is considered that the additional lighting associated with the Proposed development would not be an overly prominent feature upon the experience of visual receptors as they move in and around Coalburn during periods where the turbine lighting would be visible, with the majority of the settlement experiencing no views of the turbine lighting at all.

### Lesmahagow

Distance from settlement edge to nearest lit turbine	5.9 km
L VIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline – Moderate/minor (not significant) Assessment against Future Baseline – Moderate/minor (not significant)

71. Lesmahagow lies to the north-east of the site, at around 5.9 km distance. Much of the settlement lies outside of the ZTV of the proposed turbine lighting and therefore would experience no effects during the low light period. Daytime visualisations have been prepared for Viewpoint 3 at Hillcrest in the southern part of the town, which is within the small part of the settlement from which views of the turbines during the night-time period would be available. These show that the hubs of a number of the turbines would be visible in the middle distance of the view.

72. Whilst the turbines may be visible, it is considered that they would bring about no more than a medium magnitude of change that would bring about a **moderate/minor** effect which would not be significant, particularly considering the distance and the wider context in which they would be seen. The lit turbines would not be a dominant feature upon the experience of visual receptors in Lesmahagow. In the future baseline scenario, aviation lighting associated with the Cumberhead turbines would already form a visible element of the view in the same direction as the Proposed Development. There would therefore be a small reduction in the degree of change brought about by the Proposed Development in this context, however the overall assessment judgments would remain the same.

Muirkirk

Distance from settlement edge to nearest lit turbine	5.9 km
LVIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline – Moderate/minor (not significant)  Assessment against Future Baseline – Moderate/minor (not significant)

73. Muirkirk lies around 5.9 km from the site and is represented in this appraisal by Viewpoint 13, discussed previously. This viewpoint serves as a worst-case representation of the view from the settlement which might be experienced during low light levels, as it is from an open location within Victory Park. Much of the settlement would have far less visibility due to the screening effects of built environment. As such, whilst there would be a worst-case **moderate/minor** visual effect which is not significant, for much of the settlement this impact would be further reduced.

**Road Users**

74. Consideration has also been given to the potential visual effects on road users across the 20 km study area. An assessment of the effects on the principal road from which the lighting would be theoretically visible (the M74 and the minor road network to the north-east of the site) is set out below. Where appropriate, reference is given to the individual viewpoints discussed previously and the corresponding visualisations, where these are located within or in close proximity to the roads. The A70 also passes through the study area, but potential visibility of the lit turbines would be limited to short sections of the route, parts of which would be screened by vegetation. Effects on the route would therefore not be significant and the A70 is therefore not discussed further in this section.

M74

Distance from road at its nearest point to the nearest lit turbine	7 km
LVIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline - Moderate (not significant)  Assessment against Future Baseline – Moderate/minor

75. The M74 runs in a north north-west to south south-east direction to the east of the site. At its closest point between junctions 10 and 11, the route passes approximately 7 km to the east of the site.
76. The daytime assessment established that between Junctions 11 and 10 views would be available intermittently, with some sections affording relatively open views in a westerly direction towards the Proposed Development but with other views restricted by roadside vegetation and road cuttings in places. Cars travelling at typical motorway speed would pass through the locations with visibility of the

Proposed Development within a matter of seconds. It was therefore identified that there would be no more than a moderate but not significant effect against the existing baseline, which would reduce to a moderate/minor effect against the future baseline.

77. During the low light period when the lit turbines would be visible, there would be the potential visibility of the lit turbines from the same brief sections of the M74 as described above with regard to the daytime period. However, as with the daytime, the nature of the speed of travel on the motorway is such that sections would be passed in a very short period of time during which, at 7 km away, the lit turbines would be a noticeable but relatively minor element in the view, which would not result in any more than a **minor** effect. The turbine lights would be seen in the context of the numerous elements of lighting within the landscape between the motorway and the site, but also in particular with headlights and interior lights of other vehicles using the route, which would be much more notable than the turbines.

Minor road network to the north-east of the site

Distance from road at its nearest point to the nearest lit turbine	3 -5 km
LVIA Assessment of daylight period Visual Effect	Assessment against Existing Baseline – <b>Major/Moderate</b> Assessment against Future Baseline – <b>Major/Moderate</b>

78. The Minor road network to the north-east of the site is represented by Viewpoint 4 at Brackenridge, which lies 3.6 km from the Proposed Development and, as discussed previously above, would experience a major/moderate (significant) effect during the night-time period when assessed against the current baseline, reducing to a moderate (significant) effect once the future baseline, with its consented aviation lighting, is considered. These effects are broadly typical of those that would arise from the wider extent of the minor road network in this location, with significant effects likely to be limited to up to a distance of no more than 4 km. It is recognised that there are also a small number of individual residential properties in this part of the landscape which may experience a similar view to that of the road network, however there are no settlements within 4 km and therefore there are only a very small number of visual receptors who would be likely to experience the view from this location during low light-periods, many of which are not orientated towards the site and/or are served by local screening close to the properties.

**Cumulative Effects with Application Stage schemes**

79. The cumulative assessment considers the likely effects of the introduction of the Proposed Development into a landscape that also includes the proposed Hare Craig and Douglas West Extension Wind Farms.
80. The ZTV at Figure 4 presents the theoretical extent in which the lit turbines of the Proposed Development would be seen alongside the lit turbines of the proposed Hare Craig and Douglas West Extension schemes. The ZTV demonstrates that the lit turbines of the Proposed Development would not be seen without the presence of the lit turbines of these other proposed schemes across much of the landscape within 10 km. It can therefore be concluded that the Proposed Development would not introduce new aviation lighting into a dusk and night time landscape in substantive parts of the local or wider area, including any notable settlement, in the scenario that the Hare Craig and Douglas West Extension schemes were also present in the landscape. Those areas where new visibility would arise would be rural and sparsely populated.
81. The cumulative visualisations (sheet D) produced in association with Viewpoints 1, 4 and 13 demonstrate the overall level of aviation lighting seen in the local landscape when considering the Proposed Development alongside existing wind farms, consented schemes and the proposed Hare Craig and Douglas West Extension schemes.

82. There would already be a presence of aviation lighting as a result of the other schemes at all key receptor locations, and thus the addition of the proposed lit turbines of the Proposed Development to the ‘Hagshaw Cluster’ would serve to reinforce the existing nature of night time views rather than bring about further cumulative effects. Overall, there would generally be **no change** to the effects already reported previously, however in the case of Muirkirk, where the lighting associated with the Hare Craig scheme would be notable, the effect of the introduction of the Proposed Development would be reduced.

## ***Summary of Landscape and Visual Effects***

83. The assessment of landscape and visual effects of aviation lighting has identified that the visible lighting would be screened by landform and topography from parts of the surrounding 10 km, in particular from Douglas and large sections of A70, with those views which are available generally seen in areas where night time lighting is a familiar element of the landscape.
84. There would be the potential for significant effects on the character of the landscape in the immediate vicinity of the site during low-light levels, up to approximately 4 km. In terms of visual effects, significant effects have been identified for the minor road network to the north-east of the site and a small number of associated residential receptors with a view towards the site, again within up to approximately 4 km. For Coalburn, a significant effect has been identified when assessed against the existing baseline, but this would reduce to non-significant once the future baseline landscape, including the lit turbines at Dalquhandy, is considered. From elsewhere, including the settlements of Lesmahagow and Muirkirk, the effects of the proposed aviation lighting would not give rise to significant landscape and visual effects, and any effects would reduce further when considered against the future baseline. It is important to note that the assessment has been carried out on a worst case basis, with the 2000 cd lighting operating at full intensity and no reduction in directional intensity. In reality, the embedded mitigation built into the scheme would mean that in good visibility conditions these effects would be reduced when the 2000 cd lighting is operating at a reduced intensity and the directional intensity mitigation would reduce effects in all conditions.
85. Overall, it is acknowledged that there are a small number of additional significant landscape effects which would occur during low-light levels, over and above those which have been identified in relation to the daytime. However, in the future baseline scenario there would be no significant effects on any of the settlements within the 10 km detailed study area, with significant effects being limited to the generally rural area within 4 km of the site, in which few receptors would be likely to experience the view during the low light conditions in which the lighting would be in operation. These limited effects should be taken forward and considered within the wider planning balance when assessing the overall acceptability of the proposals.

### **Summary Table**

<b>Receptor</b>	<b>Worst Case Level of Effect</b>	<b>Significant?</b>
<u>Landscape Character</u>		
Up to approximately 4 km from the site:	Assessment against Existing Baseline - <b>Major</b> Assessment against Future Baseline - <b>Major</b>	<b>Yes</b> <b>Yes</b>
Beyond 4 km from the site:	Assessment against Existing Baseline – no greater than Moderate (not significant) Assessment against Future Baseline – no greater than Moderate (not significant)	No No
<u>LVIA Viewpoints</u>		



VP1 – Muirburn Place, Coalburn	Assessment against Existing Baseline – <b>Moderate (significant)</b> Assessment against Future Baseline – Moderate (not significant)	<b>Yes</b>  No
VP4 – Minor Road, North Brackenridge	Assessment against Existing Baseline – <b>Major/moderate</b> Assessment against Future Baseline – <b>Moderate (significant)</b>	<b>Yes</b>  <b>Yes</b>
VP13 – Victory Park, Muirkirk	Assessment against Existing Baseline – Minor Assessment against Future Baseline - Minor	No  No
<u>Settlements</u>		
Coalburn	Assessment against Existing Baseline – <b>Moderate (significant)</b> Assessment against Future Baseline – Moderate (not significant)	<b>Yes</b>  No
Lesmahagow	Assessment against Existing Baseline – Moderate/Minor Assessment against Future Baseline – Moderate/Minor	No  No
Muirkirk	Assessment against Existing Baseline – Moderate/Minor Assessment against Future Baseline – Moderate/Minor	No  No
<u>Road Users</u>		
M74	Assessment against Existing Baseline - Moderate (not significant) Assessment against Future Baseline – Moderate/minor	No  No
Minor road network to the north-east of the site	Assessment against Existing Baseline – <b>Major/moderate (up to 4 km)</b> Assessment against Future Baseline – <b>Moderate (significant) (up to 4 km)</b>	<b>Yes</b>  <b>Yes</b>

# ANNEX 1 - Visible Turbine Lighting Assessment: Criteria and Methodology

1. The primary source of best practice for Landscape and Visual Impact Assessment (LVIA) in the UK is *'The Guidelines for Landscape and Visual Impact Assessment'*, 3rd Edition (GLVIA3) (Landscape Institute and the Institute for Environmental Management and Assessment, 2013). The assessment criteria for the assessment of effects of visible turbine lighting has been developed in accordance with the principles established in this best practice document. It should however be acknowledged that GLVIA3 establishes guidelines not a specific methodology. The preface to *GLVIA3* states:  
  
*'This edition concentrates on principles and processes. It does not provide a detailed or formulaic 'recipe' that can be followed in every situation – it remains the responsibility of the professional to ensure that the approach and methodology adopted are appropriate to the task in hand.'*
2. The assessment criteria set out below have therefore been developed specifically for this appraisal to ensure that the methodology is fit for purpose.
3. The purpose of an LVIA when undertaken in the context of an Environmental Impact Assessment (EIA) is to identify any likely significant landscape and visual effects arising as a result of the proposals. An LVIA should consider both:
  - *effects on the landscape as a resource in its own right (the landscape effects); and*
  - *effects on specific views and visual amenity more generally (the visual effects).*
4. It is recognised that in some circumstances, it may be possible for turbine lighting to result in a significant effect on the character of the surrounding landscape. For example, if the proposed wind energy development is located within or in close proximity to a designated dark sky area, or is remote from existing sources of visible lighting, such as residential areas, commercial or industrial sites, farms, or major roads.
5. For wind energy developments which are not located in such areas, it is considered that there would be no potential for significant effects on landscape character to arise from visible turbine lighting of the type proposed. This is because in these areas the character of the landscape during low natural light levels is already in part characterised by the presence of artificial lighting. Therefore, the addition of visible turbine lighting would not have the potential bring about a fundamental change to the characteristics of the landscape.
6. The Proposed Development lies away from recognised dark sky areas, within a surrounding landscape context which contains some existing sources of artificial light, particularly within surrounding settlements, industrial developments and along highways. However, it is understood that an assessment of the potential for significant effects on landscape character should be undertaken, due to the location of the site itself within an area which is less characterised by the presence of visible light. Therefore, criteria are set out below for the assessment of both landscape character and visual effects.
7. For a daytime assessment, one assesses the worst-case situation (i.e. clear full visibility as if a perfect day). A daytime assessment can therefore describe the full extent of that clear visibility, or lack of it, as a moment in time. For this study, it is not just the reverse. What is required is an understanding of low light level conditions which seeks to cover all the periods, both evening; dawn; gloomy winters day and after dark, in which the lights will to some degree be visible. This also seeks to cover the period just after it begins to get dark; the period just before it actually gets dark; the period in the middle as it moves from one to the other and the time after it is dark but a moonlit night affords some view of the landscape.

8. If one described a situation in detail, (e.g. just before sunset with the setting sun still illuminating part of the landscape; part going into deep shadow; a ridgeline in silhouette; the mid-ground in semi-darkness and a partially lit foreground because the street lights had just come on) this would be a snapshot in time for that viewpoint. Half an hour earlier in would have been different, as it would half an hour later, or at dawn, and that is before the matter of how it would have looked on another day earlier or later in the year is considered. Whether the description was looking east at sunset, or east at dawn would also radically change the description of what was seen and its impact. The report shall try to capture a single assessment that represents a typical judgement for the location in low light conditions, but not a specific set of conditions.
9. Such an assessment that was more specific would become very much larger, with the need to visit viewpoints at multiple times and in a range of light conditions, including dawn and dusk, to get the east - west, sunset - sunrise element. This could lead to multiple written descriptions and assessments for each location for both visual amenity and character effects. It is understood that this represents of proportional approach to the production of the low light assessment.

#### **Nature (Sensitivity) of Landscape Character**

10. The nature or sensitivity of landscape character reflects its susceptibility to change and any values associated with it. It is essentially an expression of a landscape's ability to accommodate a particular type of change. It varies depending on the physical and perceptual attributes of the landscape including but not necessarily limited to: scale; degree of openness; landform; existing land cover; landscape pattern and complexity; the extent of human influence in the landscape; the degree of remoteness/wildness; perception of change in the landscape; the importance of landmarks or skylines in the landscape; intervisibility with and influence on surrounding areas; condition; rarity and scenic quality of the landscape, and any values placed on the landscape including any designations that may apply. Additionally, for a consideration of landscape character during low light levels, a key further consideration is the extent to which existing artificial light sources are present in the landscape during low natural light levels.
11. In this assessment, the nature or sensitivity of landscape character shall be considered with reference to published landscape character areas/types. Information regarding the key characteristics of these character areas/types shall be extrapolated from relevant published studies. Together with on-site appraisal, an assessment of landscape sensitivity to visible wind turbine aviation lighting shall be undertaken, employing professional judgement.
12. The nature or sensitivity of landscape character shall be described as **very high, high, medium, low or very low**.

#### **Nature (Sensitivity) of Visual Receptors**

13. The nature or sensitivity of a visual receptor group reflects their susceptibility to change and any values associated with the specific view in question. It varies depending on a number of factors such as the occupation of the viewer, their viewing expectations, duration of view and the angle or direction in which they would see the site. Whilst most views are valued by someone, certain viewpoints are particularly highly valued for either their cultural or historical associations and this can increase the sensitivity of the view. The following criteria are provided for guidance only and are not exclusive:
  - **Very Low Sensitivity** – *People engaged in industrial and commercial activities, or military activities, who would be unlikely to have any particular expectation of their wider night time view.*
  - **Low Sensitivity** - *People at their place of work (e.g. offices); shoppers; users of trunk/major roads and passengers on commercial railway lines (except where these form part of a recognised and*

*promoted scenic route). The primary interest of such receptors would not generally be on the dusk/night time view.*

- **Medium Sensitivity** - *Users of public rights of way and minor roads which do not appear to be used primarily for recreational activities or the specific enjoyment of the landscape; recreational activities not specifically focused on the landscape (e.g. football). Such receptors may have some interest in their dusk/night time view of the wider landscape, but generally their primary concern would be their immediate landscape context;*
  - **High Sensitivity** – *Residents at home; users of caravan parks, campsites and ‘destination’ hotels; tourist attractions open after daylight hours with opportunities for views of the landscape (but not specifically focused on a particular vista); users of public rights of way or minor roads which appear to be used for recreational purposes or the specific enjoyment of the landscape during dusk/night time (often likely to be in close proximity to residential areas).*
  - **Very High Sensitivity** - *People at recognised vantage points (often with interpretation boards) which are designed to take in a dusk/ night time view, people at tourist attractions with a focus on a specific view which is available at dusk/ night time, visitors to historic features/estates where the setting is important to an appreciation and understanding of cultural value and can be visited and appreciated during dusk/night time.*
14. It is important to appreciate that it is the visual receptor (i.e. the person) that has a sensitivity and not a property, public right of way or road. Therefore, a large number of people may use a motorway during dusk/ night time, for example, but this does not increase the sensitivity of the receptors using it. Conversely, a residential property may only have one person living in it but this does not reduce the sensitivity of that one receptor.
15. Where judgements are made about the sensitivity of assessment viewpoints, the sensitivity rating provided shall be an evaluation of the sensitivity of the receptor represented by the viewpoint and not a reflection of the number of people who may experience the view.
16. It is also important not to confuse the concept of visual sensitivity with the perception of wind turbines. It is acknowledged that some people consider wind turbines to be unattractive, but many people also enjoy the sight of them. This matter is therefore not a factor when determining sensitivity.

#### **Nature (Magnitude) of Change on Landscape Character**

17. The magnitude of effect on landscape character from visible lighting during low light periods is influenced by the resulting alteration to the physical and perceptual characteristics of the landscape. Professional judgement shall be used as appropriate to determine the magnitude using the following criteria as guidance only. In doing so, it is recognised that usually the landscape components in the immediate surroundings, including any visible lighting, have a stronger influence on the sense of landscape character than distant features whilst acknowledging the fact that more distant features can have an influence on landscape character as well.
- **Very Low Magnitude of Change** – *No notable introduction of new visible lighting into the landscape; resulting in negligible change to the key physical and/or perceptual attributes of the landscape during the low light period.*
  - **Low Magnitude of Change** - *Introduction of a minor new extent of visible lighting into the landscape; resulting in a minor alteration to the key physical and/or perceptual attributes of the landscape during the low light period.*
  - **Medium Magnitude of Change** - *Introduction of some notable new visible lighting into the landscape; resulting in some notable change to the key physical and/or perceptual attributes of the landscape during the low light period.*

- **High Magnitude of Change** - Introduction of major new visible lighting into the landscape; resulting in a major change to the key physical and/or perceptual attributes of the landscape during the low light period.
- **Very High Magnitude of Change** - Introduction of dominant new visible lighting into the landscape; resulting in a profound change to the key physical and/or perceptual attributes of the landscape during the low light period.

#### **Nature (Magnitude) of Change on Views and Visual Amenity**

18. Visual effects are caused by the introduction of new elements into the views of a landscape, or the removal of elements from the existing view. In this case the effects would be brought about by the addition of visible lighting.
19. Professional judgement shall be used to determine the magnitude of impacts using the following criteria as guidance only:
  - **Very Low Magnitude of Change** - No change or negligible change in views;
  - **Low Magnitude of Change** - Some change in the view that is not prominent but visible to some visual receptors;
  - **Medium Magnitude of Change** - Some change in the view that is clearly notable in the view and forms an easily identifiable component in the view;
  - **High Magnitude of Change** - A major change in the view that is highly prominent and has a strong influence on the overall view.
  - **Very High Magnitude of Change** – A change in the view that has a dominating or overbearing influence on the overall view.
20. Using this set of criteria, determining levels of magnitude is primarily dependant on how prominent the lighting associated with the development would be in the landscape, and what may be judged to flow from that prominence or otherwise.
21. For clarification, the use of the term ‘prominent’ relates to how noticeable the lighting associated with the development would be. This is affected by how close the viewpoint is to the development but not entirely dependent on this factor. Other modifying factors include: the focus of the view, visual screening and the nature and scale of other landscape features and visible lighting within the view. Rather than specifying crude bands of distance at which the turbines will be dominant, prominent or incidental to the view etc, the prominence of the turbines in each view is described in detail for each viewpoint or receptor group taking all the relevant variables into consideration.

#### **Consideration of the Duration and Reversibility of Effect**

22. Prior to the publication of *GLVIA3*, LVIA practice had evolved over time in tandem with most other environmental disciplines to consider significance principally as a function of two factors, namely: the sensitivity of the receptor and the magnitude of the impact (the term ‘magnitude’ being a word most commonly used in LVIA and most other environmental disciplines to describe the size or scale of an impact).
23. The flow diagram on *page 39* of *GLVIA3* now suggests that the magnitude of effect is a function of three factors (the size/scale of the effect, the duration of the effect and the reversibility of the effect). This however is somewhat problematic in the context of assessing wind energy development. This is because wind energy developments are generally consented for a time limited period and are largely reversible at the end of their operational period. Whilst this is a material consideration in the planning balance it does not however reduce the scale of the effect during the period in which the scheme is operational (i.e.

the 'magnitude' of the effect in the traditional and commonly understood sense of the word). In this regard, it would be incorrect to report a lesser magnitude of change to the view during the operational phase as a result of the time limited period of the effect, or the relative reversibility of the effect.

24. The approach proposed to be taken in this assessment is therefore to consider magnitude of effect solely as the scale or size of the effect in the traditional sense of the term 'magnitude'.

#### **Level of Effect**

25. The purpose of an LVIA when produced in the context of an EIA is to identify any significant effects on landscape and visual amenity arising from the proposed development.
26. *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017* do not define a threshold at which an effect may be determined to be significant. In certain other environmental disciplines there are regulatory thresholds or quantitative standards which help to determine the threshold of what constitutes a significant effect. However, in LVIA, any judgement about what constitutes a significant effect is the judgement of a competent and appropriately qualified professional assessor.
27. The level (relative significance) of the landscape and visual effects is determined by combining judgements regarding sensitivity of the landscape or the viewer, the magnitude of change, duration of effect and the reversibility of the effect. In determining the level of residual effects, all mitigation measures are taken into account.
28. The level (relative significance) of effect shall be described as **Major, Major/Moderate, Moderate, Moderate/Minor, Minor, Slight/No Effect** or **No Effect**. No Effect may also be recorded as appropriate where the effect is so negligible it is not even noteworthy.
29. In the assessment, those effects described as Major, Major/Moderate and in some cases Moderate may be regarded as significant effects as required by the EIA Regulations. These are the effects which the authors of the LVIA consider to be most material in the decision making process.

#### **Production of the Zone of Theoretical Visibility (ZTV) Plan**

30. A Zone of Theoretical Visibility (ZTV) illustrates the extents from which a feature (in this case the visible lighting from several wind turbines) would theoretically be visible within a defined study area.
31. ZTVs are generated assuming a 'bare ground' terrain model. This means that the ZTVs presented are generated from topographical data only and they do not take any account of vegetation or the built environment, which may screen views of the development. They are, as such, a 'worst-case' zone of visual influence and considerably over-emphasises the actual visibility of the scheme. In reality trees, hedges and buildings may restrict views of the development from many of the areas rendered as within the ZTV.
32. A further assumption of ZTVs is that climatic visibility is 100% (i.e. visibility is not impeded by moisture or pollution in the air). In reality, such atmospheric conditions are relatively rare. Mist, fog, rain and snow are all common weather occurrences, which would regularly restrict visibility of the lighting associated with the development from some of the areas within the ZTV; this being an incrementally more significant factor with distance from the site. Atmospheric pollution is not as significant as it is in other parts of the country but is still present and would also restrict actual visibility on some occasions, again more so with distance from the site.
33. A ZTV has been generated using specialist computer software package 'WindFarm' by ReSoft Ltd. The programme uses topographical height data (OS Terrain 50) to build a terrain model. The programme then renders the model using a square grid to illustrate whether the turbine lighting would be visible in each 50 m x 50 m square on the grid for a specified distance in every direction from the site.
34. A digital ZTV has been prepared to illustrate the theoretical visibility of the turbine lighting for a radius of 20 km around the site. It should be noted that when light travels from its source it diminishes in intensity,

limiting the area that its source can illuminate, a process known as ‘light attenuation’ or ‘fall-off’. Therefore, whilst the ZTV does not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the Proposed Development.

35. It should be noted that there are several limitations to the use of ZTVs. For a discussion of these limitations please refer to *Visual Representation of Wind farms – Version 2.2* (SNH February 2017). In particular, it should be noted that the ZTV plan shall simply illustrate theoretical visibility and will not imply or assign any level of significance to those areas identified as being within the ZTV. A ZTV is a tool to assist the Landscape Architect to identify where the turbine lighting would potentially be visible from, however, the assessment of landscape and visual effects shall not rely solely on the ZTV and in all cases professional judgement shall be used to evaluate the significance of effects.

### **Production of the Dusk Period Visualisations**

#### Introduction

36. SNH Guidance, *Visual Representation of Wind Farms, Version 2.2* (February 2017), considers the matter of visible turbine lighting at paragraphs 174 to 177. This highlights that ‘Where an illustration of lighting is required, a basic visualisation showing the existing view alongside an approximation of how the wind farm might look at night with aviation lighting may be useful’. It goes on to note that ‘This is only likely to be required in particular situations where the wind farm is likely to be regularly viewed at night (e.g. from a settlement, transport route) or where there is a particular sensitivity to lighting (e.g. in or near a Dark Sky Park or Wild Land Area)’. It is also clear that ‘**Not all viewpoints will need to be illustrated in this way**’.
37. The following section provides background information in relation to the Dusk Period Visualisations which have been prepared to illustrate the visible lighting proposed as part of the Proposed Development. The text explains how the photography has been taken and how the visualisations have been prepared and presented. It includes instructions for how it is expected that the visualisations should be viewed and explains the limitations of the visualisation material.

#### Dusk Period Photography

38. SNH advises that ‘The visualisation should use photographs taken in low light conditions, preferably when other artificial lighting (such as street lights and lights on buildings) are on, to show how the wind farm lighting will look compared to the existing baseline at night. It is only necessary to illustrate visible lighting, not infrared or other alternative lighting requirements’. It goes on to note that ‘We have found that approximately 30 minutes after sunset provides a reasonable balance between visibility of the landform and the apparent brightness of artificial lights, as both should be visible in the image. It is important that the photographs represent the levels of darkness as seen by the naked eye at the time and the camera exposure does not make the image appear artificially brighter than it is in reality. It can also be helpful to note the intensity of other lights in the area to enable comparison (e.g. television transmitters) as this can aid the assessment process’.
39. In this context, the following text explains how the baseline photography has been taken for each viewpoint to be illustrated with a visualisation.
40. Each viewpoint illustrated with a visualisation has been visited during the ‘dusk period’ and photographs taken at regular intervals as the light levels decrease across the dusk period. In particular, we have sought to gather photographs during the period where street lighting and other light sources of visible light in the baseline are illuminated, but the landform remains partially visible. The ambient light conditions were recorded during each round of photography with a light meter to seek to ensure consistency across the visualisations prepared.

41. Baseline photographs of the existing view were taken using a high quality Canon 5D Mark II digital camera with a Canon EF 50 mm f/1.4 USM lens. In accordance with SNH guidance, this camera had a full frame digital sensor.
42. As far as possible, photographs were taken in good weather and clear visibility conditions.
43. Neutral density graduated filters were used as appropriate at some viewpoints to balance the exposure within some scenes – typically where there is a contrast between bright sky and darker landform. Other than this no other filters were used during the photography.
44. Photographs were captured in high resolution JPEG format and as RAW metadata files.
45. At each viewpoint the camera was mounted on a levelled tripod at a height of approximately 1.5 m above ground level (providing an approximation of average adult eye level).
46. The camera was set up on a panoramic rotating head and photographs taken at 30 degree increments of rotation from left to right.
47. In each case the camera focus was locked on the distant horizon (infinity). In doing so the photographs are in each case focussed on the development site whilst very close objects in the foreground may in some cases be out of focus. This approach is in line with best practice photography techniques. The exposure was set correctly for the centre of the development site and then locked off so that it remained constant as the camera is rotated through the panorama.

Stitching of Panoramas and Post-Photographic Processing

48. Each of the panoramic images presented for the Photographic Record and used for the Visualisations was comprised of three single frame photographs stitched together and then cropped down to a particular horizontal and vertical field of view.
49. The panoramic baseline photographs which illustrate a 90 degree horizontal angle of view was stitched in cylindrical projection as per the SNH guidance.
50. The photomontages which show a 53.5 degree horizontal field of view were based on the same single frame panoramic photographs but stitched in planar projection in accordance with the SNH guidance.
51. In some cases a degree of post photography processing of the raw image files may be undertaken to enhance the quality of the baseline photographs. As stated in the SNH guidance:
 

*‘Photographic processing involves judgements - there is no process by which a ‘pure’ photograph can be produced without the application of human decision-making, from exposure timing to the specification of the camera, and whether this is applied manually or automatically.....’*

*‘In reality there is no way to avoid a photograph being enhanced as this is an integral part of photography and photomontage production.’*
52. The extent of image enhancement undertaken in the production of the photomontages was however limited to that which would conventionally occur in a darkroom to improve the clarity of an image and did not in each case change the essential character of the image. Overall, a minimum of post-photography image enhancement took place and during the stitching process none of the photographs were distorted in terms of scaling (other than that which is an inherent and unavoidable product of stitching photography in planar projection).



## **Production of Wirelines and Photomontages**

### Wirelines

53. A wireline visualisation (sometimes also referred to as a wireframe visualisation) is a computer generated 3D outline of a particular structure (in this case a wind farm) placed on top of a 3D ground terrain model, which again is represented by a wireline. No rendering is given to any of the surfaces.
54. The wireline images of the proposed turbines (as well as any other cumulative turbines modelled) were generated utilising the actual dimensions of the proposed turbines and a model of the structures placed in position over a ground terrain model generated from Ordnance Survey Terrain 50 DTM data.
55. The coordinates of the viewpoints were recorded using a Global Positioning System (GPS) in the field. Checks on these coordinates were made with reference to Google Earth. These coordinates were used to set up viewpoints in the model from which to view the turbines. The wirelines were generated using specialist computer software package 'WindFarm' by ReSoft Ltd.
56. The wireline images are generated on a bare ground model and therefore do not take account of any vegetation or the built environment between the viewpoint and the development. As such, they represent a worst case view.
57. For each of the viewpoints which are illustrated with a Visualisation, a wireline has been presented to scale beneath a baseline photograph to illustrate the view. The wireline images illustrate the anticipated scale and position of the turbines in relation to the terrain.

### Dusk Period Photomontages

58. In simple terms, a photomontage is the superimposition of a rendered, photorealistic, computer generated model of a development (in this case a wind farm with visible lighting) on to a baseline photograph to illustrate how it will appear in the surrounding landscape context.
59. The production of the photomontages begun with the generation of a 3D digital ground terrain model and wireline images of the turbines, using ReSoft Ltd WindFarm software (as described above). The model of the structures was then rendered, and the lighting levels set appropriate to the date, time and orientation on which the photograph was taken.
60. Using world coordinates in the computer modelling programme, the photographic viewpoints for which a photomontage was prepared was replicated such that a view was set up looking at the structures from exactly the same location as where the baseline photograph was taken from. The view from the model was then superimposed over the original photograph and edited as necessary in Adobe Photoshop to give a final photomontage. Several known landmarks in the far distance of the baseline photographs were recorded on site using a GPS and used to check that the positioning and scale of the structures is correct.
61. Whilst every effort has been made to ensure the accuracy of the photomontages, it must be appreciated that no photomontage could ever claim to be 100 % accurate as there are a number of technical limitations in the model relating to the accuracy of information available from Ordnance Survey and from the GPS. In particular, it should be recognised that baseline photographs on which photomontages are based can, at best, only ever be a 'flattened' 2D representation of what the eye sees in 3D on site. A photograph will never capture as much detail as the eye would see in the field, it therefore follows that a photomontage can never truly capture the sense of perspective and detail which would be possible in reality.
62. Additionally, it has been established during the field work undertaken for previous similar studies that dusk period photographs of visible lighting do not always capture the extent to which the eye perceives light sources during the dusk period. Often photography will appear to show the lighting to be more recessive than it is actually perceived in the field. The photomontages therefore do not seek to replicate

the manner in which a dusk period photograph would capture the aviation lighting, rather they seek to replicate the manner in which the lighting is perceived when it is viewed in the field.

63. In some cases, the visibility of the turbines may also be slightly digitally enhanced to ensure that they are visible when printed out.
64. Each of the photomontages should be viewed from the stated viewing distance to give an accurate representation of what the development will look like. However, the photomontages are simply a tool to assist the Landscape Architect in their assessment of effects. The assessment of visual effects does not rely solely on the accuracy of the photomontages as it is ultimately professional judgement which is used to evaluate the significance of effects.

#### **Presentation of the Visualisation Sheets**

65. For each Dusk Period Viewpoint Visualisation, the following visualisation sheets have been presented:  
*Sheet A: Baseline Photograph of the Existing Dusk Period View and Cumulative Wireline of the Proposed Scheme and all other relevant Operational or Consented Wind Farms (including only other developments with lit turbines)*
66. The baseline photograph is an unedited existing dusk period view from the viewpoint. The image illustrates a 90 degree horizontal field of view and a 25 degree vertical field of view. This image is presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 500 mm when the image is curved through the same radius.
67. A cumulative wireline image of the Proposed Development, and the other neighbouring operational or consented wind farms which are required to have aviation lighting is set out directly beneath the corresponding baseline view. This image also presents a 90 degree horizontal field of view.  
*Sheet B: Future Baseline Photograph of the Existing Dusk Period View (Showing consented/under construction schemes digitally added) and Cumulative Wireline of the Proposed Scheme and all other relevant Operational, Consented or In Planning Wind Farms (including only other developments with lit turbines)*
68. The future baseline photograph is an edited existing dusk period view from the viewpoint showing consented/under construction schemes digitally added. The image illustrates a 90 degree horizontal field of view and a 25 degree vertical field of view. This image is presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 500 mm when the image is curved through the same radius.
69. A cumulative wireline image of the Proposed Development, and the other neighbouring operational, consented or 'in planning' wind farms which are required to have aviation lighting is set out directly beneath the corresponding baseline view. This image also presents a 90 degree horizontal field of view.  
*Sheet C: Dusk Period Photomontage of the Proposed Scheme and other relevant Operational or Consented Schemes with Aviation Lighting*
70. This sheet provides an enlarged and cropped dusk period photomontage of the Proposed Development, added into the future baseline image described above. The image illustrates a 53.5 degree horizontal field of view and an 18 degree vertical field of view. It is presented in planar projection. As such the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5 mm. This sheet presents the information required of the 'A1 Panorama' as set out in Annex C of the SNH guidance.  
*Sheet D: Dusk Period Cumulative Photomontage of the Proposed Scheme and other relevant Operational, Consented and Proposed Schemes with Aviation Lighting*

71. This sheet provides an enlarged and cropped dusk period cumulative photomontage of the Proposed Development, alongside other relevant operational, consented and proposed (in planning) wind farms. The image illustrates a 53.5 degree horizontal field of view and an 18 degree vertical field of view. It is presented in planar projection. As such the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5 mm. This sheet presents the information required of the 'A1 Panorama' as set out in Annex C of the SNH guidance.

#### **Limitations of the Visualisations**

72. Annex A of 'Visual Representation of Wind Farms', Version 2.2 (SNH, February 2017) sets out a summary of the key limitations of visualisations and recommends that these are set out for each windfarm application. The following text is therefore reproduced from Annex A of the aforementioned SNH guidance:

*'Visualisations of wind farms have a number of limitations which you should be aware of when using them to form a judgement on a wind farm proposal. These include:*

- *A visualisation can never show exactly what the wind farm will look like in reality due to factors such as: different lighting, weather and seasonal conditions which vary through time and the resolution of the image;*
- *The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate;*
- *A static image cannot convey turbine movement, or flicker or reflection from the sun on the turbine blades as they move;*
- *The viewpoints illustrated are representative of views in the area, but cannot represent visibility at all locations;*
- *To form the best impression of the impacts of the wind farm proposal these images are best viewed at the viewpoint location shown;*
- *The images must be printed at the right size to be viewed properly (260 mm by 820 mm);*
- *You should hold the images flat at a comfortable arm's length. If viewing these images on a wall or board at an exhibition, you should stand at arm's length from the image presented to gain the best impression.*
- *It is preferable to view printed images rather than view images on screen. If you do view images on screen you should do so using a normal PC screen with the image enlarged to the full screen height to give a realistic impression. Do not use a tablet or other device with a smaller screen to view the visualisations described in this guidance'.*

73. It should also be noted that the quality of all printed visualisations is also dependent on the printing methods, paper and ink used.

ANNEX 2 - Photographic Record of images of the  
Middleton Wind Farm during low light conditions  
and images of the Emley Moor Transmitter



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 622



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 454



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 334



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 212





**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 127



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 61



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 33



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 15



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 7



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 4



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 2-3



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 2





**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 2



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 1

**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 1



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 1



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

Direction from site: North east

Angle of view: 39.6 degrees

Correct viewing distance: 500mm

Lux: 1



**Viewpoint Information**

OS Reference: 252223 656272

Viewpoint height: 130m

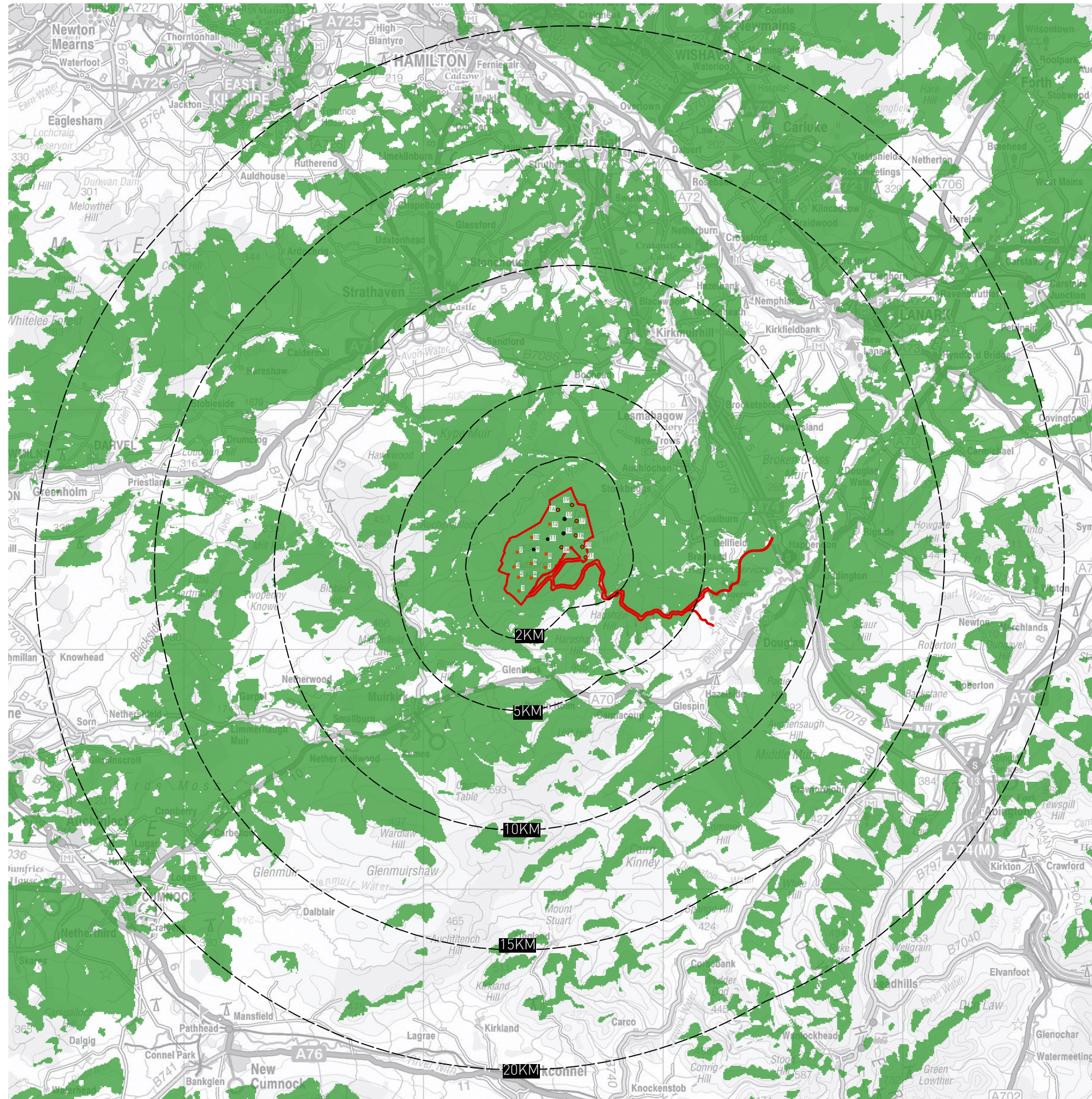
Direction from site: North east

Angle of view: 39.6 degrees





Correct viewing distance: 500mm

Lux: 1

# FIGURES

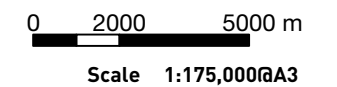



**KEY**

-  Proposed Development Site Boundary and Proposed Turbine Locations and Corresponding Turbine Number
-  Radii from Proposed Development Turbines
-  Lit turbines
-  Zone of Theoretical Visibility of Turbine Lighting for Proposed Development

It should be noted that when light travels from its source it diminishes in intensity, limiting the area that its source can illuminate, a process known as 'light attenuation' or 'fall-off'. Therefore, whilst the ZTV does not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the wind farm.

NB The Zone of Theoretical Visibility (ZTV) image illustrates the theoretical extent of where turbines will be visible from assuming 100% visibility. It is generated using terrain data only and does not take into account any screening that vegetation or the built environment may provide. It is as such a worst case ZTV and the actual extents of visibility are likely to be much less extensive.

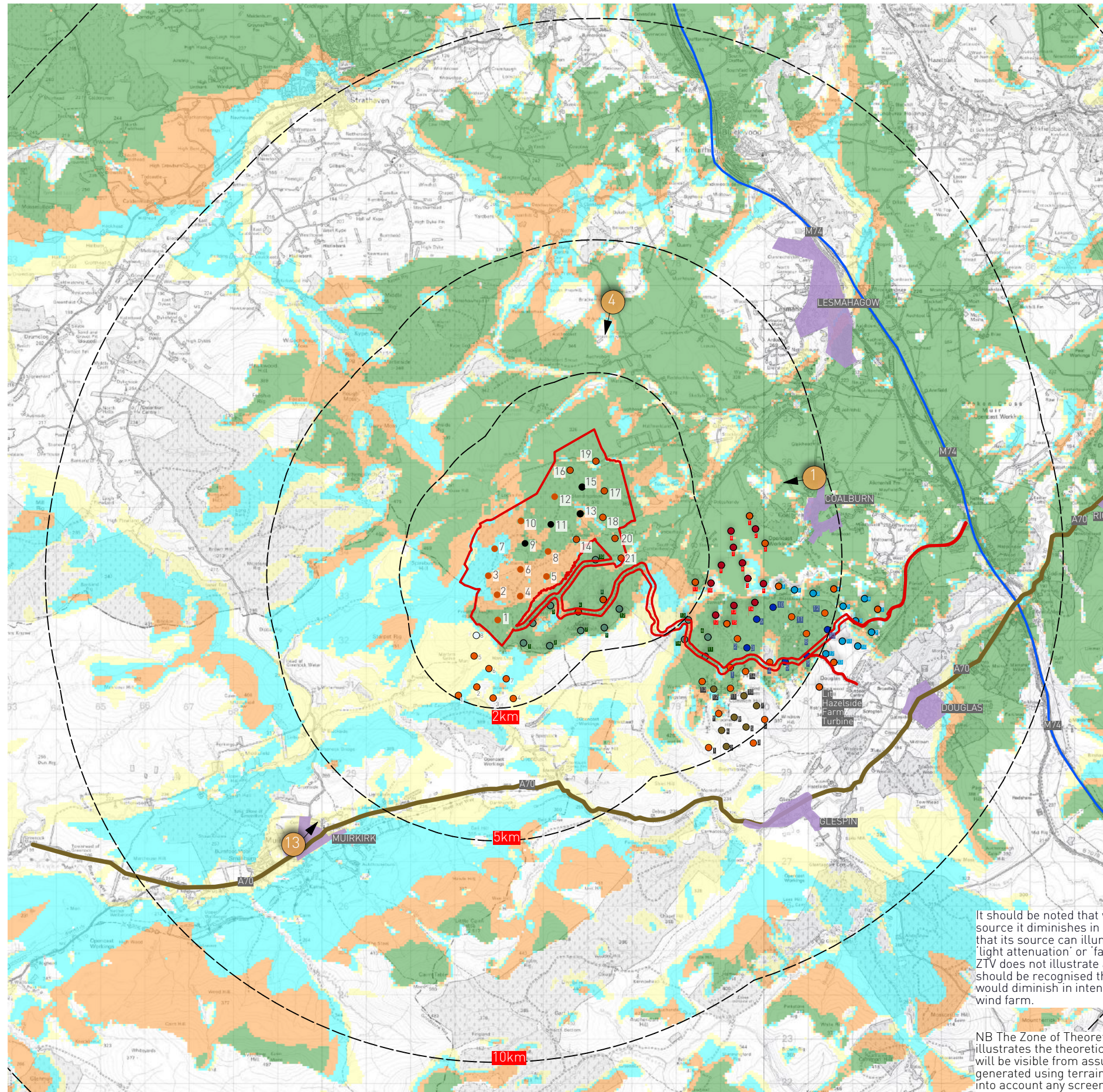


**Pegasus Group**  **Cumberhead West Wind Farm**  
Appendix 6.4

**Figure 1**

**Lit Turbine ZTV of Cumberhead West Wind Farm**



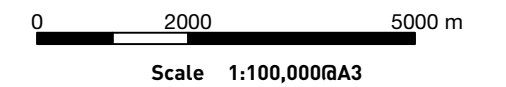


**KEY**

- Proposed Development Site Boundary and Proposed Turbine Locations and Corresponding Turbine Number
- Radii from Proposed Development Turbines
- Consented Dalquhandy Wind Farm and Corresponding Turbine Number
- Consented Douglas West Wind Farm and Corresponding Turbine Number
- Consented Cumberhead Wind Farm and Corresponding Turbine Number
- Consented Repowered Hagshaw Hill and Corresponding Turbine Number
- In Planning Hare Craig Wind Farm and Corresponding Turbine Number
- In Planning Douglas West Wind Farm Extension and Corresponding Turbine Number
- Lit turbines
- Nearby Settlements

**Zone of Theoretical Visibility of Turbine Lighting for Proposed Development**

- 1 to 4 Turbines may be Visible
- 5 to 8 Turbines may be Visible
- 9 to 12 Turbines may be Visible
- 13 to 17 Turbines may be Visible
- Night-time Assessment Viewpoints



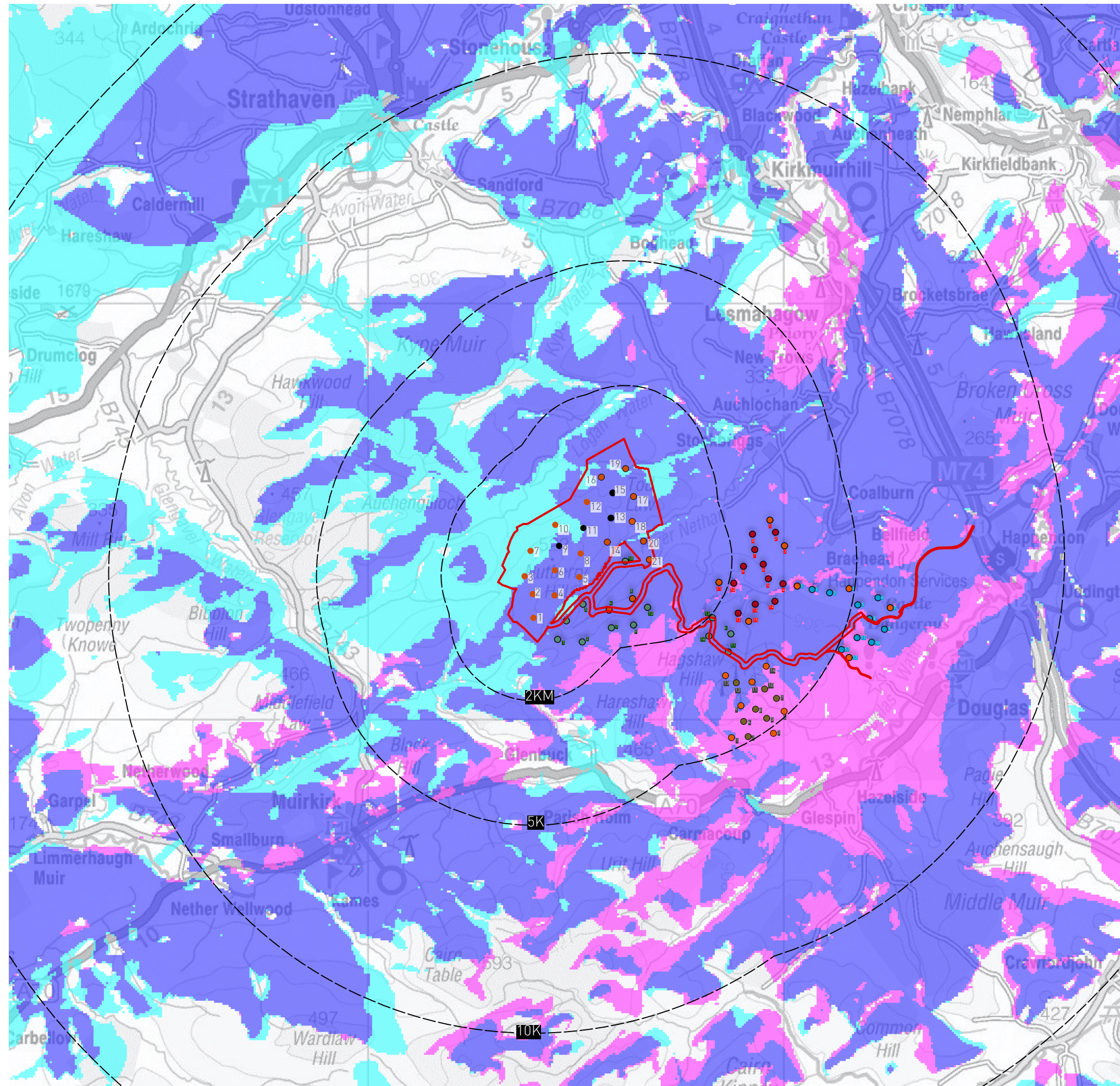
It should be noted that when light travels from its source it diminishes in intensity, limiting the area that its source can illuminate, a process known as 'light attenuation' or 'fall-off'. Therefore, whilst the ZTV does not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the wind farm.

NB The Zone of Theoretical Visibility (ZTV) image illustrates the theoretical extent of where turbines will be visible from assuming 100% visibility. It is generated using terrain data only and does not take into account any screening that vegetation or the built environment may provide. It is as such a worst case ZTV and the actual extents of visibility are likely to be much less extensive.









**Pegasus Group** Cumberhead West Wind Farm Appendix 6.4





**Figure 2**  
**ZTV of Lit Turbines and Principal Visual Receptors Including Adjacent Operational, Consented and In Planning Schemes**



**KEY**

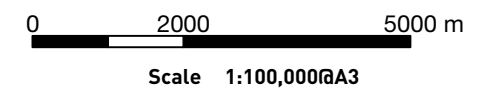
-  Proposed Development Site Boundary and Proposed Turbine Locations and Corresponding Turbine Number
-  Radii from Proposed Development Turbines
-  Lit turbines
-  Proposed Development Visible Only
-  Areas where Adjacent Consented schemes are visible only
-  Areas where both Adjacent Consented schemes and Proposed Development would be visible

**Note: Consented schemes include Douglas West Wind Farm, Cumberhead, Dalquhandy and Hagshaw Hill Repowering**

-  Consented Dalquhandy Wind Farm and Corresponding Turbine Number
-  Consented Douglas West Wind Farm and Corresponding Turbine Number
-  Consented Cumberhead Wind Farm and Corresponding Turbine Number
-  Consented Repowered Hagshaw Hill and Corresponding Turbine Number

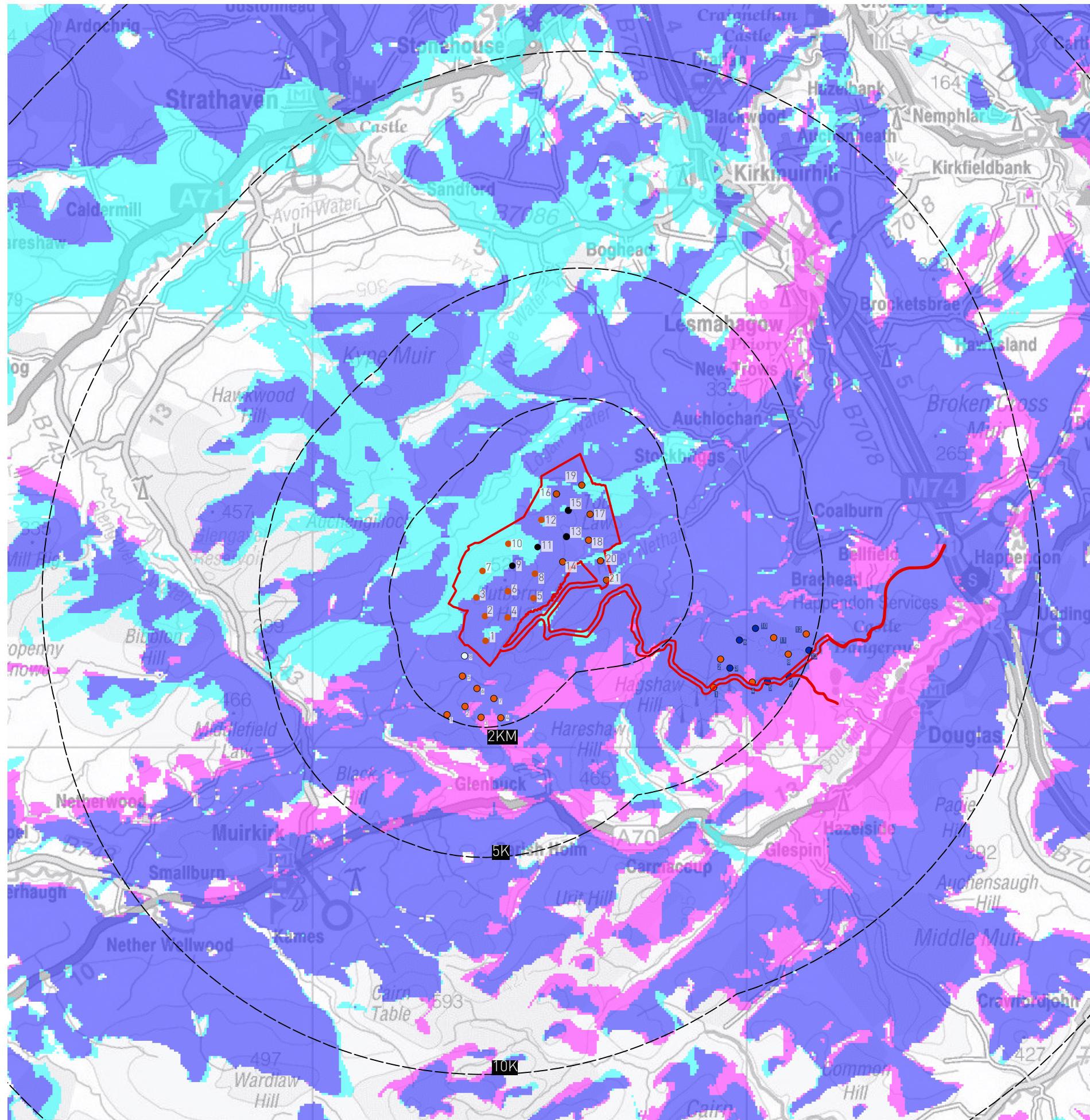
It should be noted that when light travels from its source it diminishes in intensity, limiting the area that its source can illuminate, a process known as 'light attenuation' or 'fall-off'. Therefore, whilst the ZTV does not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the wind farm.

NB The Zone of Theoretical Visibility (ZTV) image illustrates the theoretical extent of where turbines will be visible from assuming 100% visibility. It is generated using terrain data only and does not take into account any screening that vegetation or the built environment may provide. It is as such a worst case ZTV and the actual extents of visibility are likely to be much less extensive.



**Pegasus Group** Cumberhead West Wind Farm Appendix 6.4

**Figure 3**  
**Lit Turbine ZTV of Cumberhead West Wind Farm and Adjacent Consented Wind Farm Schemes**



**KEY**

Proposed Development Site Boundary and Proposed Turbine Locations and Corresponding Turbine Number  
 Radii from Proposed Development Turbines

Lit turbines

Proposed Development Visible Only  
 Areas where In Planning Schemes are visible only  
 Areas where both In Planning Schemes and the Proposed Development would be visible

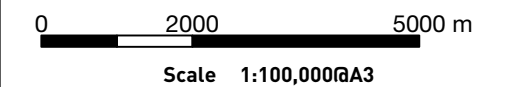
**Note: In Planning schemes include Hare Craig and Douglas West Extension**

In Planning Hare Craig Wind Farm and Corresponding Turbine Number

In Planning Douglas West Wind Farm Extension and Corresponding Turbine Number

It should be noted that when light travels from its source it diminishes in intensity, limiting the area that its source can illuminate, a process known as 'light attenuation' or 'fall-off'. Therefore, whilst the ZTV does not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the wind farm.

NB The Zone of Theoretical Visibility (ZTV) image illustrates the theoretical extent of where turbines will be visible from assuming 100% visibility. It is generated using terrain data only and does not take into account any screening that vegetation or the built environment may provide. It is as such a worst case ZTV and the actual extents of visibility are likely to be much less extensive.

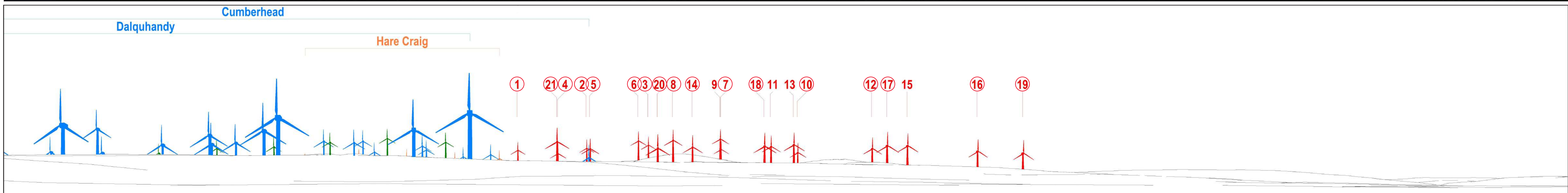


**Pegasus Group** Cumberhead West Wind Farm Appendix 6.4

**Figure 4**  
**Lit Turbine ZTV of Cumberhead West Wind Farm and In Planning Wind Farm Applications**



Baseline Photograph



Cumulative wireline drawing (including only other developments with lit turbines).

**KEY:**

- Proposed Cumberhead West Wind Farm
- Consented / Under Construction Schemes
- Schemes In Planning

○ Denotes Proposed lit Turbines of Cumberhead West Wind Farm

**App 6.4 Fig 1 (sheet A)**  
**Viewpoint 1: Coalburn, Muirburn Place**  
 CUMBERHEAD WEST WIND FARM



**Sheet A: Baseline Photograph of the Existing Dusk Period View and Cumulative Wireline of the Proposed Scheme and all other relevant Operational, Consented or In Planning Wind Farms (including only other developments with lit turbines).**

**Viewpoint Information**  
 OS Reference: E 281160, N 635512  
 Ground level: 221m (AOD)

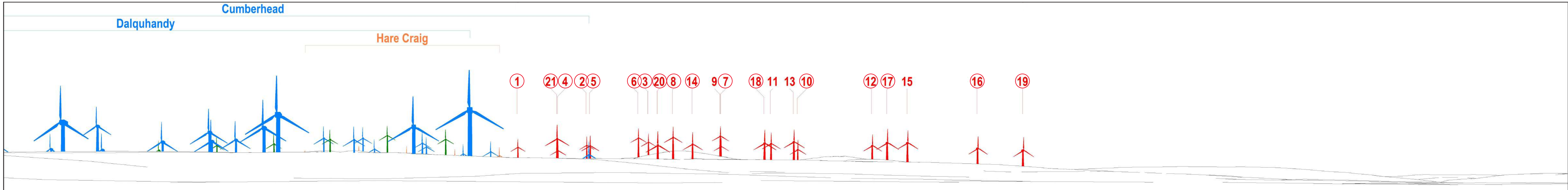
**Distance to nearest turbine:** 4494m (T20)  
**Bearing to centre of photograph:** 262.35°

**Angle of view:** 90° [cylindrical]  
**Principal distance:** 500mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 06/09/2020 20:05



Future Baseline Photograph (Showing consented/under construction scheme Cumberhead and Hagshaw Hill Repowering digitally added).



Cumulative wireline drawing (including only other developments with lit turbines).

**KEY:**  
○ Denotes Proposed lit Turbines of Cumberhead West Wind Farm  
○ Consented / Under Construction Schemes  
○ Schemes In Planning

**App 6.4 Fig 1 (sheet B)**  
**Viewpoint 1: Coalburn, Muirburn Place**  
 CUMBERHEAD WEST WIND FARM



**Sheet B: Future Baseline Photograph of the Existing Dusk Period View (Showing consented/under construction schemes digitally added) and Cumulative Wireline of the Proposed Scheme and all other relevant Operational, Consented or In Planning Wind Farms (including only other developments with lit turbines).**

**Viewpoint Information**  
 OS Reference: E 281160, N 635512  
 Ground level: 221m (AOD)  
 Distance to nearest turbine: 4694m (T20)  
 Bearing to centre of photograph: 262.35°  
 Angle of view: 90° [cylindrical]  
 Principal distance: 500mm  
 Camera: Canon EOS 5D Mark III  
 Lens: 50mm Fixed Focal Lens  
 Height: 1.5m  
 Date & Time: 06/09/2020 20:05



Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 1 (sheet C)**  
**Viewpoint 1: Coalburn, Muirburn Place**  
CUMBERHEAD WEST WIND FARM



**Sheet C: Dusk Period Photomontage of the Proposed Scheme and other relevant Operational or Consented Schemes with Aviation Lighting.**

**Viewpoint Information**  
**OS Reference:** E 281160, N 635512  
**Ground level:** 221m (AOD)

**Distance to nearest turbine:** 4694m (T20)  
**Bearing to centre of photograph:** 262.35°

**Angle of view:** 53.5° (planar)  
**Principal distance:** 812.5mm  
**Paper size:** 841 x 297 mm (half A1)  
**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 06/09/2020 20:05



Cumulative Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 1 (sheet D)**  
**Viewpoint 1: Coalburn, Muirburn Place**  
CUMBERHEAD WEST WIND FARM



**Sheet D: Dusk Period Cumulative Photomontage of the Proposed Scheme and other relevant Operational, Consented and In Planning Schemes with Aviation Lighting.**

**Viewpoint Information**  
**OS Reference:** E 281160, N 635512  
**Ground level:** 221m (AOD)

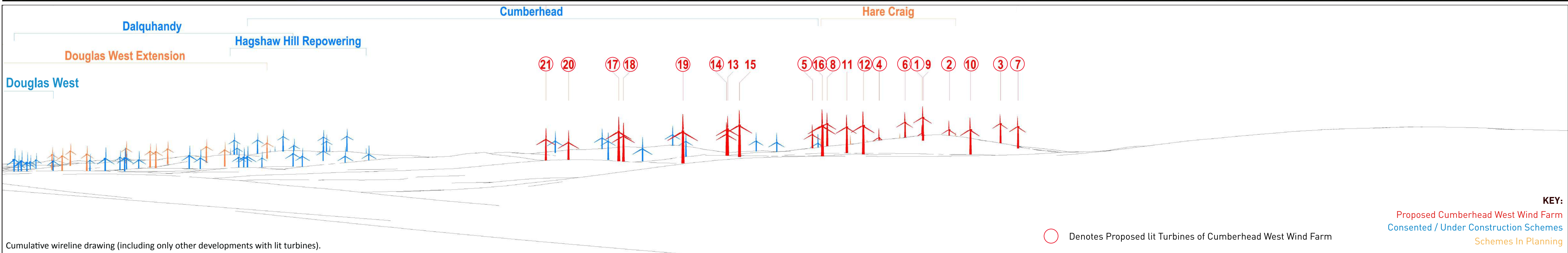
**Distance to nearest turbine:** 4694m (T20)  
**Bearing to centre of photograph:** 262.35°

**Angle of view:** 53.5° (planar)  
**Principal distance:** 812.5mm  
**Paper size:** 841 x 297 mm (half A1)  
**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 06/09/2020 20:05



Baseline Photograph



Cumulative wireline drawing (including only other developments with lit turbines).

**App 6.4 Fig 2 (sheet A)**  
**Viewpoint 4: Minor road, Brackenridge**  
 CUMBERHEAD WEST WIND FARM



**Sheet A: Baseline Photograph of the Existing Dusk Period View and Cumulative Wireline of the Proposed Scheme and all other relevant Operational, Consented or In Planning Wind Farms (including only other developments with lit turbines).**

**Viewpoint Information**  
 OS Reference: E 276584, N 639685  
 Ground level: 293m (AOD)

**Distance to nearest turbine:** 3674m (T19)  
**Bearing to centre of photograph:** 192°

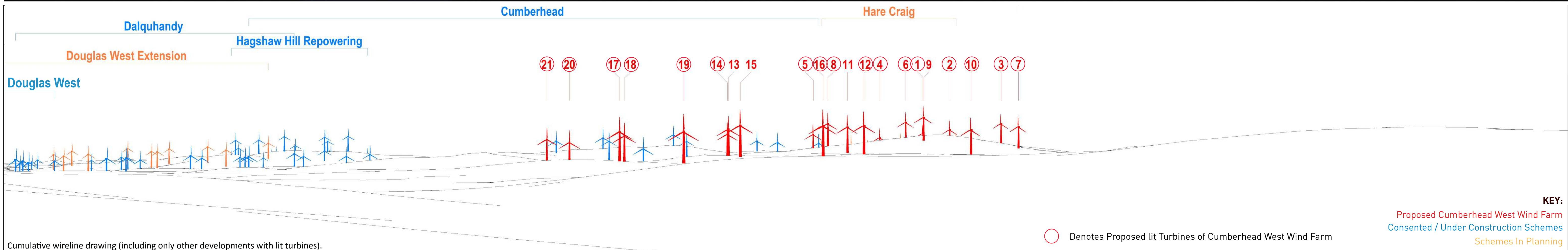
**Angle of view:** 90° [cylindrical]  
**Principal distance:** 500mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 08/09/2020 20:05





Future Baseline Photograph (Showing consented/under construction scheme Cumberhead and Hagshaw Hill Repowering digitally added).



Cumulative wireline drawing (including only other developments with lit turbines).



Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 2 (sheet C)**  
**Viewpoint 4: Minor road, Brackenridge**  
CUMBERHEAD WEST WIND FARM



**Sheet C: Dusk Period Photomontage of the Proposed Scheme and other relevant Operational or Consented Schemes with Aviation Lighting.**

**Viewpoint Information**  
**OS Reference:** E 276584, N 639685  
**Ground level:** 293m (AOD)

**Distance to nearest turbine:** 3674m (T19)  
**Bearing to centre of photograph:** 192°

**Angle of view:** 53.5° (planar)  
**Principal distance:** 812.5mm  
**Paper size:** 841 x 297 mm (half A1)  
**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 08/09/2020 20:05



Cumulative Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 2 (sheet D)**  
**Viewpoint 4: Minor road, Brackenridge**  
CUMBERHEAD WEST WIND FARM



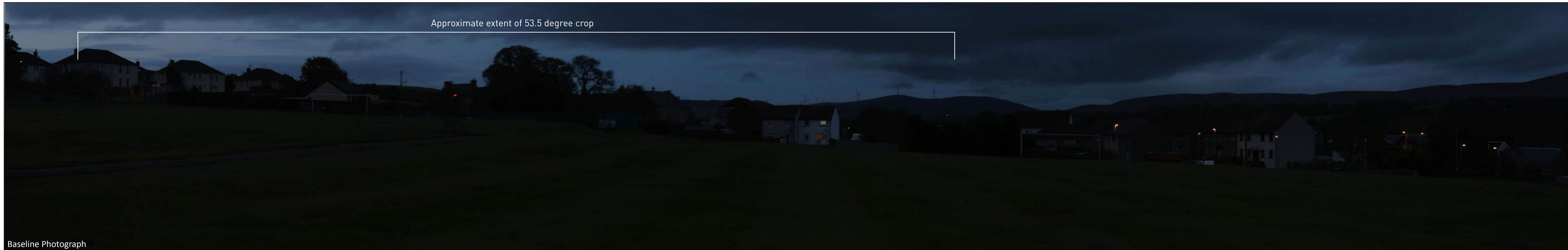
**Sheet D: Dusk Period Cumulative Photomontage of the Proposed Scheme and other relevant Operational, Consented and In Planning Schemes with Aviation Lighting.**

**Viewpoint Information**  
**OS Reference:** E 276584, N 639685  
**Ground level:** 293m (AOD)

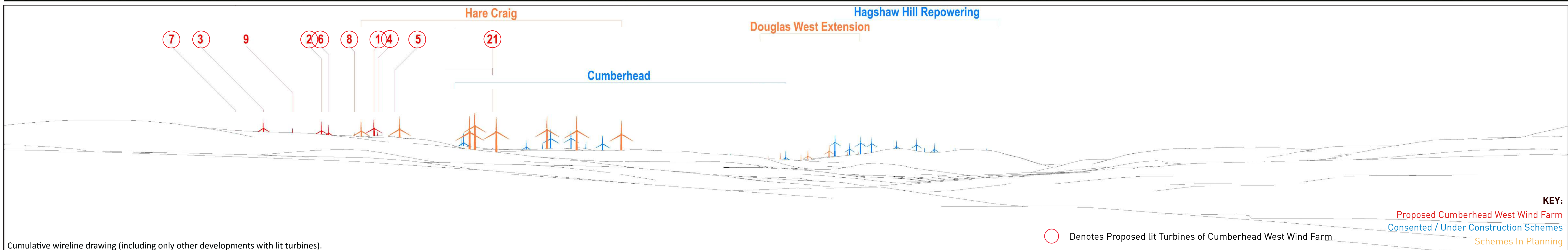
**Distance to nearest turbine:** 3674m (T19)  
**Bearing to centre of photograph:** 192°

**Angle of view:** 53.5° (planar)  
**Principal distance:** 812.5mm  
**Paper size:** 841 x 297 mm (half A1)  
**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 08/09/2020 20:05



Baseline Photograph



Cumulative wireline drawing (including only other developments with lit turbines).

**App 6.4 Fig 3 (sheet A)**  
**Viewpoint 13: Victory Park, Muirkirk**  
 CUMBERHEAD WEST WIND FARM



**Sheet A: Baseline Photograph of the Existing Dusk Period View and Cumulative Wireline of the Proposed Scheme and all other relevant Operational, Consented or In Planning Wind Farms (including only other developments with lit turbines).**

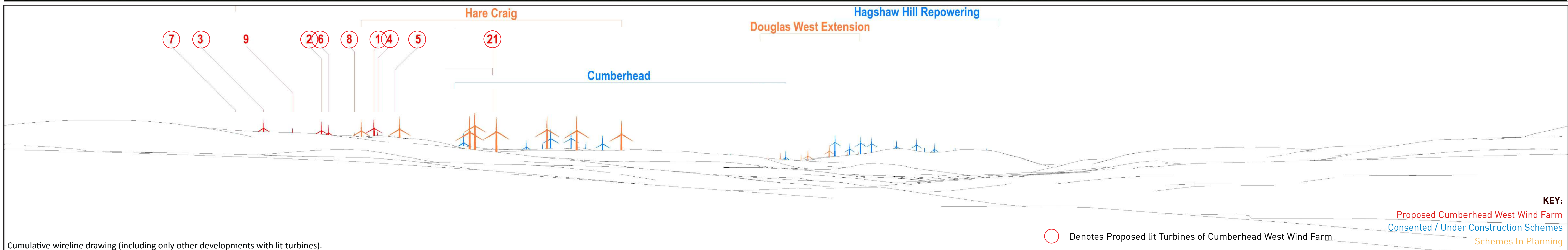
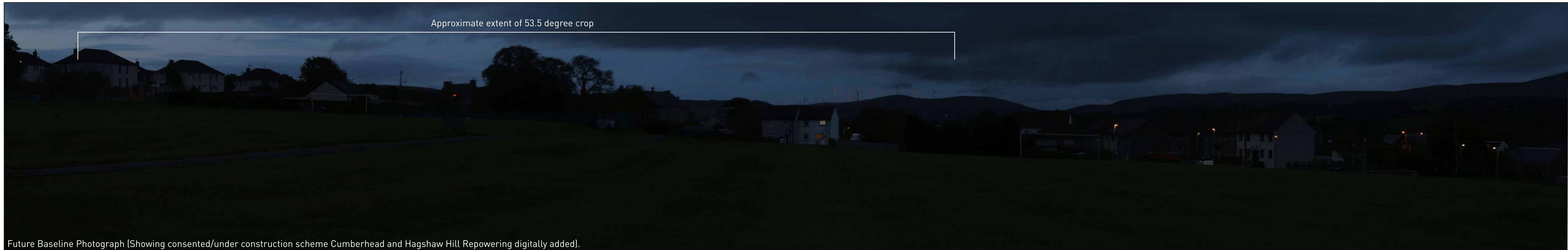
**Viewpoint Information**  
 OS Reference: E 269993, N 627332  
 Ground level: 234m (AOD)

**Distance to nearest turbine:** 6868m (T1)  
**Bearing to centre of photograph:** 65.23°

**Angle of view:** 90° [cylindrical]  
**Principal distance:** 500mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 24/09/2018 18:10

**KEY:**  
 Proposed Cumberhead West Wind Farm  
 Consented / Under Construction Schemes  
 Schemes In Planning



Cumulative wireline drawing (including only other developments with lit turbines).



Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 3 (sheet C)**  
**Viewpoint 13: Victory Park, Muirkirk**  
CUMBERHEAD WEST WIND FARM



Sheet C: Dusk Period Photomontage of the Proposed Scheme and other relevant Operational or Consented Schemes with Aviation Lighting.

**Viewpoint Information**

**OS Reference:** E 269993, N 627332  
**Ground level:** 234m (AOD)

**Distance to nearest turbine:** 6868m (T1)  
**Bearing to centre of photograph:** 65.23°

**Angle of view:** 53.5° (planar)

**Principal distance:** 812.5mm

**Paper size:** 841 x 297 mm (half A1)

**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III

**Lens:** 50mm Fixed Focal Lens

**Height:** 1.5m

**Date & Time:** 24/09/2018 18:10



Cumulative Photomontage

View flat at a comfortable arm's length

**App 6.4 Fig 3 (sheet D)**  
**Viewpoint 13: Victory Park, Muirkirk**  
CUMBERHEAD WEST WIND FARM



**Sheet D: Dusk Period Cumulative Photomontage of the Proposed Scheme and other relevant Operational, Consented and In Planning Schemes with Aviation Lighting.**

**Viewpoint Information**  
**OS Reference:** E 269993, N 627332  
**Ground level:** 234m (AOD)

**Distance to nearest turbine:** 6868m (T1)  
**Bearing to centre of photograph:** 65.23°

**Angle of view:** 53.5° (planar)  
**Principal distance:** 812.5mm  
**Paper size:** 841 x 297 mm (half A1)  
**Correct printed image size:** 820 x 260mm

**Camera:** Canon EOS 5D Mark III  
**Lens:** 50mm Fixed Focal Lens  
**Height:** 1.5m  
**Date & Time:** 24/09/2018 18:10

