Technical Appendix 7.3

Visual Assessment of Turbine Lighting

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Technical Appendix 7.3

Visual Assessment of Turbine Lighting

7.1 Introduction

1. The Air Navigation Order (ANO) requires that 'en-route obstacles' at or above 150 m above ground level are lit with visible lighting to assist their detection by aircraft. As such, there is potential that parts of the proposed Development may be visible at night. The effect of the proposed Development at night would result from visible lighting located on the nacelles, and on the turbine towers, of all proposed turbines. It should be noted that all turbines would also include infra-red lighting on the turbine hubs which would not be visible to the human eye. The focus of this technical appendix is on the visual assessment of the visible lighting requirements of the proposed Development.

2. A description of the proposed turbine lighting is found within **Chapter 3 Description of the Proposed Development** and **Chapter 15**, Section 15.8 Aviation and Defence, based on this, the following assumptions have been made with regards to lighting of the proposed Development for the LVIA. **Figures TA: 7.3-1** and **TA: 7.3-2** are found within this Technical Appendix, night time visualisation **Figures 7.3-3 to 7.3-7** can be found in Volume 3d.

7.1.1 Representative Night Time Viewpoints

3. A hub height ZTV of those turbines with tips heights at or exceeding 150 m was used to identify where there could be direct line of sight from the surrounding area to those turbines proposed to be lit (**Figure TA: 7.3-1a**). This ZTV does not take account of any intervening screening that may arise as a result of forestry or woodland cover. A further ZTV has also been produced showing the theoretical visibility of the tower lights (**Figure TA: 7.3-1b**). The night time visual assessment has been carried out from four viewpoint locations. Three of these were selected from the LVIA viewpoints and agreed with statutory consultees (viewpoints A-C) and the fourth (viewpoint D) was added on request by SAC. Night time photomontage visualisations (**Figures TA: 7.3-4 to TA: 7.3-7**) have been produced to inform this assessment. The four night time visual assessment viewpoints are:

- Viewpoint A: Wallace Terrace, Barrhill (LVIA VP 04);
- Viewpoint B: Minor road south of Pinwherry (LVIA VP 07);
- Viewpoint C: A714 road near Corwar House (LVIA VP 13); and
- Viewpoint D: Minor road between Colmonell and Lendalfoot.

7.1.2 Approach to Assessment of Lighting Effects

4. GLVIA 3 (page 103) provides the following guidance on the assessment of lighting effects: *'For some types of development the visual effects of lighting may be an issue. In these cases it may be important to carry out night-time 'darkness' surveys of the existing conditions in order to assess the potential effects of lighting and these effects need to be taken into account in generating the 3D model of the scheme. Quantitative assessment of illumination levels, and incorporation into models relevant to visual effects assessment, will require input from lighting engineers, but the visual effects assessment will also need to include qualitative assessments of the effects of the predicted light levels on night-time visibility.'*

5. In terms of how lighting is captured in visualisations, the main change in the latest version of the SNH guidance "Visual Representation of Wind Farms" (Version 2.2, February 2017) is in paragraphs 174-177, which states: *"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"… "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."*

6. The night time photography has therefore been captured in low light conditions, when other artificial lighting (such as street lights and lights on buildings) is on, to show how the windfarm lighting would look compared to the existing baseline at night. For the assessment of lighting effects, the visual sensitivity and magnitude criteria described in **TA: 7.1** (LVIA Methodology) has been applied.

7. Existing lights shown in the photographs (**Figures TA: 7.3-4 to TA: 7.3-7**) appear larger and more blurred than those seen to the naked eye in the field when the photographs were captured. The term used in photography to describe this effect is 'Bokeh' which has been defined as 'the way the lens renders out-of-focus points of light'. This has proved difficult to avoid when taking photographs of light at varied distances across a view. The blurred nature of the lights is also exacerbated by their movement, particularly on vehicle headlights. Where the lights of the proposed Development have been added to the night time views this effect has been emulated.

8. The turbine blades, when they intermittently pass in front of the aviation lights, would cause randomised flickering when the lights are switched 'on'. The turbines used in the night time visualisations have been positioned so that their blades face away from the viewpoint so that all the lights are visible and on within the visualisations, representing a worst-case impression. The flickering effect caused by the blades interacting with the lights would be most usually apparent from a south westerly direction due to the prevailing south westerly wind.

9. The lighting represented in the viewpoint visualisations has been calibrated using examples of existing, equivalent, turbine lighting observed in the field in other parts of Scotland, during similar periods of dusk / darkness as captured in the photography for the agreed viewpoints. Photographic examples of existing turbine lights are also therefore included in this TA as reference (**See Figure TA: 7.3-3**).

7.1.3 Civil Aviation Authority (CAA) Requirements

10. Elements of the proposed Development, at 150 m or greater in height, would require lighting under Article 222 of the Air Navigation Order (ANO, 2016). This requires medium intensity 'steady' red aviation lights (emitting 2,000 candela) to be fitted at nacelle level. In addition, the CAA requires low intensity lights to be fitted at the intermediate level on the turbine tower (CAA, 2017). The intermediate lights will be 32 candela. It is proposed that visibility sensors are installed on relevant turbines to measure prevailing atmospheric conditions and visibility range. Should atmospheric conditions (for example an absence of low cloud cover, rain, mist, haze or fog) mean that visibility around the Site is greater than 5 km from the proposed Development, CAA policy permits lights to operate in a lower intensity mode of 200 candela (being a minimum of 10% of their capable illumination). If visibility is restricted to 5 kms or less, the lights would operate at 2000 candela.

11. Consideration is also given to the potential to reduce or eliminate visible lighting at elevations less than -1 degree vertical angle from the horizontal plane at the top of the nacelles where the light is fitted. The International Civil Aviation Organization (ICAO) Annex 14 and European Union Aviation Safety Agency (EASA) specifications for 2000 candela steady red aviation obstruction lights set out the required minimum intensity of the light at different vertical angles of elevation, relative to the lighting horizontal plane, as follows:

- 0 degrees: 1500 candela; and
- -1 degrees: 750 candela.

12. In addition to the above ICAO/EASA provisions, the CAA Policy Statement (CAA, 2017) provides that the 2000 candela lights may be controlled by visibility sensors that reduce the intensity of the light to not less than 10% of the minimum peak intensity when the visibility is recorded as exceeding 5 km. This provision will mean that the intensity of the light at all elevation angles will be reduced to not less than 10% of its nominal value when clear visibility prevails. As a consequence, a light meeting the minimum required intensity of 750 candela at -1 degrees elevation will be reduced to 75 candela at that elevation angle when the visibility exceeds 5 km.

13. The CAA has no specified intensity requirements at elevation angles lower than -1 degrees from the light. It is open to obstacle light manufacturers and the owners/operators of obstacles taller than 150 m to determine the extent of any illumination projected downwards by the light at those lower elevations. The specific requirements for aviation lighting would be agreed with the relevant stakeholders post-consent and prior to construction.

14. On the basis of this guidance, it is evident that the effect of the visible lights of the proposed Development will be dependent on a range of factors, including the intensity of lights used, the clarity of atmospheric visibility and the degree of negative vertical angle of view from the light to the receptor. For this visual assessment, a worst case approach is applied which considers the effects of 2000cd lights and 200cd lights during periods of clear visibility. It should be noted however, that as the required medium intensity lights are only intended to be used during periods of poor visibility, that 2000cd lighting actually represents an unrealistic worst case position, as it is unlikely to ever be experienced at that maximum illumination level. Similarly, 200cd is unlikely to be experienced by observers at locations lower than the turbine nacelle heights due to the reduction in light intensity at negative elevation angles from the light.

15. The graph in plate **TA: 7.3.1** below illustrates the reduction in intensity that may be experienced at various vertical angles with the horizontal plane of the lights represented by 0 degree vertical angle. This graph is the performance graph for one particular model of light and whilst the precise model of light to be used is not known at this time, the graph clearly demonstrates the effect of negative elevation angle to light intensity.

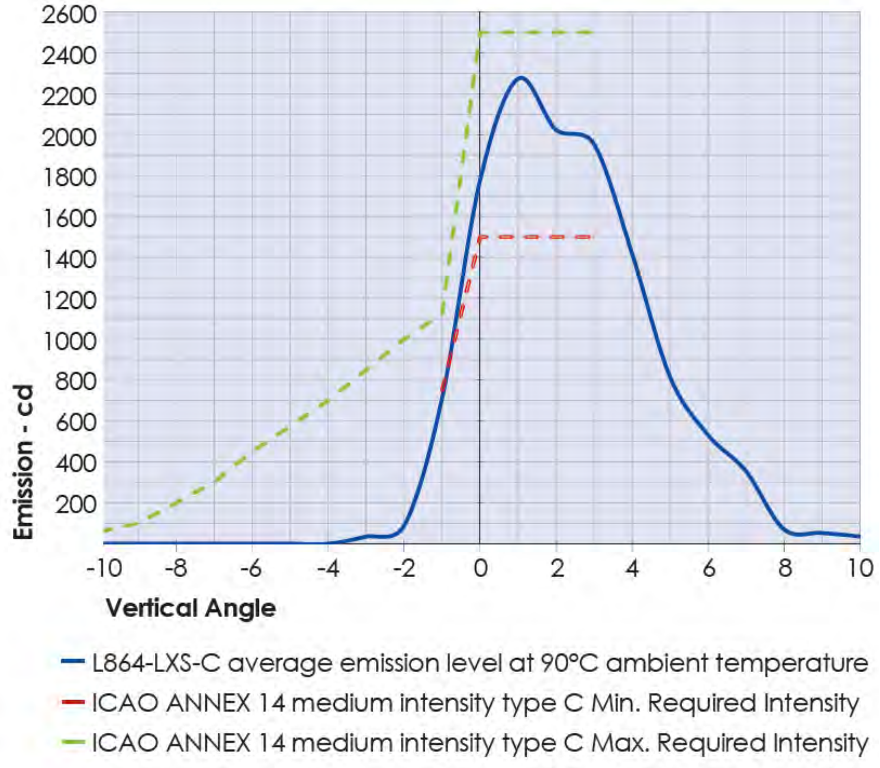


Plate 7.3.1: Lighting Intensity Graph [1]

16. With specific relation to the proposed Development **Figure TA: 7.3-2** - Lighting Intensity ZTV, illustrates where the vertical angles shown in this graph occur on the landform of the study area along with the corresponding intensity reductions for each of the 2000cd and 200cd situations. It is clear from **Figure TA: 7.3-2** that the full intensity of the lights would only theoretically be experienced from a small proportion of the study area when on similar or more elevated terrain.

17. Following the graph in **Plate TA: 7.3.1**, the intensity of light emissions reduces as the vertical elevation angle changes. At -10 negative elevation angle the reduction in intensity would result in a 2000 cd light being barely perceptible. Adopting the precautionary principle, the worst-case approach in this visual assessment assesses both 2000cd and 200cd intensity of light observed at each of the viewpoints considered. However, it should be noted that the actual light perceived at these locations is likely to be less than assessed or represented in the visualisations. These calculations also do not take account of the potential for some of the emitted light spilling onto the passing blades which would be visible at all negative angles, albeit as a less intense and diffuse reflected glow. The vertical elevation angles for the viewpoints and resultant perceived intensity of light are calculated in T**able TA 7.3.1** as follows:

Viewpoint	Distance to nearest turbine (m)	Vertical Angle from Horizontal plane of light location to viewpoint location	Approximate intensity for each viewpoint allowing for vertical angle	
			2000cd light	200cd light
Viewpoint A: Wallace Terrace, Barrhill (LVIA VP 04)	3946	**-3.65º**	40cd	4cd
Viewpoint B: Minor road south of Pinwherry (LVIA VP 07)	4655	**-3.19 º**	40cd	4cd
Viewpoint C: A714 road near Corwar House (LVIA VP 13)	6820	**-1.46 º**	300cd	30cd
Viewpoint D: Minor road between Colmonell and Lendalfoot	7199	**-1.47 º**	300cd	30cd

Table 7.3.1: Viewpoint Lighting Intensity Calculations

26. This table confirms that all 4 viewpoints are positioned below 0 degree vertical angle from the horizontal plane of the light fittings. **Figure TA: 7.3-2** illustrates where negative elevation angles (ranging from 0 to 3 degrees vertical angle above the horizontal plane and 0 to -10 degrees vertical angle below the horizontal plane) would occur within the predicted full extent ZTV for the proposed lit turbines of the proposed Development.

7.1.4 Lighting Mitigation

27. In addition to the control measures that may be applied to dim the lighting, as described above, it is proposed to explore the possibility of using 'smart' aviation lighting (aviation obstruction lighting detection system) whereby the lights would only be switched on when aircraft approach them (discussed further in **Chapter 15**, Section 15.8 Aviation and Defence).

28. The CAA is in the process of consulting on a new policy statement on En-Route Aviation Detection Systems for Wind Turbine Obstruction Lighting Operation. SPR has had an opportunity to review the CAA's proposal as part of an industry working group considering this guidance. It is expected that this guidance will be finalised and released during 2019.As this technology is not yet fully approved at the time of writing, the assessment has not considered this mitigation in its conclusions. The draft guidance would allow the aviation lights only to be illuminated when an aircraft is detected by a radar entering a volume bounded by 4 km (horizontal distance) from the perimeter group of turbines and 300m above the highest turbine tip of the Site. Our calculations estimate that the upper boundary of this volume would be around 2500 ft above ground level[2]. The aviation lighting would not be activated when commercial airlines pass over the Site as such aircraft ordinarily operate in Controlled Airspace (CAS), the base of which CAS over the Site being 5,000 ft and above. Given the lights are only required for general aviators flying at night in the vicinity of the Site at altitudes of up to 2500 ft, it is anticipated that the lights will be rarely on in this quiet airspace. The widest transit across proposed Development is circa 4 km (approx. north to south between turbine 4 and turbine 13), then the horizontal coverage volume would be 12km (4+4+4). At 250 knots the lights would be on for approximately 2 minutes, provided the radar can track the aircraft across the windfarm. If radar activated lighting is required, this would require a separate planning application, radar licencing and relevant CAA approvals. Optimally, any such radar deployment could benefit multiple windfarms in the South Ayrshire or Dumfries and Galloway regions.

29. If this technology could be installed, the level of exposure of visual receptors in the area to turbine lights would be greatly reduced, in line with the amount of time during which passing air traffic would activate the aviation lights. As this technology is not yet approved, the assessment has not considered this mitigation in its conclusions.

[1] LuxSolar Medium Intensity Obstruction Light CAP 168 MIOL-C: Data Sheet, January 2018.
[2] In terms of the maximum height of the coverage volume, this is calculated as follows (300m above the highest part of the turbine or group of turbines). The highest height above sea level within the proposed Development is turbine 2 (see Figure 3.1 of the EIA Report) located at 220m (rounded up to the nearest 10m contour). With 200 m turbines and 300 m above the highest part of the turbine, the maximum height of the radar coverage required would be 720 m or 2362 ft, rounded up to 2500 ft.

7.1.5 Parameters of Assessment

30. The following assumptions have been made with regards to visible lighting of the proposed Development for the LVIA:

- the CAA requires that all obstacles at or above 150 m above ground level are fitted with visible lighting and in the case of wind turbines these should be located on the nacelle;
- the CAA requires that a secondary light is fitted for use only when the primary light fails and would not be lit concurrently; and
- there is an additional requirement for lights to be provided at an intermediate level of half the nacelle height. These would need to be fitted around the towers to allow for 360-degree horizontal visibility.

31. In relation to the proposed Development the worst-case scenario for night time effects includes the following parameters:

- all turbines would have red, medium intensity visible lights mounted on the nacelle (125 m);
- 2000cd and 200cd intensity lights have been assessed representing 2 differing worst case situations. 2000cd represents the maximum intensity possible. 200cd represents the maximum intensity that would be used when visibility exceeds 5 km;
- all turbines would also have low-intensity lights (32 candela) to be provided on the turbine towers at an intermediate level of half the nacelle height (62.5 m); and
- the steady red lighting fixed to the top of the nacelles and to the turbine towers may appear to flicker on and off with the blade movement. This would occur when the turbine blades pass between the lights and the observers.

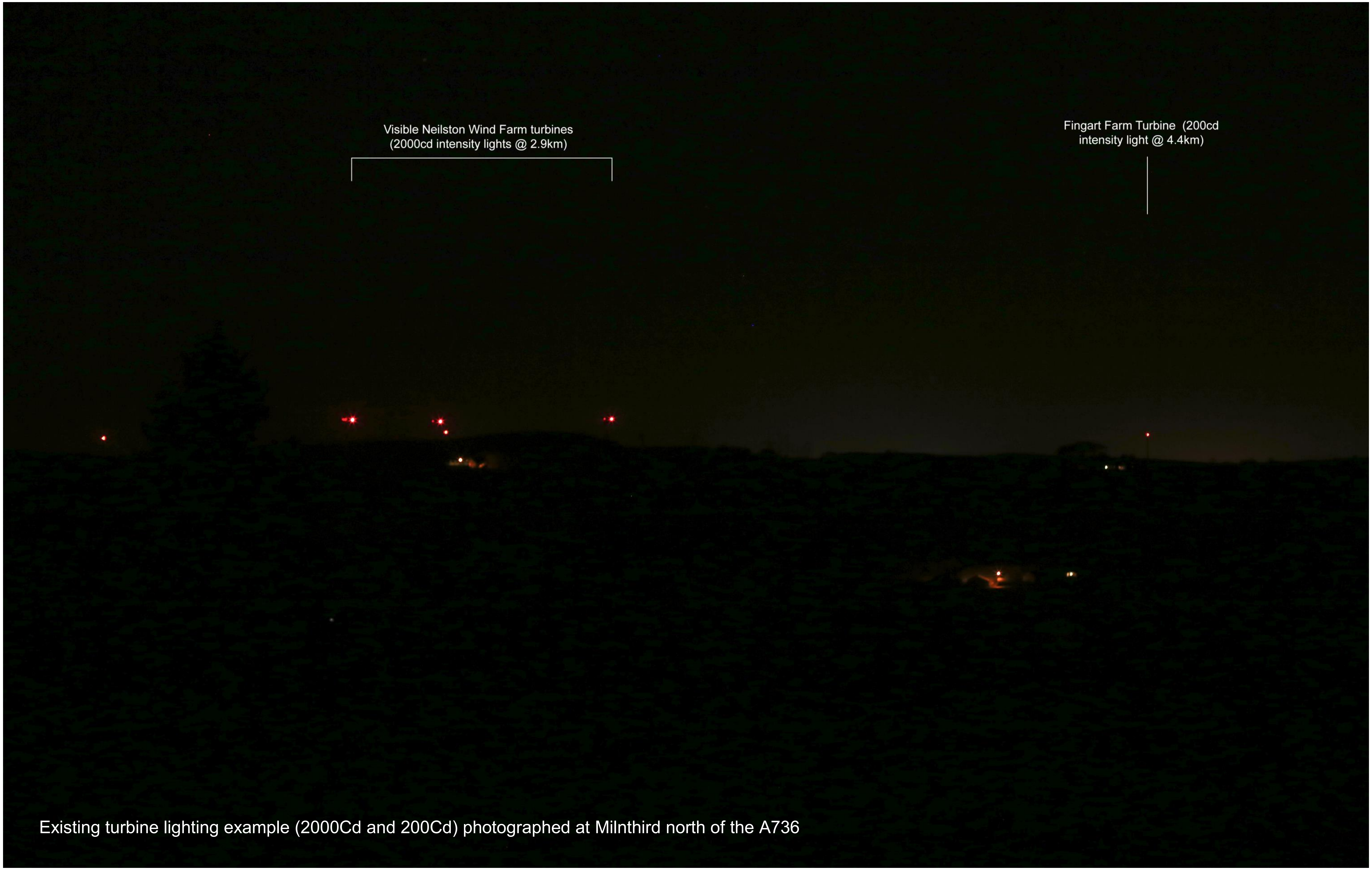
7.2 Summary of night time visual effects

32. At night the turbines would not in themselves be visible during times of darkness. Nevertheless, the assessment of night time effects for the proposed Development has predicted significant effects for some of the viewpoints where effects were assessed as not significant during the day. This is largely due to the appearance of lighting on an upland horizon which is currently far less affected by the effects of any other existing lighting.

- for receptors at Viewpoint A: Wallace Terrace, Barrhill (LVIA VP 04) the magnitude of change for a 2000cd light in clear visibility would be increased in comparison to effects experienced during the day resulting in a significant effect for residential receptors but not for road users. When considered for 200cd in clear visibility the effect is considered to be not significant for both receptors assessed;
- whilst the receptor sensitivity is reduced during periods of darkness for Viewpoint B: Minor road south of Pinwherry (LVIA VP 07) and Viewpoint C: A714 road near Corwar House (LVIA VP 13), the predicted magnitude of change for the effect of 2000cd lighting in clear visibility is at a level that would result in a significant night time effect. However, when these receptors are considered for 200cd in clear visibility the effect is considered to be not significant; and
- viewpoint D: Minor road between Colmonell and Lendalfoot is considered to experience a significant effect during periods of darkness as a result of the 2000Cd lighting. However, the predicted magnitude of change for the effect of 200cd lighting in clear visibility is not at a level that would result in a significant night time effect.

33. These effects are based on the worst-case approach adopted in this visual assessment which assesses both 2000cd and 200cd intensity of light observed at each of the viewpoints considered. However, it should be noted that the actual light perceived at these locations is likely to be less than assessed or represented in the visualisations due to a reduced intensity of light perceived depending on the vertical angle from horizontal plane of light location to viewpoint location.

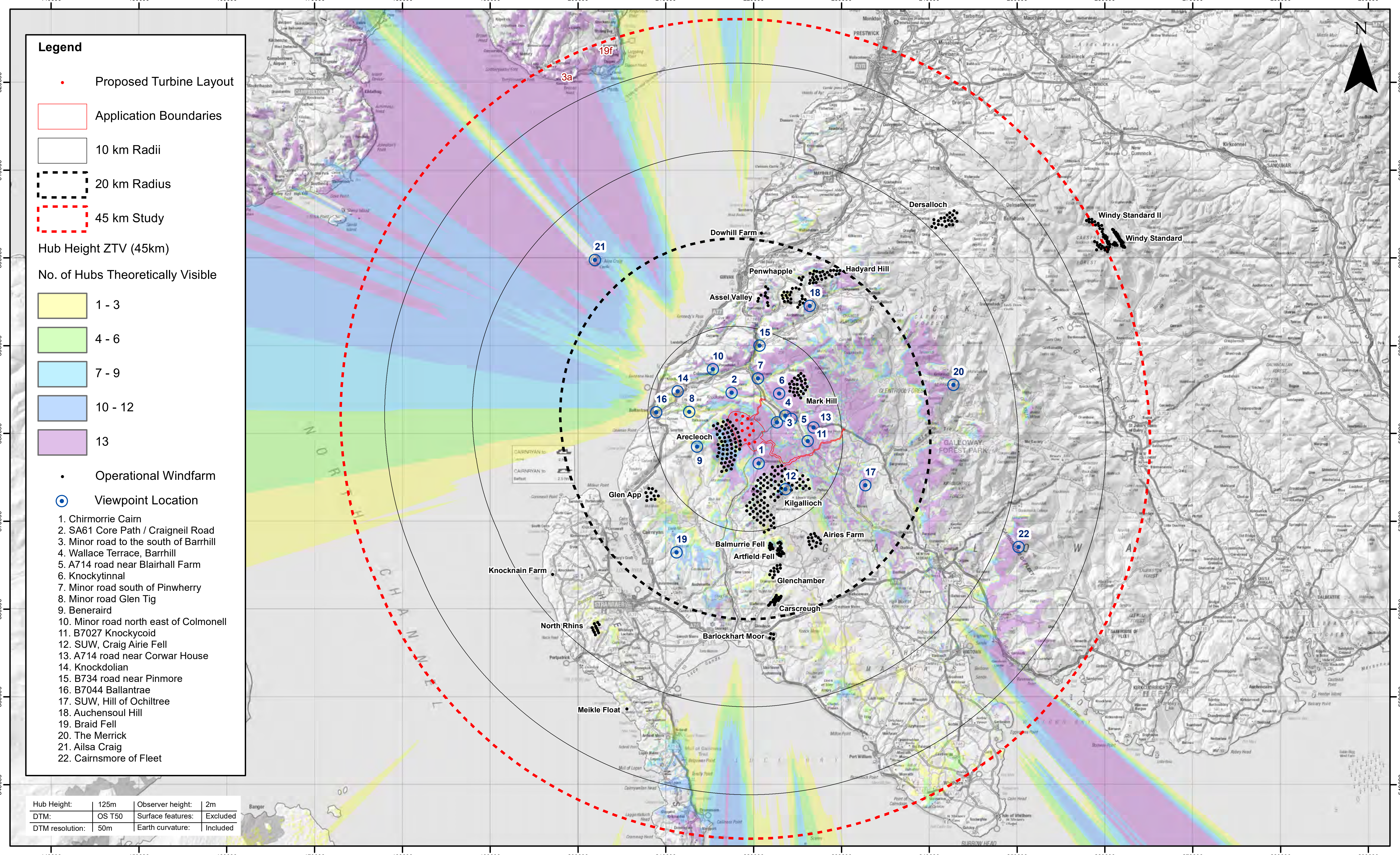
34. The duration of the effect of the lights on receptors is likely to be over a relatively short period, more commonly experienced during evening and morning hours of darkness, around dusk and sunrise. The visual effects of the proposed Development at night would also be limited by the activity of receptors at night. Receptors that experience views at night are generally limited to residents of settlements, rural properties and motorists using the road network. Views from within properties are likely to be restricted by the use of window coverings, particularly in winter. Views from remote rural / coastal locations, beaches, mountains and footpaths etc. are visited infrequently at night therefore numbers of receptors affected will be low. The assessment of night time effects is also based on clear night time viewing conditions. At dusk and sunrise it may be possible to identify the formation of the turbines with the red CAA lighting, but only in conditions of good and excellent visibility. At sunrise it may also be possible, in views from the west, to see the turbines lit and backlit by the rising sun.


Visible Neilston Wind Farm turbines
(2000cd intensity lights @ 2.9km)
Fingart Farm Turbine (200cd
intensity light @ 4.4km)
Existing turbine lighting example (2000Cd and 200Cd) photographed at Milnthird north of the A736

7.3 Detailed Night Time Visual Effects

Receptor	Night Time Effects		
	Night Time Baseline Condition and Sensitivity	Night Time Effect (2000cd lights)	Night Time Effect (200cd lights)
Night Time Viewpoint A: Wallace Terrace, Barrhill (LVIA VP 04) Nearest Visible Turbine Light: 3946m	This viewpoint is not located within any national landscape designations it is however within the Duisk valley part of the Ayrshire Scenic Area, which is locally valued. The viewpoint represents the view experienced by residents of properties in south Barrhill and road users on a section of the A714 with oblique views to the west when travelling northbound. The view from this viewpoint at night includes the residential lighting in the nearby properties and street lighting both on the A714 and on Wallace Terrace. On the road itself, the lights of passing cars are relatively frequent particularly away from summer months when dusk is in the evening or late afternoon and traffic is busier on this road as people return home from work. There is a strong visual contrast in the view west between the dark of the landscape in the foreground and the western sky at dusk which often appears much lighter as a result of the setting sun. This effect varies in intensity depending on the level of cloud cover to the west. The value and susceptibility differs from the assessment carried out for day time conditions and receptors. At night it is anticipated that value and susceptibility levels attributed to such views at night are lower as the landscape is a less valued part of the night time context and people tend to look out over it less than they do during the day. Given the view north west from Barhill is direct facing from nearby residential properties, this reduction in sensitivity is less marked from this location. Taking this into account the sensitivity to change is considered to be Medium – Low for road users although is still considered to be High for residential receptors in the southern part of Barrhill close to the viewpoint location.	Only 4 hubs of the proposed Development are theoretically visible. In reality 2 are screened by intervening forestry and trees on the horizon, therefore only 2 lights would be visible from this location. The remaining 2 visible hub lights would site close to the horizon and the intervening forest edge. No tower lights would be visible from this location. The proposed turbine lights would appear in the backdrop to the settlement lights (street lighting, residential lights and passing cars). During the hours of darkness the horizon would not be visible and the lights would appear without context within the backdrop to Barrhill. The location of the viewpoint relative to the prevailing south westerly wind would mean that the lights on the hubs would at most times be seen in front of the rotors and would not be intermittently obscured by intervening blades. On this basis they would not appear to flicker as the turbine blades pass the hub and tower lights. The appearance of 2 lights of the proposed Development in the backdrop to the Barrhill settlement would create a slightly more intense effect on the setting of the settlement than the proposed Development would have in daylight hours. Given the relatively close proximity of the lights in this view, the magnitude of change is assessed as Medium resulting in a Significant effect for residential receptors and a Not Significant effects for road users. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 2000cd lights would be perceived as 40cd lights (See **Table 7.3.1**).	The description of lights visible for 2000cd also applies to 200cd lights. The effect differs, however, due to a reduction in intensity. It is considered that the 200cd lights whilst noticeable would form a less intense addition to the baseline view resulting in a magnitude of change of Low. The effect for both residential receptors and road users is considered to be Not Significant. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 200cd lights would be perceived as 4cd lights (See **Table 7.3.1**).
Night Time Viewpoint B: Minor road south of Pinwherry (LVIA VP 07) Nearest Visible Turbine Light: 4655m	This viewpoint is not located within any national landscape designations it is however within the Duisk valley part of the Ayrshire Scenic Area, which is locally valued. This viewpoint is located on a section of the minor road which is elevated. The national speed limit applies although this is a minor road and the road is winding with likely road speeds likely to be between 40-50 mph. The overall impression of the night time view to the south is of a dark landscape punctuated by the lights of farmsteads within the intervening valley landscape with the lights of the property at Ballaird sitting the horizon. Occasional lights of passing cars on the A714 and connecting minor roads can also be seen, particularly when turning to face the viewpoint on roads that align with the viewpoint. The contrast between land and sky on the south west skyline can be seen beyond dusk as the setting sun maintains a low glow against the skyline to the west for a sustained period. The effect of this is more prolonged in summer months. The value and susceptibility differs from the assessment carried out for day time conditions and receptors. At night it is anticipated that value and susceptibility levels attributed to such views at night are lower as the landscape is a less valued part of the night time context and people tend to look out over it less than they do during the day. Taking this into account the sensitivity to change is considered to be Medium.	Only 2 hubs of the proposed Development are visible above the horizon to the west as a result only 2 lights would be visible and no tower lights would be visible from this location. The proposed turbine lights would appear in the backdrop to the occasional lights of scattered properties and within close context to the Ballaird property lights which sits on the horizon and is close to one of the proposed lights. During the hours of darkness the horizon would not be visible. The location of the viewpoint relative to the prevailing south westerly wind would mean that the lights on the hubs would at most times be seen in front of the rotors and would not be intermittently obscured by intervening blades. On this basis they would not appear to flicker as the turbine blades pass the hub and tower lights. The proposed Development lights would be seen as an increase of lights to a part of the horizon where scattered properties and minor roads result in a visible albeit infrequent level of lighting seen from this view. The proposed lights would also appear close to the Ballaird property on the horizon which would appear to impinge upon on it from this specific viewpoint. Taking all of this into account, the magnitude of change is assessed as Medium resulting in a Not Significant effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 2000cd lights would be perceived as 300cd lights (See **Table 7.3.1**).	The description of lights visible for 2000cd also applies to 200cd lights. The effect differs, however, due to a reduction in intensity. It is considered that the 200cd lights whilst noticeable would form a less intense addition to the baseline view. The magnitude of change is considered to be Low resulting in a Not Significant effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 200cd lights would be perceived as 4cd lights (See **Table 7.3.1**).
Night Time Viewpoint C: A714 road near Corwar House (LVIA VP 13)	This viewpoint is not located within any national landscape designations it is however overlooking the Duisk valley part of the Ayrshire Scenic Area, which is locally valued. This viewpoint is located on the A714, near the access gate to Corwar House. The national speed limit applies although this section of the road is winding and road speeds are likely to be between 40-50 mph. As the road winds, some sections are directly facing the proposed Development in views across the Duisk valley increasing road users susceptibility. Views to the west and north west during the day are across a landscape mosaic of moorland, forestry, rough grazing and windfarms. At night however these landscape	All of the 13 proposed Development nacelle and tower lights would be visible from this location. The proposed Development lights would be seen as an introduction of lights to a part of the upland horizon where none are currently seen and where there is existing lighting at farmsteads, they are difficult to discern. The prevailing south westerly wind would mean that the lights on the hubs would mostly be intermittently obscured by intervening blades so that they would appear to flicker as the turbine blades pass the hub and tower lights.	The description of lights visible for 2000cd also applies to 200cd lights. The effect differs, however, due to a reduction in intensity. It is considered that the 200cd lights whilst noticeable on the horizon to the south would form a less

Receptor	**Night Time Effects**		
	Night Time Baseline Condition and Sensitivity	**Night Time Effect (2000cd lights)**	**Night Time Effect (200cd lights)**
Nearest Visible Turbine Light: 6820m	elements and landscape pattern are difficult to discern and the overall impression of the night time view at this location is of a very dark upland landscape. The contrast between land and sky on the west skyline can be seen beyond dusk as the setting sun maintains a low glow against the skyline to the west for a sustained period. The effect of this is more prolonged in summer months. The only lighting in the view west is of window lights within a few farmsteads or the very occasional passing motorist on the minor roads that cross the plateau landscape or the Duisk valley, including sections of the B7027. The value and susceptibility differs from the assessment carried out for day time conditions and receptors. At night it is anticipated that value and susceptibility levels attributed to such views at night are lower as the landscape is a less valued part of the night time context and people tend to look out over it less than they do during the day. Taking this into account the sensitivity to change is considered to be Medium-Low.	The distance from the proposed Development would reduce the intensity of the turbine lighting although it is considered these lights would form a substantial addition to the existing baseline view from the road. Whilst the view of the landscape would not form a key part of the experience of road users at night, the road direction when northbound is aligned with the direction of the proposed Development, intensifying the effect as a consequence of the direct facing and elevated nature of the view. Taking all of this into account, the magnitude of change is assessed as Medium – High resulting in a **Significant** effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 2000cd lights would be perceived as 300cd lights (See **Table 7.3.1**).	intense addition to the baseline view. The magnitude of change is considered to be Medium resulting in a Not Significant effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 200cd lights would be perceived as 30cd lights (See **Table 7.3.1**).
Night Time Viewpoint D: Minor road between Colmonell and Lendalfoot Nearest Visible Turbine Light: 7199m	This viewpoint is not located within any national landscape designations. It is within the Ayrshire Scenic Area, which covers a large percentage South Ayrshire, particularly in the south of the region where this viewpoint is located. This viewpoint is located on the minor road between Colmonell and Lendalfoot on a section which has elevated views towards the proposed Development Site. The national speed limit applies although this minor road is narrow and winding with passing places and road speeds are likely to be between 30-40 mph as a result. The section of road on which the viewpoint is located is aligned to the south east and southbound road users have direct facing views towards the proposed Development Site as a result. Views to the south east during the day are across an upland moorland landscape. The immediate foreground drops in elevation towards the northern top slope of the Stinchar valley and whilst the upper slopes of the Stinchar valley are visible the valley landscape of the Stinchar and its differing characteristics are not apparent in this view. A ridgeline of plateau edge hills forms the backdrop to the view south. The distant horizon created by these edge hills are part forest covered and the existing Arecleoch windfarm is skylined above this horizon with some turbines appearing above the part visible Arecleoch Forest treeline. At night however these landscape elements and landscape pattern are difficult to discern and the overall impression of the night time view at this location is of a very dark upland landscape. Other than the occasional other road user there are no other lights in this view. At night it is anticipated that value and susceptibility levels are lower as the landscape is a less valued part of the night time context and people tend to look out over it less than they do during the day. Taking this into account the sensitivity to change is considered to be Medium-Low.	All of the 13 proposed Development nacelle and tower lights would be visible from this location. There are no existing lights on the skyline in any direction and the proposed Development lights would be seen as an introduction of lights to a part of the upland horizon where none are currently seen. The prevailing south westerly wind would mean proposed turbines would face approximately perpendicular to the viewpoint for the majority of the time. Light from the hubs and towers would not therefore directly intervene in the view of the lights for the most part although a westerly wind could turn the turbines enough for this to occur on occasion. When this situation does arise the lights would appear to flicker as the turbine blades pass the hub and tower lights. Whilst the intensity of the turbine lighting experienced at this location would appear reduced because of distance, it is considered that these lights would form a noticeable addition to the existing baseline, which is at present almost entirely without lights other than a very occasional passing car. Taking this into account, the magnitude of change is assessed as Medium - High resulting in a **Significant** effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 2000cd lights would be perceived as 300cd lights (See **Table 7.3.1**).	The description of lights visible for 2000cd also applies to 200cd lights. The effect differs, however, due to a reduction in intensity. It is considered that the 200cd lights whilst noticeable on the horizon to the south would form a less intense addition to the baseline view. The magnitude of change is considered to be Medium resulting in a Not Significant effect. Allowing for changes in light intensity due to vertical elevation angle from turbine lights the 200cd lights would be perceived as 30cd lights (See **Table 7.3.1**).



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Rev	Date	By	Comment
2	12/06/19	TH	Second Issue.
1	28/05/19	TH	First Issue.

1:400,000
Scale @ A3

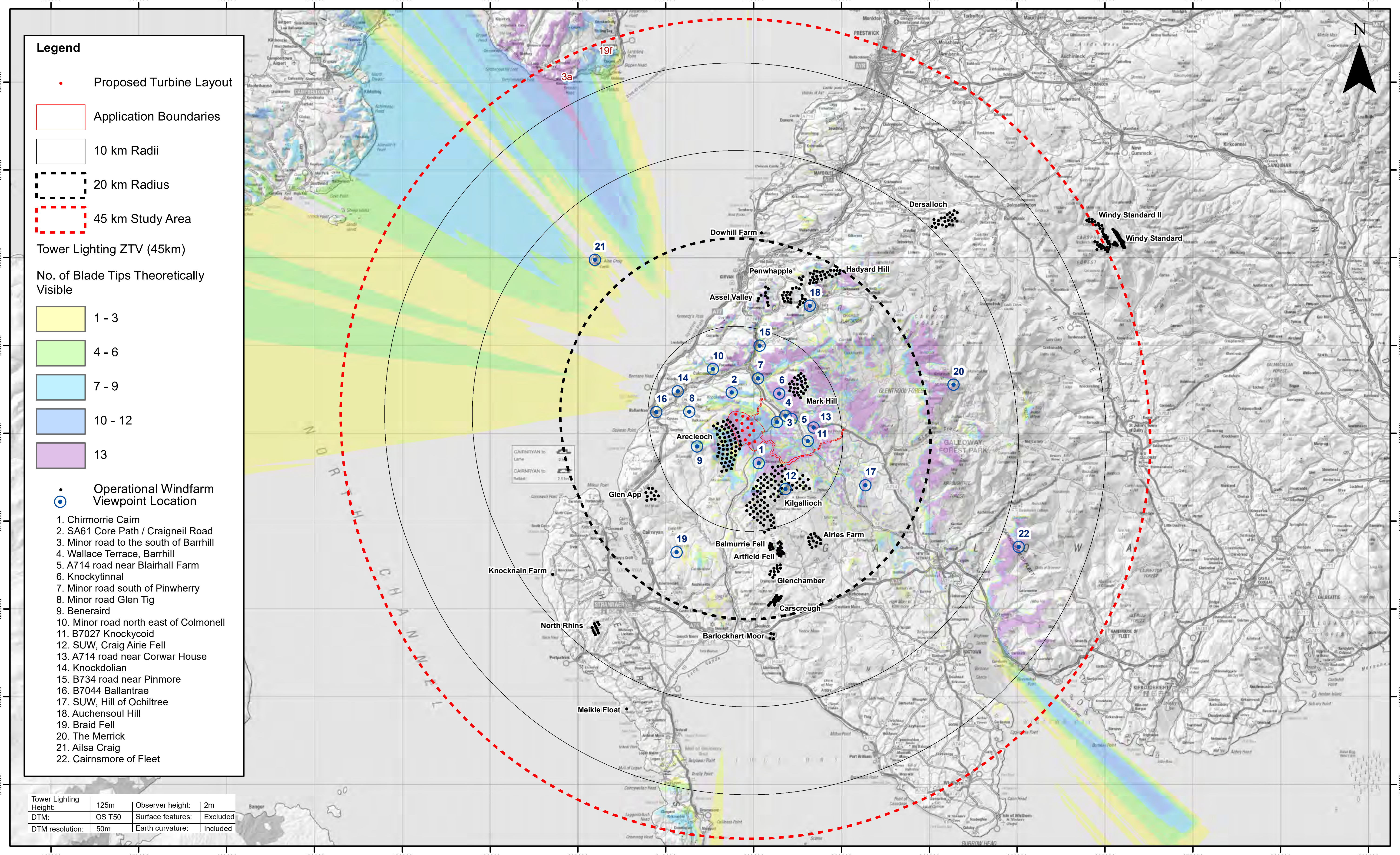
0 10 20 Km

Arecleoch Windfarm Extension – EIAR

Technical Appendix 7.3 - Figure 1a

ZTV of Hub Turbine Lighting (45 km)

Drg No	191303-TA7.3-1a	
Rev	B	Datum: OSGB36
Date	12/06/19	Projection:
Figure	TA7.3-1a	TM



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
1	12/06/19	TH	First Issue.

1:400,000
Scale @ A3

0 10 20 Km

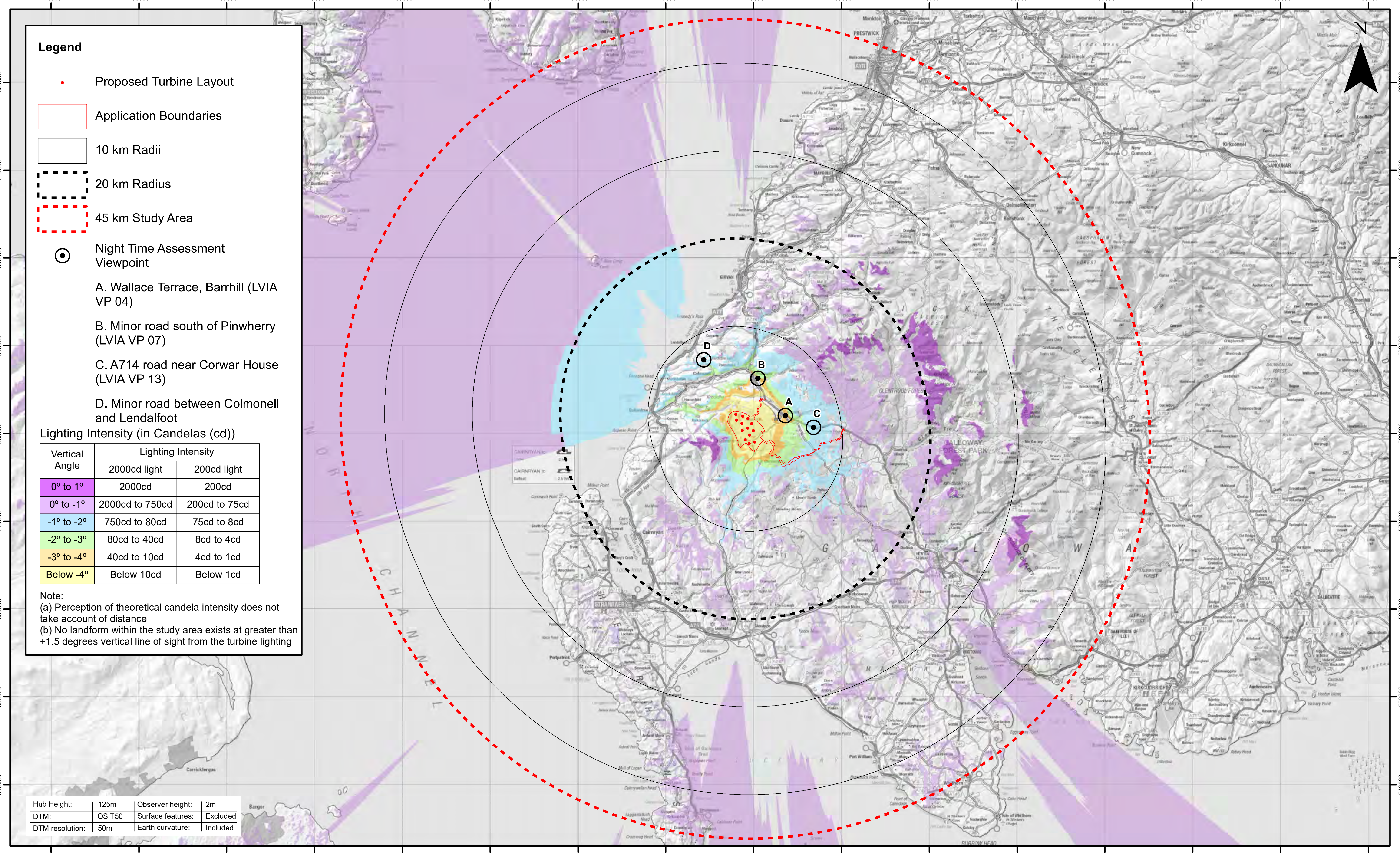
Arecleoch Windfarm Extension – EIAR

Technical Appendix 7.3 - Figure 1b

ZTV of Tower Turbine Lighting (45 km)

Drg No	191303-TA7.3-1b
Rev	A
Date	12/06/19
Figure	TA7.3-1b

Datum: OSGB36
Projection: TM



Vertical Angle	Lighting Intensity	
	2000cd light	200cd light
0º to 1º	2000cd	200cd
0º to -1º	2000cd to 750cd	200cd to 75cd
-1º to -2º	750cd to 80cd	75cd to 8cd
-2º to -3º	80cd to 40cd	8cd to 4cd
-3º to -4º	40cd to 10cd	4cd to 1cd
Below -4º	Below 10cd	Below 1cd

Note:
(a) Perception of theoretical candela intensity does not take account of distance
(b) No landform within the study area exists at greater than +1.5 degrees vertical line of sight from the turbine lighting

Hub Height:	125m	Observer height:	2m
DTM:	OS T50	Surface features:	Excluded
DTM resolution:	50m	Earth curvature:	Included

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
2	12/06/19	TH	Second Issue.
1	28/05/19	TH	First Issue.

1:400,000
Scale @ A3
0 10 20 Km

Arecleoch Windfarm Extension – EIAR
Technical Appendix 7.3 - Figure 2
Lighting Intensity ZTV (45 km)

Drg No	191303-TA7.3-2	
Rev	B	Datum: OSGB36
Date	12/06/19	Projection: TM
Figure	TA7.3-2	