

Plumbworkz, Tir Llywd Enterprise Park, Conwy
[Lighting Assessment](#)

[Prepared for:](#) AXIS P.E.D. Ltd
[Date:](#) October 2019

EXECUTIVE SUMMARY

Outline Scope

Strenger Ltd were appointed by AXIS P.E.D. Ltd to undertake an exterior lighting assessment for an exterior lighting installation associated with 2No. proposed commercial / light industrial units at Tir Llywd Enterprise Park, Conwy (hereon in, 'the Proposed Development'). The assessment is required in order to quantify the impact of artificial light associated with the Proposed Development on its surroundings.

Assessment

In order to assess the potential impacts associated with the lighting installation, the following has been undertaken:

- review of pertinent legislation, policy and guidance;
- review of the site and surrounding area using aerial photography and OS mapping;
- production of a scheme of lighting (assessed Scheme of Lighting) suitable for environmental assessment;
- detailed 3D computational modelling of the Assessed Scheme of Lighting;
- calculation of 'light trespass' (vertical illuminance) at residential receptors;
- calculation of 'glare' (viewed source intensity) at residential receptors;
- calculation of 'sky-glow' (upward light ratio) to the wider surrounding area;
- comparison of the obtrusive light levels with national guideline values;
- production of light spill contours for the Assessed Scheme of Lighting;
- calculation of glare at highway receptors; and
- comparison of the predicted glare levels at highway receptors with national guideline values.

Conclusions

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the residential receptor criteria as set out in the Institution of Lighting Professionals (ILP) (2011) Guidance Notes for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the obtrusive light criteria as set out for ILP Environmental Zone E2. For which, the post-curfew criteria are as follows:

- 'Light trespass' limit of 1 Lux (E_v - vertical illuminance)
- 'Glare limit' of 500 cd (I – viewed source intensity)
- 'Sky-glow' limit of 2.5 % (Upward Light Ratio)

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the highway user criteria as set out in the Institution of Lighting Professionals (ILP) (2011) Guidance Notes for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the obtrusive light criteria as set out for an ME6 / ME5 road. For which, the criteria are as follows:

- Threshold Increment of 15 % based on adaptation luminance of 1 cd/m² (TI)
- Veiling Luminance of 0.25 cd/m² (L_v)

Compliance has been achieved with the adoption of an environmentally sympathetic scheme of lighting having the following mitigation measures:

- the use of luminaires with minimal to zero direct contribution to upward light;
- minimising luminaire uplift angles;
- careful aiming and positioning of luminaires;
- careful selection of luminaires;
- the use of optimal optics for their specific location and orientation;
- optimisation of mounting heights;
- the adoption of the lowest intensity LED modules practicable; and
- minimising the task illuminance level.

1. LEGISLATION, POLICY, GUIDANCE & STANDARDS

Legislation

Clean Neighbourhoods and Environment Act (CNEA), 2005

- 1.1 Light pollution was introduced within the Clean Neighbourhoods and Environment Act (2005) as a form of statutory nuisance under the Environmental Protection Act (the 'EPA', 1990) which was amended in 2006 to include the following nuisance definition:

"(fb) artificial light emitted from premises so as to be prejudicial to health or nuisance;"

Guidance produced in Sections 101 to 103 of the *CNEA 2005* by the Department of Environment, Food and Rural Affairs (DEFRA) in April 2006 extends the duty on local authorities to ensure their areas are checked periodically for existing and potential sources of statutory nuisances including nuisances arising from artificial lighting. Local authorities must take reasonable steps to investigate complaints of such nuisances from artificial light. Once satisfied that a statutory nuisance exists or may occur or recur, local authorities must issue an abatement notice (in accordance with section 80(2) of the *Environmental Protection Act 1990*), requiring that the nuisance cease or be abated within a set timescale.

Although light was described as having the potential to cause statutory nuisance in the CNEA, no prescriptive limits or rules were set for impact assessment purposes. The Guidance Notes for the Reduction of Obtrusive Light produced by the Institute of Lighting Professionals (ILP) has, therefore, been referred to for the purposes of this assessment.

Guidance produced by Defra, *Statutory Nuisance from Insects & Artificial Light (2006)* on s101 to s103 of the CNEA (2005) has also been referred to which places a duty on local authorities to ensure that their areas are checked periodically for existing and potential sources of statutory nuisances - including nuisances arising from artificial lighting. Local authorities must take reasonable steps to investigate complaints of such nuisances from artificial light. Once satisfied that a statutory nuisance exists or may occur or recur, local authorities must issue an abatement notice (in accordance with s80(2) of the EPA 1990), requiring that the nuisance cease or be abated within a set timescale.

National Planning Policy

National Planning Policy Framework (NPPF), 2019

- 1.2 The National Planning Policy Framework (NPPF) states that the purpose of the planning system is to contribute to the achievement of sustainable development and constitute the Government's view on what sustainable development in England means in practice for the planning system. A principal concept contained within the NPPF is the presumption in favour of sustainable development and with regard to artificial lighting, the NPPF states:

'...limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.' (paragraph 180 (c))

The NPPF is currently supplemented by Planning Practice Guidance with regard to light pollution. In light of this new guidance, this assessment has considered the following implications of the proposed lighting design:

- *'does a new development proposal, or a major change to an existing one, materially alter light levels outside the development and/or have the potential to adversely affect the use or enjoyment of nearby buildings or open spaces?*
- *does an existing lighting installation make the proposed location for a development unsuitable? For example, this might be because:*
 - *the artificial light has a significant effect on the locality; or*
 - *users of the proposed development (e.g. a hospital) may be particularly sensitive to light intrusion from the existing light source.*
- *does a proposal have a significant impact on a protected Site or species e.g. located on, or adjacent to, a designated European Site or where there are designated European protected species that may be affected?*
- *is the development in a protected area of dark sky or an intrinsically dark landscape where it may be desirable to minimise new light sources?*
- *are forms of artificial light with a potentially high impact on wildlife (e.g. white or ultraviolet light) being proposed close to sensitive wildlife receptors or areas, including where the light shines on water?*

- *does the proposed development include smooth, reflective building materials, including large horizontal expanses of glass, particularly near water bodies (because it may change natural light, creating polarised light pollution that can affect wildlife behavior).*

If the answer to any of the above questions is 'yes', consideration should be made for:

- *where the light shines;*
- *when the light shines;*
- *how much light shines; and*
- *possible ecological impact.'*

International Guidance

Comission Internationale De L'Eclairage 150: Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2003

- 1.3 The purpose of Comission Internationale De L'Eclairage 150: Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2003 (CIE 150) is to aid in formulating guidelines for assessing the environmental effects of exterior lighting and to provide limits for relevant lighting parameters to control the obtrusive effects of exterior lighting to tolerable levels. CIE 150 refers to the potentially adverse effects of exterior lighting on both natural and man-made environments.

Comission Internationale De L'Eclairage 126: Guidelines for Minimising Sky Glow, 1997

The Comission Internationale De L'Eclairage 126: Guidelines for Minimising Sky Glow, 1997 (CIE 126) gives general guidance for lighting designers and policy makers on the reduction of sky glow. The report gives recommendations about maximum permissible values for exterior lighting installations. These values are regarded as limiting values. Lighting designers should strive to meet the lowest criteria for the design. Practical implementation of the general guidance is left to national regulations.

National Guidance

Institution of Lighting Professionals (ILP) Guidance Notes for the Reduction of Obtrusive Light GN01, 2011

- 1.4 The ILP has proposed obtrusive lighting guidance and criteria for local authorities with a recommendation that these are incorporated at the local plan level. The ILP Guidance Notes define various forms of light pollution and describe a series of environmental zones. The ILP Guidance Notes provide suitable criteria against which the effects of artificial lighting can be assessed.

Institution of Lighting Professionals (ILP) PLG 04 - Guidance on Undertaking Environmental Lighting Impact Assessments, 2013

- 1.5 The aim of the Guidance on Undertaking Environmental Lighting Impact Assessments (ILP PLG04:2013) is to outline good practice in lighting design and provide practical guidance on production and assessment of lighting impacts within new developments.

The document was produced following the publication of the NPPF in April 2012 and the importance of lighting design being part of a planning application, this document aims to:

- provide an explanation of, and guidance on, the process for producing a lighting assessment;
- prompt the lighting designer on important aspects of specific projects which should be used to remove or minimise potential environmental problems; and
- look at the overall processes and evaluation procedures regarding lighting which are considered to be relevant.

HSG38

- 1.6 The Health and Safety Executive published HSG38: Lighting at Work aimed at those who are responsible for health and safety at work. The guidance explains how lighting contributes to the health and safety of people at work. It deals with assessing and managing the health and safety risks attributable to lighting in the workplace, good practice and the minimum recommended illumination levels that meet health and safety requirements. As the lighting level criteria as set out in HSG38 is relatively limited in comparison to that as set out in BS EN 12464-2, no further consideration is given to HSG38 within this report.

British & European Standards**BS EN 12464-2:2014 Light and lighting – Lighting of work places Part 2: Outdoor work places**

- 1.7 This standard specifies requirements for lighting of tasks in most outdoor work places and their associated areas in terms of quantity and quality of illumination. In addition, recommendations are given for good lighting practice.

2. CRITERIA

Residential - ILP Guidance Notes

- 2.1 In the absence of statutory guidance, the ILP Guidance Notes have been used as criteria against which to assess the effects of artificial lighting on residential receptors; this is considered best practice.

ILP Environmental Zone Classification

The ILP has developed an Environmental Zone classification system for the categorisation of areas with regard to suitable obtrusive lighting limits. The Environmental Zone classifications are reproduced in (Table 2.1).

Environmental Zone	Surrounding	Lighting Environment	Examples
E0	Dark	Dark	UNESCO Starlight Reserves
E1	Natural	Intrinsically Dark	National Parks, Areas of Outstanding Natural Beauty
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Small town centres or suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

ILP Environmental Zone Criteria

- 2.2 For each Environmental Zone, obtrusive light limits for exterior lighting installations have been determined. These are summarised in (Table. 2.2) and are intended to support decision makers in establishing whether artificial lighting is detrimental to local amenity or a potential statutory nuisance.

Environmental Zone	Max Sky Glow ^(a) (%)	Light Trespass (into windows) E_v (lux) ^(b)		Source Intensity I (kilo candelas – kcd) ^(c)	
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew
E0	0	0	0	0	0
E1	0	2	1 ^(d)	2.5	0
E2	2.5	5	1	7.5	0.5
E3	5.0	10	2	10	1.0
E4	15.0	25	5	25	2.5

(a) Upward light ratio (ULR) of the installation – maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.

(b) Vertical illuminance measured flat at the glazing at the centre of the window.

(c) Luminance.

(d) From public road lighting installations only.

There are no set time periods for lighting curfews; however 23:00 is often adopted

Determination of ILP Environmental Zone

- 2.3 The Proposed Development site and its immediate surroundings are considered to be within a ‘medium’ brightness district. However, as the wider surroundings to the south and east of the Proposed Development site are of ‘medium’ to potentially ‘low’ district brightness depending on the considered lighting metric, ILP Environmental Zone E2 has been adopted as the most appropriate classification for the purposes of this obtrusive light assessment. This approach is qualified by the ‘sky brightness’ mapping as set out in Appendix A of this report.

ILP Environmental Zone E2 Criteria

- 2.4 Based on ILP Environmental Zone E2, the ILP obtrusive light limits for the Proposed Development are as follows:

- Pre-curfew ‘light trespass’ limit of 5 Lux (E_v - vertical illuminance)
- Post-curfew ‘light trespass’ limit of 1 Lux (E_v - vertical illuminance)
- Pre-curfew ‘glare’ limit of 7,500 cd (I – viewed source intensity)
- Post-curfew ‘glare’ limit of 500 cd (I – viewed source intensity)
- ‘Sky-glow’ limit of 2.5 % (Upward Light Ratio)

Adopted Residential Criteria

- 2.5 In order to represent a reasonable worst-case scenario, only the post-curfew ILP criteria have been adopted for the purposes of this assessment. The obtrusive light level limits are therefore as follows:

- ‘Light trespass’ limit of 1 Lux (E_v - vertical illuminance)
- ‘Glare’ limit of 500 cd (I – viewed source intensity)
- ‘Sky-glow’ limit of 2.5 % (Upward Light Ratio)

Highway

- 2.6 The ILP Guidance Notes for the Reduction of Obtrusive Light have been used as criteria against which to assess the effects of artificial lighting associated with the Proposed Development on highways receptors; this is considered best practice.

Road Classification	Threshold Increment (TI)	Veiling Luminance (L_v)
No road lighting	15 % based on adaptation luminance of 0.1 cd/m ²	0.04
ME6 / ME5	15 % based on adaptation luminance of 1 cd/m ²	0.25
ME4 / ME3	15 % based on adaptation luminance of 2 cd/m ²	0.40
ME2 / ME1	15 % based on adaptation luminance of 5 cd/m ²	0.84

Determination of Road Classification

- 2.7 As the assessed highway is purposefully lit and the lighting design levels are unknown, although not a 'high speed' road, the lowest ME Road Classification as set out in (Table 2.3) above has been adopted for the purposes of this assessment i.e. ME6 / ME5. Class ME6 is broadly equivalent to Class S4 or P4, which would seem a reasonable minimum lighting level for such a situation.

Adopted ILP Obtrusive Light Limitation Criteria – Highway users

- 2.8 Based on a road lighting classification of 'ME6 / ME5', the ILP obtrusive light limits for the Proposed Development affecting highway users are as follows:

- Threshold Increment of 15 % based on adaptation luminance of 1 cd/m² (TI)
- Veiling Luminance of 0.25 cd/m² (L_v)

3. RECEPTORS

Residential

- 3.1 Within the context of this assessment, residential receptors are taken as those with the potential to be affected by obtrusive light associated with the Proposed Development. Key existing residential receptors which have the potential to be impacted by obtrusive light from the Proposed Development have been identified and adopted as receptor locations within the assessment. Residential receptors are positioned at local ground level +2.0 m (i.e. ground floor level windows). At such a height, the angle subtended with the light sources will be less than that if assessed at first floor level windows. The assessed receptor height therefore represents a reasonable worst-case scenario, as the level of 'glare' (viewed source intensity) will be at its maximum. The assessed residential receptors are set out in Strenger drawing ref: SK-01 Residential Receptor Location Plan.

Highway

- 3.2 Within the context of this assessment, highway receptors are taken as those that have been identified as being potentially light-sensitive and having the potential to be affected by the Proposed Development. Key existing highway receptors which have the potential to be impacted by obtrusive light from the Proposed Development have been identified and adopted as receptor locations within the assessment. Highway receptors are positioned at local ground level +1.5 m high facing in the direction of travel, accounting for a 15° visibility splay towards the Proposed Development site at -1° inclination. The assessed highway receptors are set out in Strenger drawing ref: SK-02 Highway Receptor Location Plan.

4. EXTERIOR LIGHTING

Overview

- 4.1 Artificial lighting will be required as part of safe passage, security and health and safety requirements during periods of darkness. The associated potential obtrusive light effects towards surrounding light-sensitive receptors would be minimised through the controlled application of lighting in accordance with current best practice.

Assessed Scheme of Lighting

- 4.2 An indicative outline scheme of lighting (Assessed Scheme of Lighting) has been produced for the Proposed Development. The Assessed Scheme of Lighting adopts LED luminaires; such technology offers significant energy savings and provide a high degree of optical control, thus minimising obtrusive light. With regard to this assessment, the luminaires - whilst specific, can be considered to be relatively generic; provided that sensible selection of another manufacturer's luminaires is made by a competent Lighting Engineer. The final selection of luminaires and their positioning shall be determined by the Responsible Lighting Engineer in order to meet the Proposed Development site final risk assessed lighting requirements; but bearing in mind any obtrusive lighting impact that the selection may have.

Indicative Lighting Criteria

- 4.3 The indicative lighting criteria adopted for the purposes of this environmental assessment are taken from relevant British Standards and recognised national guidance documentation. All criteria adopted for the Final Scheme of Lighting shall be subject to appropriate risk assessment.
- 4.4 The indicative illuminance and uniformity criteria adopted for the design of the Assessed Scheme of Lighting are set out in (Table 4.1) below:

Area	Average illuminance E_m – lux	Uniformity U_o	Source
General Area	20	0.25	BS EN 12464-2:2014 Table 5.7 Industrial sites and storage areas – 5.7.1 Short-term handling of large units and raw materials, loading and unloading of solid bulk goods
Car Parking	20	0.25	BS EN 12464-2:2014 Table 5.9 Parking Areas – 5.9.3 Heavy traffic. N.B. criterion could likely be reduced to 10 lux but 20 lux requirement for surrounding area potentially prohibitive
HGV Parking	20	0.25	BS EN 12464-2:2014 Table 5.9 Parking Areas – 5.9.3 Heavy traffic. N.B. although heavy traffic would not be expected, a higher level of illuminance has been adopted due to the higher risk associated with HGVs.
Unloading Area	50	0.40	BS EN 12464-2:2014 Table 5.1 General requirements for areas – 5.1.4 Vehicle Turning

4.5

The details of the luminaires used in the Assessed Scheme of Lighting are set out in (Table 4.2) below. The Assessed Scheme of Lighting is set out in Strenger drawing ref: SK-03 Assessed Scheme of Lighting. Column positions are based on those as marked on the proposed site layout plans provided. In some instances it has been necessary to add additional columns and reposition the columns. Passive safety measures, physical protection measures and set-back distances shall be considered as part of the Final Lighting Design. The drawing details the position, height and type of all assessed lighting. The levels of light spill associated with the Assessed Scheme of Lighting are set out in Strenger drawing ref: SK-04 Light Spill.

Table 4.2: Assessed Scheme of Lighting Details					
Reference	No. off	Manufacturer	Luminaire	Module (driving current)	Distribution
LUM-A1	2	DW Windsor	Kirium Pro 2	32 LED (1000 mA)	B2
LUM-A2	7	DW Windsor	Kirium Pro 2	48 LED (1000 mA)	C2
LUM-B1	2	DW Windsor	Sabre	32 LED (1000 mA)	B1
LUM-B2	2	DW Windsor	Sabre	32 LED (1000 mA)	C2
LUM-B3	4	DW Windsor	Sabre	64 LED (750 mA)	C2
LUM-C1	10	Kingfisher Lighting	Quarto	20 W LED (<i>max.</i>)	Cycle



Figure 4.1: DW Windsor Kirium Pro 2



Figure 4.2: DW Windsor Sabre



Figure 4.3: Kingfisher Lighting Quarto

5. MODELLING

- 5.1 Light modelling was undertaken using DIALux software, an independent lighting modelling software tool which is capable of calculating artificial lighting scenes in exterior scenarios. The software incorporates recognised calculation methodologies and is commonly used for lighting assessment worldwide. An indicative scheme of lighting has been produced for the purposes of this assessment and has been inputted into the lighting model.
- 5.2 In order to represent a reasonable worst-case scenario for environmental assessment, the maintenance factor within the lighting model was set to 1.0, such that the lighting scheme was assessed based on the full design lumen output, rather than the maintained minimum design lumen output.
- 5.3 Such as to provide an illustrative overview of the lighting model, ray-traced imagery of the rendered lighting model is appended to this report in Appendix B.

6. MITIGATION

6.1 The following mitigation measures are integral to good lighting design, and have therefore been included in the Proposed Scheme of Lighting as a matter of course:

- the use of luminaires with minimal to zero direct contribution to upward light;
- minimising luminaire uplift angles;
- careful aiming and positioning of luminaires;
- careful selection of luminaires;
- the use of optimal optics for their specific location and orientation;
- optimisation of mounting heights;
- the adoption of the lowest intensity LED modules practicable; and
- minimising the task illuminance level.

7. ASSESSMENT

Residential

'Light Trespass' (vertical illuminance)

7.1

The levels of 'light trespass' from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at residential receptors. The resultant levels of 'light trespass' are set out in (Table 7.1) against the criterion. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 7.1: 'Light Trespass'			
Receptor	'Light Trespass' Criterion - E _v (lux)	Predicted 'Light Trespass' - E _v (lux)	Outcome
RES-01	1	0.00	PASS
RES-02	1	0.00	PASS
RES-03	1	0.00	PASS
RES-04	1	0.00	PASS
RES-05	1	0.00	PASS
RES-06	1	0.00	PASS
RES-07	1	0.00	PASS
RES-08	1	0.00	PASS
RES-09	1	0.00	PASS
RES-10	1	0.00	PASS
RES-11	1	0.01	PASS
RES-12	1	0.01	PASS
RES-13	1	0.01	PASS
RES-14	1	0.01	PASS
RES-15	1	0.01	PASS
RES-16	1	0.01	PASS
RES-17	1	0.01	PASS
RES-18	1	0.01	PASS
RES-19	1	0.01	PASS
RES-20	1	0.01	PASS
RES-21	1	0.01	PASS
RES-22	1	0.01	PASS
RES-23	1	0.00	PASS
RES-24	1	0.00	PASS

7.2

As can be seen from (Table 7.1) above, the predicted levels of 'light trespass' at residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew criterion of 1 lux.

'Glare' (viewed source intensity)

7.3

The maximum levels of 'glare' from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at residential receptors. The resultant maximum levels of 'glare' are set out in (Table 7.2) against the criterion. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 7.2: 'Glare'			
Receptor	'Glare Criterion' - l (cd)	Predicted Maximum 'Glare' - l (cd)	Outcome
RES-01	500	105	PASS
RES-02	500	103	PASS
RES-03	500	105	PASS
RES-04	500	81	PASS
RES-05	500	52	PASS
RES-06	500	47	PASS
RES-07	500	42	PASS
RES-08	500	44	PASS
RES-09	500	46	PASS
RES-10	500	30	PASS
RES-11	500	0	PASS
RES-12	500	0	PASS
RES-13	500	0	PASS
RES-14	500	0	PASS
RES-15	500	0	PASS
RES-16	500	0	PASS
RES-17	500	0	PASS
RES-18	500	0	PASS
RES-19	500	0	PASS
RES-20	500	0	PASS
RES-21	500	0	PASS
RES-22	500	0	PASS
RES-23	500	0	PASS
RES-24	500	0	PASS

7.4

As can be seen from (Table 7.2) above, the predicted maximum levels of 'glare' at residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew criterion of 500 cd.

Wider Surrounding Area

'Sky-glow' (upward light ratio)

- 7.5 The level of 'sky-glow' from the Assessed Scheme of Lighting associated with the Proposed Development has been predicted. The resultant level of 'sky-glow' is set out in (Table 7.3) against the criterion. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 7.3: 'Sky-glow'			
Receptor	'Sky-glow' Criterion (ULR %)	Predicted 'Sky-glow' (ULR %)	Outcome
Wider surrounding area	2.5	0.0	PASS

- 7.6 As can be seen from (Table 7.3) above, the predicted level of 'sky-glow' from the Assessed Scheme of Lighting associated with the Proposed Development is compliant with the criterion of 2.5 %.

Highway

Veiling Luminance

7.1

The levels of veiling luminance from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at highway receptors. The resultant levels of veiling luminance are set out in (Table 7.4) against the highway user criteria as set out in Section 2 of this report. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 7.4: Veiling Luminance			
Receptor Location	Veiling Luminance Criterion	Predicted Veiling Luminance	Outcome
HWY-01	0.25	0.00 (east) 0.01 (west)	PASS
HWY-02	0.25	0.01 (east) 0.01 (west)	PASS
HWY-03	0.25	0.02 (east) 0.01 (west)	PASS
HWY-04	0.25	0.03 (east) 0.04 (west)	PASS
HWY-05	0.25	0.02 (east) 0.06 (west)	PASS
HWY-06	0.25	0.03 (east) 0.08 (west)	PASS
HWY-07	0.25	0.03 (east) 0.04 (west)	PASS
HWY-08	0.25	0.03 (east) 0.04 (west)	PASS
HWY-09	0.25	0.03 (east) 0.09 (west)	PASS
HWY-10	0.25	0.03 (east) 0.07 (west)	PASS
HWY-11	0.25	0.02 (east) 0.04 (west)	PASS
HWY-12	0.25	0.02 (east) 0.04 (west)	PASS
HWY-13	0.25	0.00 (east) 0.03 (west)	PASS
HWY-14	0.25	0.00 (east) 0.01 (west)	PASS
HWY-15	0.25	0.00 (east) 0.00 (west)	PASS
HWY-16	0.25	0.00 (east) 0.00 (west)	PASS
HWY-17	0.25	0.00 (east) 0.00 (west)	PASS

Table 7.4: Veiling Luminance			
Receptor Location	Veiling Luminance Criterion	Predicted Veiling Luminance	Outcome
HWY-18	0.25	0.00 (east) 0.01 (west)	PASS

7.2

As can be seen from (Table 7.4) above, the predicted levels of veiling luminance from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP criterion of 0.25.

Threshold Increment

7.3

The levels of Threshold Increment from the Assessed Scheme of Lighting associated with the Proposed Development have been calculated at Highway Receptors based on the predicted veiling luminance values and an adaptation luminance of 1 cd/m². The resultant levels of Threshold Increment are set out in (Table 7.5) against the highway user criteria as set out in Section 2 of this report. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 7.5: Threshold Increment			
Receptor Location	ILP Threshold Increment Criterion (%)	Predicted Threshold Increment (%)	Outcome
HWY-01	15 (1 cd/m ²)	0.0 (east) 0.7 (west)	PASS
HWY-02	15 (1 cd/m ²)	0.7 (east) 0.7 (west)	PASS
HWY-03	15 (1 cd/m ²)	1.3 (east) 0.7 (west)	PASS
HWY-04	15 (1 cd/m ²)	2.0 (east) 2.6 (west)	PASS
HWY-05	15 (1 cd/m ²)	1.3 (east) 3.9 (west)	PASS
HWY-06	15 (1 cd/m ²)	2.0 (east) 5.2 (west)	PASS
HWY-07	15 (1 cd/m ²)	2.0 (east) 2.6 (west)	PASS
HWY-08	15 (1 cd/m ²)	2.0 (east) 2.6 (west)	PASS
HWY-09	15 (1 cd/m ²)	2.0 (east) 5.9 (west)	PASS
HWY-10	15 (1 cd/m ²)	2.0 (east) 4.6 (west)	PASS
HWY-11	15 (1 cd/m ²)	1.3 (east) 2.6 (west)	PASS
HWY-12	15 (1 cd/m ²)	1.3 (east) 2.6 (west)	PASS
HWY-13	15 (1 cd/m ²)	0.0 (east) 2.0 (west)	PASS
HWY-14	15 (1 cd/m ²)	0.0 (east) 0.7 (west)	PASS
HWY-15	15 (1 cd/m ²)	0.0 (east) 0.0 (west)	PASS
HWY-16	15 (1 cd/m ²)	0.0 (east) 0.0 (west)	PASS
HWY-17	15 (1 cd/m ²)	0.0 (east) 0.0 (west)	PASS

Table 7.5: Threshold Increment			
Receptor Location	ILP Threshold Increment Criterion (%)	Predicted Threshold Increment (%)	Outcome
HWY-18	15 (1 cd/m ²)	0.0 (east) 0.7 (west)	PASS

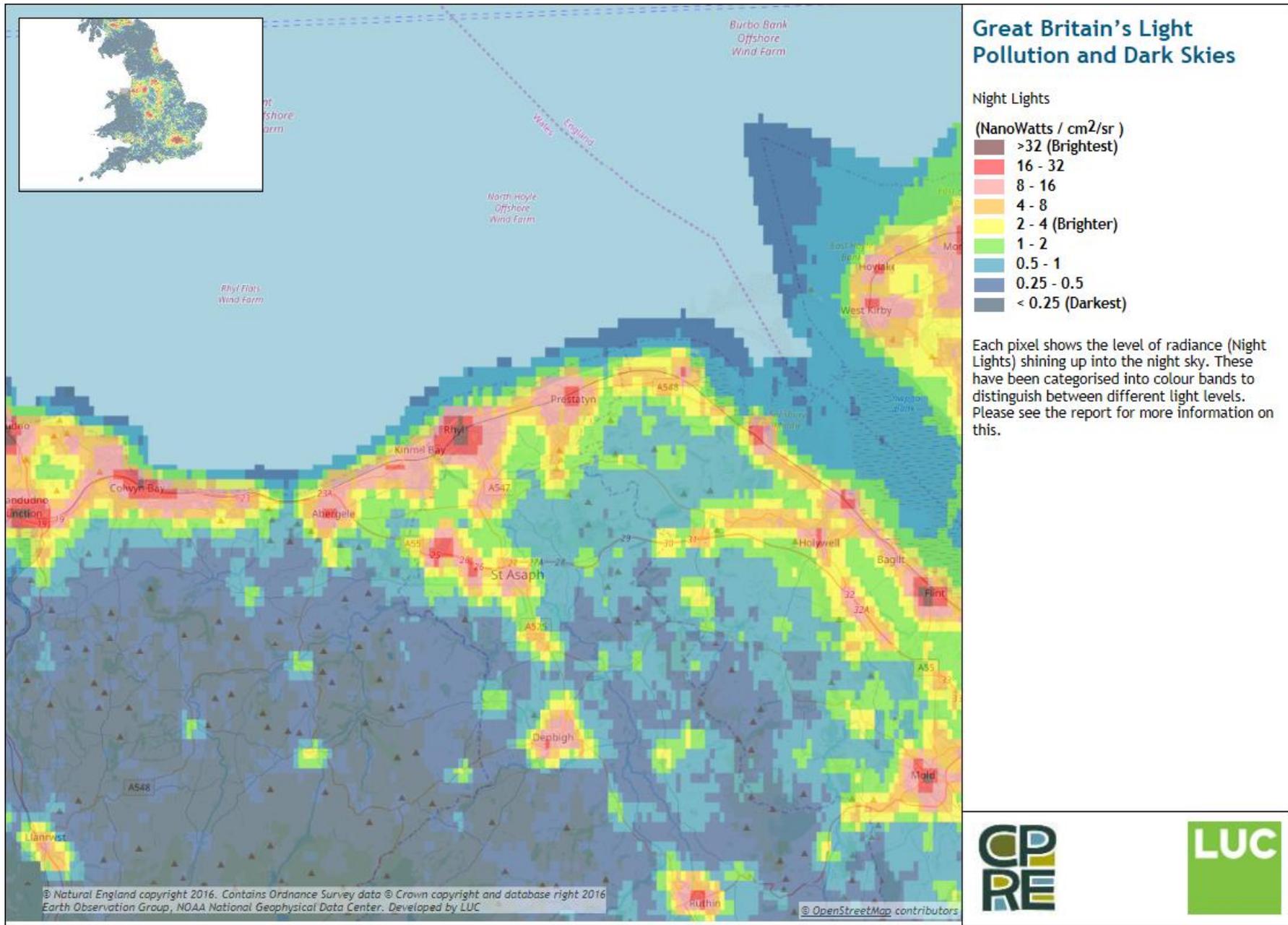
7.4

As can be seen from (Table 7.5) above, the predicted levels of threshold increment from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP criterion of 15 % (1 cd/m²).

8. CONCLUSIONS

- 8.1 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the residential receptor criteria as set out in the Institution of Lighting Professionals (ILP) (2011) Guidance Notes for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the obtrusive light criteria as set out for ILP Environmental Zone E2. For which, the post-curfew criteria are as follows:
- 'Light trespass' limit of 1 Lux (E_v - vertical illuminance)
 - 'Glare limit' of 500 cd (I – viewed source intensity)
 - 'Sky-glow' limit of 2.5 % (Upward Light Ratio)
- 8.2 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the highway user criteria as set out in the Institution of Lighting Professionals (ILP) (2011) Guidance Notes for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the obtrusive light criteria as set out for an ME6 / ME5 road. For which, the criteria are as follows:
- Threshold Increment of 15 % based on adaptation luminance of 1 cd/m^2 (TI)
 - Veiling Luminance of 0.25 cd/m^2 (L_v)
- 8.3 Compliance has been achieved with the adoption of an environmentally sympathetic scheme of lighting having the following mitigation measures:
- the use of luminaires with minimal to zero direct contribution to upward light;
 - minimising luminaire uplift angles;
 - careful aiming and positioning of luminaires;
 - careful selection of luminaires;
 - the use of optimal optics for their specific location and orientation;
 - optimisation of mounting heights;
 - the adoption of the lowest intensity LED modules practicable; and
 - minimising the task illuminance level.

Appendix A – CPRE ‘Sky Brightness’ Mapping



Appendix B - Lighting Model Ray-traced Imagery

