LAND ADJACENT TO JUNCTION 10 M40

LIGHTING ASSESMENT

ALBION LAND

Light PaD

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1 Executive Summary

This lighting assessment has been prepared to support two outline applications for the erection of buildings comprising logistics (Use Class B8) and ancillary office (Use Class Eg(i)) floorspace; and the construction of associated parking, servicing, hard and soft landscaping and new site accesses from the B4100.

The two outline applications being submitted are for 'land to the west of the A43 and south of the B4100' (the Western Site) and for 'land to the east of the A43 and south of the B4100' (the Eastern Site).

As these are outline applications the final layout, scale, appearance and landscaping of each development is not known and is reserved for future approval. However, future development will be required to comply with the submitted parameter plans and the Development Specification. The Land Use Parameter Plans identify the 'build zones', 'hard landscaping zones (including servicing and parking and internal access') and 'soft landscaping zones' within each Site. The Parameter Plans also identify the maximum height of buildings to be provided on site as well as the existing vegetation to be removed or retained/enhanced and strengthened.

An indicative masterplan has also been submitted (for information only) for each Site. The indicative masterplan demonstrates one way in which development could come forward in accordance with the Parameter Plans.

This report examines the existing lighting environment and primarily assesses for potential adverse obtrusive lighting effects as a result of External Lighting Parameters for the artificial lighting of the Land Use Parameter plans for the two Sites Proposed Development and for the indicative masterplan.

Following assessment of the potential external lighting parameters that could be bought forward within later stages further mitigation measures have been developed, for consideration, to ensure that the future proposals meet with policy, lighting guidance and the requirements in relation to area sensitivities.

Artificial Light Condition Summary - Overview of the Sites and Adjacent Area

The Sites are principally unlit farmland. However, the adjacent A43, roundabouts and junctions (which separate the Sites) are currently lit to highway requirements.

Appendix 1.0 provides an overview of the measured survey undertaken.

With lighting generally being limited to adjacent highway, the Sites and their surroundings are considered representative of being E2 Zone (Low district brightness areas – Village or relatively dark outer suburban locations) with lit highway and adjacent commercial premises being comparable to that of an E3 Zone (medium brightness).

Therefore, on a precautionary approach LightPaD's interpretation of the Environmental Zones to the Sites and their surroundings are:

- **E2 Zone (Rural surroundings, low district brightness areas)**

Although, in terms of skyglow, the Sites and their surroundings can currently be associated with an environment that is typical for an **E2 / E3 environment**. This is a result of the poorly controlled highway lighting (high pressure sodium).

Sensitive Receptors included within this Assessment

A study has been undertaken to identify relevant legislation, good practice guidance, local designations and relevant planning policy in relation to lighting following the Institute of Lighting Professionals – Guidance Notes for the Reduction of Obtrusive Light GN01: 2021 and CIE 150 (2017) guidance.

The overall study area includes sensitive receptors within and outside the boundaries of the Sites which are likely to have a direct line of sight towards the Proposals and which may therefore be affected during the operational phase. The following provides an overview of the proximity sensitivities included within this assessment:

- Ecology;
- Residential;
- Aerodrome (Upper Heyford USAF Station); and
- Dark Sky

External Lighting Parameters

External Operational Lighting Parameters (**Appendix 2.0**) have been prepared for the purposes of these assessments. These are in tandem with the preliminary lighting layout prepared to support the illustrative masterplan and is assessed independently within **Appendix 3.0**.

Including for the parameters and mitigation recommended within this report, it is the intent that a detailed lighting design will be prepared for approval as part of future reserved matters applications.

Quantitative Assessment

The intention of the assessments are to convey how the proposals fit into the existing Illumination profile of the local area and how they may comply with relevant legislation requirements and best practise Design Guidance.

Following assessment, further mitigation measures (over the embedded) are developed to ensure that the future proposals meet with policy, lighting guidance and the requirements in relation to area sensitivities.

Conclusion and Mitigation

In general, for the outline applications it is considered that, **without further mitigation** (over the embedded), the majority of ecological locations will be adversely effected and close vicinity residential may suffer as a result of non-compliant glare and light spill.

With regards to the preliminary lighting layout prepared to support the illustrative masterplan (**Appendix 3.0**), due to being more concise in terms of use allocation the number of adversely affected ecological locations reduces marginally in total (alongside the magnitude of effect) and close vicinity residential become subject to glare adversities only.

For these assessments, potential adverse effects towards the Aerodrome (Upper Heyford USAF Station) and potential skyglow are effectively mitigated though recognised good design practice and embedded measures. In essence, maintaining a no change condition.

In addition to the listed standard good practice embedded measures, the following summarises the further mitigation measures that should be considered within future proposals.

- **Site Access - Typical Access Road (Local Authority), Site Access - Typical Unit Access Road**
- Glare shields and rear back shields to all luminaire positions.
- **Build Areas - Typical Gate House, Typical Service Yard, Typical Yard Link Road**
- Dim down to 5% output capabilities, based on zonal occupancy to Build Zone Parameters; and
- Glare shields and rear back shields to relevant luminaire positions.
- **Hard Landscaping - Typical Car Park, Typical Unit Walkway**
- Dim down to 10% output capabilities, based on zonal occupancy to Hard Landscaping Zone (incl. Servicing and Parking) Parameters;
- Luminaire mounting heights at perimeters restricted to 6m;
- Angled 5° tilt to inwards facing perimeter luminaires; and
- Rear back shields to all perimeter luminaires.

In regards to potential glare, during all periods of illuminated night time activities, this effect can be avoided through the embedded measures; including considered design, luminaire positioning and further measures relating to the implementation of glare shields to relevant luminaire types.

For light spill compliance, the primary further mitigation measure relates to the dimming of light levels outside of illuminated night time activities (when full light output is not required). As a result, excessive light spill levels to perimeter locations (ecology and residential) can be avoided and will only exceed the thresholds during potential scheduled night illuminated activities (when localised full light output is required for a limited duration and frequency).

The single exception is sensitivity E24, which is located on the northern boundary of the western site. Here, the further mitigation measures above are unlikely to be appropriate (occupancy based dimming cannot be fully committed to as being a mitigation measure to highway) and localised light spill levels are likely to continually exceed the thresholds. However, it should be noted that (from good design practise) potential light spill in excess of 0.5 Lux is limited to being less than 4.0m above ground level and further beneficial light screening is considered likely from the proposed hedgerow enhancements (in addition and subject to future development).

2 Introduction

The intent for this Lighting Assessment is to provide a quantitative assessment of the potential obtrusive light impact to receptor locations in relation to published guidance limiting thresholds, policy and specialist discipline recommendation.

Where applicable, this will outline the requirements of mitigation measures (over standard embedded measures) to be implemented at design and operational stages in order to reduce or remove potential impact.

The potential impacts of obtrusive light are categorised as follows:

- Light Spill: The spilling of light beyond the boundary of a property which may cause nuisance to others - Horizontal (ground level) and Vertical (residential windows and ecology zones);
- Glare: The uncomfortable brightness of the light source against a dark background which results in dazzling the observer, which may cause nuisance to residents and a hazard to road users;
- Sky Glow: The upwards spill of light into the sky which can cause a glowing effect and is often seen above cities when viewed from a dark area.

3 Relevant Policy and Guidance

Legislation

Clean Neighbourhoods and Environment Act (CNEA) 2005 [1]

The Clean Neighbourhoods and Environment Act (CNEA) 2005 gives Local Authorities additional powers to deal with artificial lighting by classifying artificial light emitted from defined premises as a statutory nuisance (from April 2006). Guidance produced on Sections 101 to 103 of the CNEA 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.

Empowerment to Light Roads - The Highways Act 1980 [2]

Section 97 empowers a Highway Authority to provide lighting for any highway or proposed highway for which they are or will be the Highway Authority. District Councils and many Parish or Town Councils also have the power to provide lighting as local lighting authorities.

National Planning Policy

The National Planning Policy Framework 2021 [3]

The National Planning Policy Framework sets out the Government's planning policies for England and how these should be applied1. It provides a framework within which locally-prepared plans for housing and other development can be produced.

Paragraph 185 states that; *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

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

The National Planning Policy Framework (NPPF) encourages good design with planning policies and decisions limiting the effect of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Artificial lighting needs to be considered when a development may increase levels of lighting or would be sensitive to prevailing levels of artificial lighting. Artificial light provides valuable benefits to society, including through extending opportunities for sport and recreation, and can be essential to a new development. However, for maximum benefit, it is important to get the right light, in the right place and for it to be used at the right time.

Artificial light is not always necessary. It has the potential to become what is termed 'light pollution' or 'obtrusive light', and not all modern lighting is suitable in all locations. It can be a source of

annoyance to people, harmful to wildlife and undermine enjoyment of the countryside or the night sky, especially in areas with intrinsically dark landscapes. Intrinsically dark landscapes are those entirely, or largely, uninterrupted by artificial light. National parks and nature reserves can serve as good examples, particularly where they support habitats for native nocturnal animals.

The following National Planning Practice Guidance (NPPG) further details the factors relevant to the control of obtrusive light.

NPPG 2019– Light pollution[4]

The NPPG advises on how to consider light within the planning system, specifically focusing on:

- What light pollution considerations does planning need to address?
- What factors can be considered when assessing whether a development proposal might have implications for light pollution?
- What factors are relevant when considering where light shines?
- What factors are relevant when considering when light shines?
- What factors are relevant when considering how much the light shines?
- What factors are relevant when considering possible ecological impacts of lighting?
- What other information is available that could inform approaches to lighting and help reduce light pollution?

National Model Design Code – Part 2 Guidance Notes (Ministry of Housing, Communities and Local Government 2021[5]

This guidance note sets out possible contents for a design code, modelled on the ten characteristics of well-designed places set out in the National Design Guide. Where:

- P.3 Security and Public Space; P.3.i Secured by Design; Lighting – "*Ensuring appropriate and non-obtrusive lighting levels are achieved"*

- N.1.iii Open space Design; 20. Open Space Design; 8. Lighting: *"...should avoid light spillage that causes nuisance and harms wildlife"*

Regional Planning Policy

The Cherwell Local Plan 2011 – 2031 - Part 1 Adopted 20 July 2015 (incorporating Policy Bicester 13 re-adopted on 19 December 2016) [6]

The Local Plan is the document which sets the long term strategic 'spatial vision' for a local authority area. It contains the strategic spatial framework and policies to help deliver that vision. Policy ESD 15: The Character of the Built and Historic Environment states:

"…New development proposals should: Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation….

Obtrusive Light and Design Guidance

Institute of Lighting Professionals – Guidance Notes for the Reduction of Obtrusive Light GN01:2021 [7]

This Guidance provides measurable design guidance limits and recommendations to ascertain acceptability of obtrusive light levels at night.

CIE – 150:2017 - Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations [8]

The purpose of this Guide is to help formulate guidelines for assessing the environmental effects of outdoor lighting and to give recommended limits for relevant lighting parameters to contain the obtrusive effects of outdoor lighting within tolerable levels. As the obtrusive effects of outdoor lighting are best controlled initially by appropriate design, the guidance given is primarily applicable to new installations; however, some advice is also provided on remedial measures which may be taken for existing installations. This Guide refers to the potentially adverse effects of outdoor lighting on both natural and man-made environments for people in most aspects of daily life, from residents, sightseers, transport users to environmentalists and astronomers.

BS5489-1: 2020 – Code of practice for the design of road lighting – Part 1: Lighting of roads and public amenity area [9]

This part of BS 5489 gives recommendations on the general principles of road lighting, and its aesthetic and technical aspects, and advises on operation and maintenance.

BS EN 13201-2: 2015 – Road lighting – Part 2: Performance requirements [10]

This part of this European Standard defines, according to photometric requirements, lighting classes for road lighting aiming at the visual needs of road users, and it considers environmental aspects of road lighting.

BS EN 12464-2: 2014 – Lighting of Work Places – Part 2: Outdoor Work Places [11]

This European standard specifies lighting requirements for outdoor work places, which meet the needs for visual comfort and performance. All usual visual tasks are considered.

Campaign to Protect Rural England (CPRE) – Night Blight 2017 [12]

CPRE – Night Blight data (2017) gives a broad-brush indication of upwards light (sky glow) experienced within the UK. The interactive mapping tool allows specific areas and locations to be assessed with regards to a baseline condition.

Bats and Lighting Guidance

BCT / ILP – Guidance Note 08/18 – Bats and Artificial Lighting in the UK [13]

This document is aimed at lighting professionals, lighting designers, planning officers, developers, bat workers/ecologists and anyone specifying lighting. It is intended to raise awareness of the impacts of artificial lighting on bats, and mitigation is suggested for various scenarios.

4 Baseline Conditions

The Application Sites are located within the administrative boundary of Cherwell District Council and adjacent to Junction 10 of the M40 motorway.

Baynards Green and other residential development lays immediately adjacent to and North of the Application Sites. This location currently receives stray light as a consequence of A43 highway lighting. The other nearest residential settlements are approximately 0.6km from the Application Sites (e.g. Fewcott, Ardley), with further afield development (e.g. Fritwell, Stoke Lyne) being approximately 1.5km.

Laying adjacent to the M40 Junction 10 / A43 and situated in proximity to Baynards Green the Application Sites are principally unlit farmland. However, the adjacent A43, roundabouts and junctions (which separate the Sites from North to South) are currently lit to highway requirements.

Situated Southeast of the Sites, M40 Cherwell Valley motorway services is currently also illuminated on a 24 hour operated basis, although limited in expanse this location can be considered as being an E3 Environmental Zone (medium district brightness).

Further afield, towards the Southwest of the Sites (>2km) lays the Upper Heywood USAF Station which comprises of residential properties, extensive vehicle parking areas and a runway, which is artificially illuminated for operational uses.

Natural and potentially ecology habitat (e.g. bats) including hedgerows, trees and natural features, are located within and in proximity to the Sites. Notable areas of woodland (including Stoke Woods) are located 0.35km to the South East of the Application Sites and beyond the illuminated motorways services.

The Sites are principally unlit farmland. However, the adjacent A43, roundabouts and junctions (which separate the Sites) are currently lit to highway requirements.

Appendix 1.0 reviews the artificial lighting currently installed to adjacent surrounding areas. Comment is made regarding the resulting lighting levels found, with regards to current standards and guidelines, where relevant. Ecological receptors are assessed relative to their present lighting conditions to enable further assessment to be made of the potential impact the proposed development may have.

The Moon was not visible in the sky when lighting measurements were taken. The unscreened moonlight condition measured as **0.01 Lux** (Horizontal) and **0.02 Lux** (Vertical).

Light Readings (illuminance levels in Lux) were taken using a handheld Minolta T-10A illuminance meter. All horizontal lux readings were taken on the ground; all vertical lux readings were taken at arm's length from a standing position; approximately 1.5m above ground.

Sensitive Receptors included within this Assessment

The study area includes sensitive receptors within and outside the boundaries of the Application Sites which are likely to have a direct line of sight towards the Proposed Development and which may therefore be affected during the operational phase. The following provides an overview of the proximity sensitivities included within this assessment:

- **Ecology (E1 to E31) –** Various ecological receptors identified in **Figures 1.0** and **2.0;**
- **Residential (R1 to R24) –** Surrounding private residential receptors identified in **Figure 3.0;**
- **Aerodrome (A1) –** Air traffic use identified in **Figure 4.0** (Upper Heyford USAF Station); and
- **Dark Sky (SG1) –** (Not shown, being Site wide).

Sensitive Receptors excluded from this Assessment:

- **Lit and Unlit Highway**

With respect to the proposed use of the Sites, and the expected luminaire types predominately being highway and associated area lighting (inherent glare control) disability glare is not considered to present any significant impact and is therefore excluded from the future assessment.

- **Public Rights of Way**

Existing public rights of ways cross / are located adjacent to the western and eastern sites. Relating to obtrusive light and unless ecologically / view point designated, public rights of way are considered to be nil in terms of sensitivity due to limited frequencies and durations of night time human use and activity. As such, public rights of way are not included as part of the future assessment.

- **Other Locations**

Due to the expected type and nature of light effect, in relation to the likely activities and periods of occupation, existing commercial, industrial and employment developments are considered to have a nil sensitivity and are therefore excluded from this assessment.

Figure 1.0 – Ecology Receptor Locations – East

Figure 2.0 – Ecology Receptor Locations - West

Figure 3.0 – Residential Receptor Locations

Figure 4.0 – Aerodrome Receptor Location

Environmental Zone Classification

Assessment of the designation, use, habitat and external lighting condition dictates the classification of Environmental Zones across the Sites and surrounding areas. The Environmental Zones relate to limiting guidance published by the Institute of Lighting Professionals ILP for obtrusive light (residential and highway) - ILP Guidance Notes for the Reduction of Obtrusive Light (2021).

This guidance provides reference for the Environmental Zone Criteria for light nuisance into windows (measured in Lux), the zone definitions are as follows:

- E0: Protected surroundings, dark landscapes – UNESCO Starlight reserves, IDA Dark Sky Parks;
- E1: Intrinsically dark landscapes – National Parks, Areas of Outstanding Natural Beauty etc.;
- E2: Low district brightness areas – Village or relatively dark outer suburban locations;
- E3: Moderate district brightness – Small town centres or suburban locations; and
- E4: High district brightness – Town/city centres with high levels of night-time activity.

This guidance then provides limiting obtrusive light thresholds for the respective zone.

With lighting generally being limited to adjacent highway, the Sites and surroundings are considered representative of being an E2 Zone (Low district brightness areas – Village or relatively dark outer suburban locations) with lit highway and adjacent commercial premises being comparable to that of an E3 Zone (medium brightness).

Therefore, on a precautionary approach LightPaD's interpretation of the Environmental Zones to the Sites and surroundings are:

- **E2 Zone (Rural surroundings, low district brightness areas)**

Although, in terms of skyglow, the Sites and surroundings can be associated with an environment that is typical for an E2 / E3 environment. This is a result of the poorly controlled highway lighting (high pressure sodium).

The ILP guideline values for the Environmental Zones are outlined in the following tables:

Table 4.1: ILP Guidance Notes for the Reduction of Obtrusive Light (2021) – Vertical Light Spill

Table 3 (CIE 150 table 2): Maximum values of vertical illuminance on properties.						
Light technical parameter	**Application conditions**	**Environmental zone**				
		E0	**E1**	**E2**	**E3**	**E4**
Illuminance in the vertical plane (E_v)	Pre-curfew	n/a	2 lx	5 lx	10 lx	25 lx
	Post-curfew	n/a	<0.1 lx*	1 lx	2 lx	5 lx

Table 4.2: ILP Guidance Notes for the Reduction of Obtrusive Light (2021) – Luminous Intensity

Ap = Projected Area of Visible Brightness and *d = Distance of Observer*

Table 4 (CIE 150 table 3 (amended)): Limits for the luminous intensity of bright luminaires[4].							
Light technical parameter	**Application conditions**	**Luminaire group (projected area A_p in m²)**					
		$0<A_p \leq 0.002$	$0.002<A_p \leq 0.01$	$0.01<A_p \leq 0.03$	$0.03<A_p \leq 0.13$	$0.13<A_p \leq 0.50$	$A_p>0.5$
Maximum luminous intensity emitted by luminaire (I in cd)	E0						
	Pre-curfew	0	0	0	0	0	0
	Post-curfew	0	0	0	0	0	0
	E1						
	Pre-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500
	Post-curfew	0	0	0	0	0	0
	E2						
	Pre-curfew	0.57 *d*	1.3 *d*	2.5 *d*	5.0 *d*	10 *d*	7,500
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	500
	E3						
	Pre-curfew	0.86 *d*	1.9 *d*	3.8 *d*	7.5 *d*	15 *d*	10.000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	1,000
	E4						
	Pre-curfew	1.4 *d*	3.1 *d*	6.3 *d*	13 *d*	26 *d*	25,000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500

Table 4.3: ILP Guidance Notes for the Reduction of Obtrusive Light (2021) – Sky Glow – Maximum values of upward flux ratio of installation (of four or more luminaires)

Table 7 (CIE 150 table 6): Maximum values of upward flux ratio of installation (of four or more luminaires).								
Light technical parameter	**Type of installation**	**Environmental zones**						
		E0	**E1**	**E2**		**E3**		**E4**
Upward flux ratio (UFR)/%	Road	n/a	2	5		8		12
	Amenity	n/a	n/a	6	9%	12		35
	Sports	n/a	n/a	2		6		15

5 External Lighting Parameters and Mitigation

Appendix 2.0 provides an overview of the External Lighting Parameters that have been used within the assessments. Through Applicant team consultation in relation to constraints, considered design measures, operation and internal site allocations (lighting, building and landscape developments) the future design shall be evolved to minimise potential obtrusive light adverse effects from the outset.

With respect to constraints and internal site allocation, lighting shall only be included where essential to the safe night use of the Proposals. This includes activities in relation to uses and activities in regard to the proposed 24-hour operation of the Proposals. All other areas, which are currently unlit, will remain as being unlit in the interests of maintaining the current baseline condition to identified local constraints.

With respect to the External Lighting Parameters (**Appendix 2.0**) the following good practice embedded measures are included, within the assessments which are intended as being the base principals for the future lighting developments of the Sites:

- Wherever possible, ensuring the use of controlled light distribution, optimised optics (flat glass - controlled light distribution below the horizontal) minimal inclination and considered luminaire positioning / minimal heights are employed (maximum 6m at inwards facing perimeter with 5° inclination and maximum 10m (0°) to build and hard landscaped areas);
- Rear back shield employed at all perimeter locations;
- Where possible, modern LED luminaires should be employed throughout the Sites to minimise the obtrusive light spill footprint and be as energy efficient as possible;
- All luminaires used around the perimeter should be mounted within the Sites (at a reduced height where practicable), in order that the main photometric distribution of the luminaire will be towards the task area, keeping all light within the boundary of the development and preventing artificial light spilling outside of this;
- Adopting a light quality that minimises disruption to existing ecological systems in the form of ‘LED’ light sources (<3000K and >550 nm) which emit minimal UV and blue light; and
- Minimising surface reflectances (minimising reflected uplight) – Ground and Landscape <8%, Build <20%.

The following further mitigation measures will be considered and, if necessary and appropriate, shall be incorporated into future detailed lighting design / installation:

- Unless occupied, individual or groups of luminaires will operate at a dimmed output (5 to 10% of full output), this relates to proposed build zones and hard landscaping zones (incl. serving and parking). All roadways will be lit at 100%. In addition, when not required and subject to Health and Safety (H&S) assessment, non-essential lighting will be switched off (occupancy sensing) at a pre-determined curfew time (suggested as 23:00 in accordance with ILP Guidance Notes) in order to further reduce the effect.
- Wherever possible consideration should be given to the need for lighting in areas which include or are directly adjacent to ecology habitat. Should artificial lighting be required in these areas for health and safety reasons all luminaires should be directed away from the habitat area;
- Wherever possible and subject to landscape design, the retention of trees to the perimeters;

- Where applicable, and not integral to the luminaire type, additional glare controlling louvres and light shields should be applied post installation (where necessary and to all Site access roadway luminaires); and
- The implementation of new / supplementary dense natural screening (treelines, foliage etc.) / buffer zones where applicable to minimise light spill and luminaire visibility.

6 Scope and Methodology of Assessment

Impact Assessment

The calculated effect from the External Lighting Parameters (all operational, inclusive of mitigation) is modelled quantitatively and, where applicable to existing baseline measurements, a cumulative impact is provided.

It should be noted that the process of assessment, initially based on the Land Use Parameter plans, provides a broad overview of the types and heights of lighting equipment that could potentially be employed within the Sites. These are modelled as coverage arrays (within standard good design practice and based on a precautionary principal) for the proposed uses within each Site.

This methodology provides an understanding of the maximum adverse effect and defines the potential future mitigation requirements for the possible future masterplan development options.

Being less concise than an illustrative masterplan, it should be noted that this method can also result in an exaggerated overview of impact, therefore, **Appendix 3.0** provides assessment for the preliminary lighting layout prepared to support the illustrative masterplan (**Appendix 3.0**). This is intended to provide an understanding of how the Enteral Lighting Parameter based mitigation measures will be relevant to the potential future design development options.

Assessment for Sensitivities

With respect to relative sensitivities the following methodology applies:

- **Ecology**

The Applicant ecologist has advised the bat commuting, foraging and potential roost locations that were surveyed and the relative light effect calculation measurement criteria and heights to support the ecological light effect assessment.

Currently there is a lack of evidence regarding the light levels below which there are no/reduced effects on bats. Responses of bats to light levels are likely to vary between species and between behaviours. A “light threshold” below which there is little effect on bats may not exist for some species which may be light averse regardless of intensity.

However, in support of the Ecology Assessment, the assessments illustrate where the light level condition is likely to exceed 0.5 Lux.

Relative to species, obtrusive light effects are provided on the peak vertical effect condition (vertical being the more relevant indicator and maximum adverse effect to bat flight, up to 10m in height) for the representative ecology zones. Where a potential significant effect is possible, tabulated baseline, effect and resultant values are provided for locations on the centre line of the respective ecology zone.

- **Residential**

In terms of common locations, orientation and aspects relating to the Proposals, individual residential premises are grouped into representative receptor zones.

For occupied residential receptors the lighting assessment to the vertical plane (window locations) has followed the methodology outlined within CIE 150 (2017) and the Institute of Lighting Professionals – Guidance Notes for the Reduction of Obtrusive Light.

Similarly, obtrusive light effects are also related to glare (luminaire source intensity) from the observer location.

- **Aerodrome (Upper Heyford USAF Station)**

Not quantitatively assessed, the embedded mitigation and lighting strategy takes account of guidance for lighting within the proximity of aerodromes.

Where, BS5489-1: 2020 provides the following design considerations; *'Road lighting can present a hazard due to the effect of lighting upon the pilot's visual picture within the flight paths around an aerodrome. For instance, where a road lies in the vicinity of an aerodrome that has approach lighting and the road has a similar alignment to the runway, the road lighting can present a pattern to the pilot that is similar to the runway lighting. Where a light or lighting is deemed by the relevant authority to present a possible hazard to aircraft, measures are usually taken by the CAA to require the operator of the light(s) to remove the hazard. This can involve a reconfiguration of the pattern of lights, and/or their colour, intensity and visibility from an aircraft. When designing road lighting in the vicinity of aerodromes, lighting designers should consult the relevant aerodrome operator and obtain safeguarding maps to assess whether the design will have special requirements'.*

- **Dark Sky**

The upward spill of light into the sky, which can cause a glowing effect and is often seen above artificially lit areas when viewed from a darker area. Direct and reflected Sky glow is assessed as a Site Wide effect and is based on a scenario where the most onerous of lighting effect is applied relative to the potential uses within each area.

Sky Glow cannot be accurately measured. Therefore, the baseline is professionally judged relative to visual baseline survey conditions and published CPRE – Night Blight data.

The CIE150 and ILP Guidance Notes for the Reduction of Obtrusive Light provides the limiting Upwards Flux Ratio (UFR%) relative to the Environmental Zone. This is assessed on a sample area, representing a Site wide basis, relative to the overarching Environmental Zone classification for intended and existing artificially lit uses.

Assumptions / Limitations

External Operational Lighting Parameters have been prepared for the purposes of this assessment, refer to **Appendix 2.0.**

For the purposes of demonstrating a robust assessment, the following standard industry precautionary measures are applied to the assessment calculation:

- On the basis that the Proposed Sites are for logistics uses ,the landscape surfaces are expected to be 8% reflectivity (tarmac) and building surfaces 20% reflective;
- Assessment is usually provided for a pre and post curfew condition. Where curfew is defined as being the time at which non-essential lighting is turned off (industry standard recognised as being 23:00 subject to Health and Safety approval). However, due to the Proposals being 24-hour operation the assessment is based on all lighting operational (100% and dimmed for relevant luminaire types / groups);
- A unity maintenance factor of 1.0 is applied to represent the maximum adverse condition from initial installation (maximum light output not including for light losses through light source degradation and dirt accumulation); and

- As per standard industry practice and for the demonstration of maximum effects existing and proposed landscape bunding and planting / trees are not included within the assessment calculations.

7 Assessment

The following provides the obtrusive light assessment, in tandem with the Planning Application, which provides assessment of the operational External Lighting Parameters (**Appendix 2.0**) effect on the surrounding environment.

The intention of the assessment is to convey how illumination for the proposed Land Use Parameters will fit into the existing Illumination profile of the area and how that will comply with relevant legislation requirements and best practise Design Guidance.

Overview

Alongside baseline data provided within **Appendix 1.0,** the illustrated horizontal illuminance effect contours within **Figures 7.1 and 7.2** are provided to inform the application.

Obtrusive Light Effects to Sensitive Receptors

- **Ecology**

The data represented with **Table 7.1** is relevant to identified **Ecology** where, with reference to the baseline and a resultant value, assessment is provided on the peak vertical effect condition for representative ecology zones.

- **Residential**

The data represented within **Table 7.2** is relevant to identified **Residential Locations** where vertical illuminance to facing elevations and luminaire source intensity (glare) are the recognised key indicators.

- **Aerodrome (Upper Heyford USAF Station)**

Not quantitatively assessed, the embedded mitigation and lighting parameters take into account BS5489-1: 2020 guidance for lighting within the proximity of aerodromes. Where the future external lighting proposals will consider the pattern of lights, and/or their colour, intensity and visibility from an aircraft.

Consequently, further mitigation is not considered to be a future requirement.

- **Dark Sky**

On a sample area identified (which reflects the Sites and provides assessment for the most onerous variants of luminaire types). In accordance with CIE 150, the Upward Flux Ratio (UFR %) is calculated. The data represented in **Table 7.3** is relevant to identified **Sky Glow** where the calculated UFR % is assessed as the key indicator.

Figure 7.1: Graphical representation of horizontal illuminance (Land Use Parameters with Embedded Mitigation)

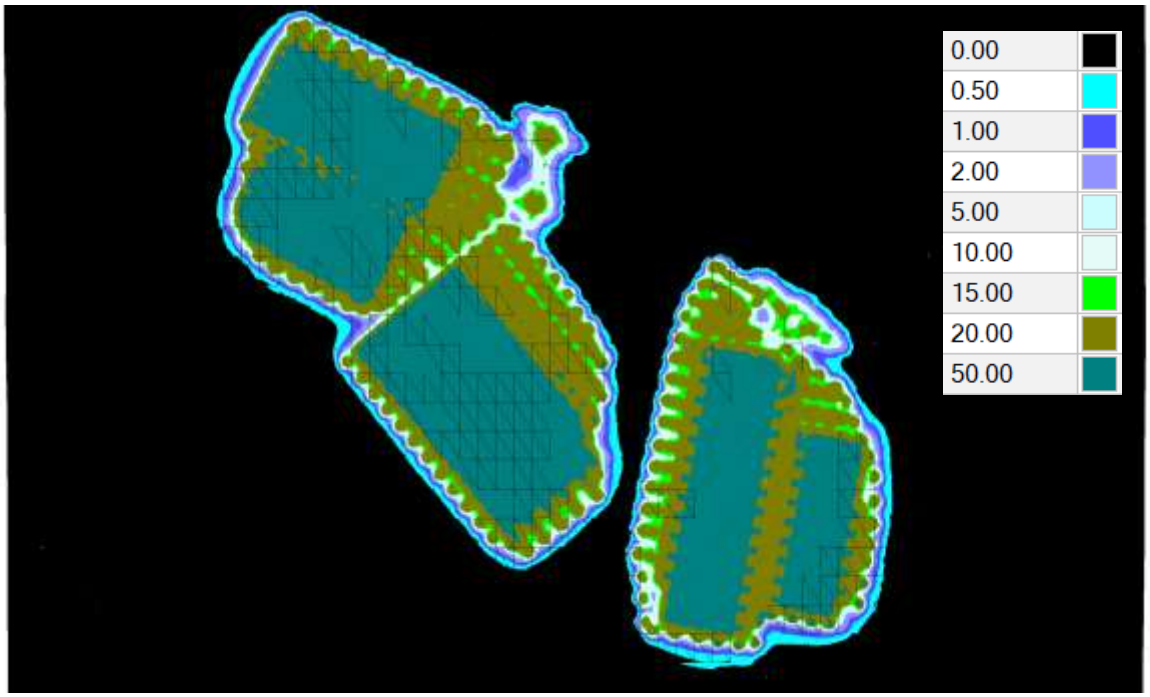
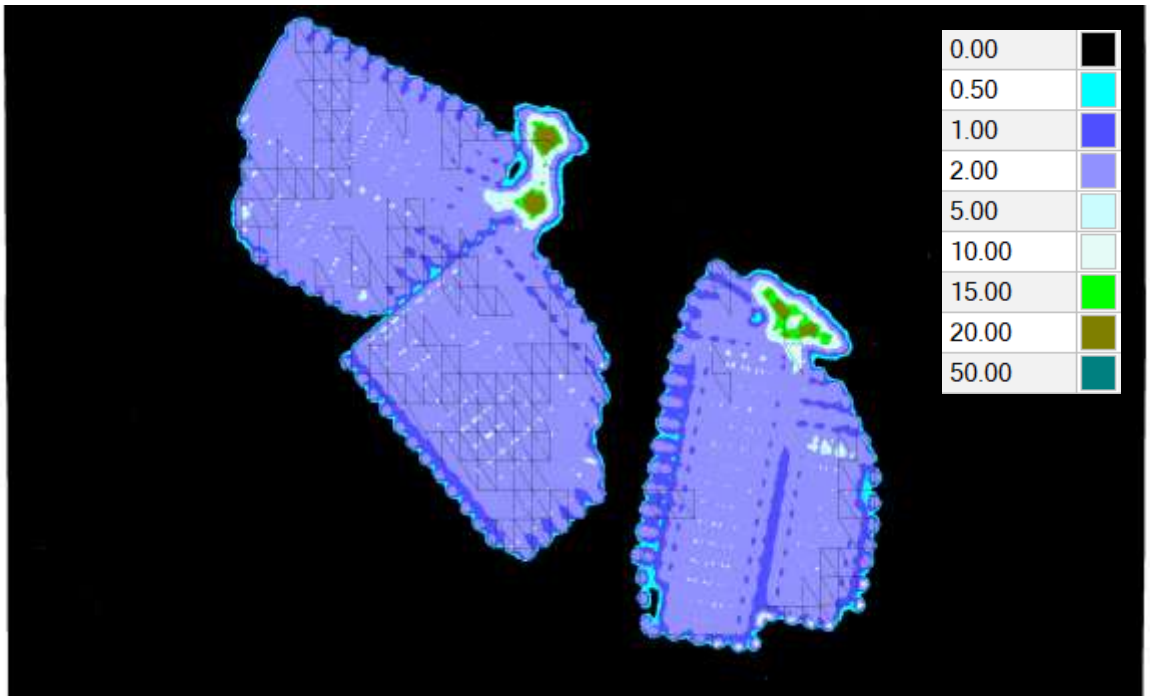


Figure 7.2: Graphical representation of horizontal illuminance (Land Use Parameters with Embedded Mitigation and Further Mitigation)



Note:

Maintenance Factor – 1.0.

Direct illuminance at ground level, excl videstrees.

Refer to tables for vertical impact to identified receptor locations.

Ecology – Light Sensitive (Bat)

Table 7.1: Vertical Illuminance (Lux) based on Land Use Parameters

Ecology	Existing Illuminance (Lux)	Light Spill - Vertical Plane (Lux) Height				Resultant Max. Vertical Illuminance (Lux) (maximum value incl. current retained baseline)			
		Maximum (100%) operation (embedded mitigation)		Dimmed by occupancy operation (further mitigation)		Maximum (100%) operation (embedded mitigation)		Dimmed by occupancy operation (further mitigation)	
		Height above ground	Lux	Height above ground	Lux	Height above ground	Lux	Height above ground	Lux
TEXT COLOUR LEGEND Lux Value > 0.5 Lux due to retained existing Baseline Condition (Negligible change in Condition) Lux Value >0.5 Lux due to proposed Land Use Parameters									
E01	0.01	0m	2.2	0m	0.1	0m	**2.21**	0m	**0.11**
		2.0m	1.9	2.0m	0.1	2.0m	**1.91**	2.0m	**0.11**
		4.0m	1.6	4.0m	0.1	4.0m	**1.61**	4.0m	**0.11**
		6.0m	1.2	6.0m	0.1	6.0m	**1.21**	6.0m	**0.11**
		8.0m	0.8	8.0m	0	8.0m	**0.81**	8.0m	**0.01**
		10.0m	0.4	10.0m	0	10.0m	**0.41**	10.0m	**0.01**
E02	0.01	0m	3.8	0m	0.2	0m	**3.81**	0m	**0.21**
		2.0m	3.2	2.0m	0.2	2.0m	**3.21**	2.0m	**0.21**
		4.0m	2.5	4.0m	0.1	4.0m	**2.51**	4.0m	**0.11**
		6.0m	1.8	6.0m	0.1	6.0m	**1.81**	6.0m	**0.11**
		8.0m	1.1	8.0m	0.1	8.0m	**1.11**	8.0m	**0.11**
		10.0m	0.4	10.0m	0	10.0m	**0.41**	10.0m	**0.01**
E03	0.01	0m	4.3	0m	0.2	0m	**4.31**	0m	**0.21**
		2.0m	3.6	2.0m	0.2	2.0m	**3.61**	2.0m	**0.21**
		4.0m	2.9	4.0m	0.1	4.0m	**2.91**	4.0m	**0.11**
		6.0m	2.2	6.0m	0.1	6.0m	**2.21**	6.0m	**0.11**
		8.0m	1.4	8.0m	0.1	8.0m	**1.41**	8.0m	**0.11**
		10.0m	0.6	10.0m	0	10.0m	**0.61**	10.0m	**0.01**
E04	0.02	0m	2.97	0m	0.2	0m	**2.99**	0m	**0.22**
		2.0m	2.5	2.0m	0.1	2.0m	**2.52**	2.0m	**0.12**
		4.0m	1.9	4.0m	0.1	4.0m	**1.92**	4.0m	**0.12**
		6.0m	1.4	6.0m	0.1	6.0m	**1.42**	6.0m	**0.12**
		8.0m	1	8.0m	0.1	8.0m	**1.02**	8.0m	**0.12**
		10.0m	0.5	10.0m	0	10.0m	**0.52**	10.0m	**0.02**
E05	0.02	0m	4.8	0m	0.3	0m	**4.82**	0m	**0.32**
		2.0m	4	2.0m	0.2	2.0m	**4.02**	2.0m	**0.22**
		4.0m	3.1	4.0m	0.2	4.0m	**3.12**	4.0m	**0.22**
		6.0m	2.2	6.0m	0.1	6.0m	**2.22**	6.0m	**0.12**
		8.0m	1.4	8.0m	0.1	8.0m	**1.42**	8.0m	**0.12**
		10.0m	0.6	10.0m	0	10.0m	**0.62**	10.0m	**0.02**

E06	0.02	0m	3.3	0m	0.3	0m	3.32	0m	0.32
		2.0m	2.6	2.0m	0.2	2.0m	2.62	2.0m	0.22
		4.0m	1.9	4.0m	0.1	4.0m	1.92	4.0m	0.12
		6.0m	1.2	6.0m	0.1	6.0m	1.22	6.0m	0.12
		8.0m	0.5	8.0m	0	8.0m	0.52	8.0m	0.02
		10.0m	0.1	10.0m	0	10.0m	0.12	10.0m	0.02
E07	2.3	0m	1.5	0m	0.2	0m	3.8	0m	2.5
		2.0m	0.9	2.0m	0.1	2.0m	3.2	2.0m	2.4
		4.0m	0.4	4.0m	0	4.0m	2.7	4.0m	2.3
		6.0m	0.1	6.0m	0	6.0m	2.4	6.0m	2.3
		8.0m	0	8.0m	0	8.0m	2.3	8.0m	2.3
		10.0m	0	10.0m	0	10.0m	2.3	10.0m	2.3
E08	0.0	0m	2.2	0m	0.2	0m	2.2	0m	0.2
		2.0m	1.4	2.0m	0.1	2.0m	1.4	2.0m	0.1
		4.0m	0.8	4.0m	0.1	4.0m	0.8	4.0m	0.1
		6.0m	0.3	6.0m	0	6.0m	0.3	6.0m	0
		8.0m	0	8.0m	0	8.0m	0	8.0m	0
		10.0m	0	10.0m	0	10.0m	0	10.0m	0
E09	0.05	0m	3.1	0m	0.2	0m	3.15	0m	0.25
		2.0m	2	2.0m	0.1	2.0m	2.05	2.0m	0.15
		4.0m	1.2	4.0m	0.1	4.0m	1.25	4.0m	0.15
		6.0m	0.6	6.0m	0	6.0m	0.65	6.0m	0.05
		8.0m	0.1	8.0m	0	8.0m	0.15	8.0m	0.05
		10.0m	0	10.0m	0	10.0m	0.05	10.0m	0.05
E10	**Removed as part of proposed Land Use Parameters**								
E11	0.01	0m	3.5	0m	0.2	0m	3.51	0m	0.21
		2.0m	2.4	2.0m	0.2	2.0m	2.41	2.0m	0.21
		4.0m	1.6	4.0m	0.1	4.0m	1.61	4.0m	0.11
		6.0m	0.9	6.0m	0.1	6.0m	0.91	6.0m	0.11
		8.0m	0.3	8.0m	0	8.0m	0.31	8.0m	0.01
		10.0m	0.1	10.0m	0	10.0m	0.11	10.0m	0.01
E12	0.02	0m	3.7	0m	0.2	0m	3.72	0m	0.22
		2.0m	3	2.0m	0.2	2.0m	3.02	2.0m	0.22
		4.0m	2.1	4.0m	0.1	4.0m	2.12	4.0m	0.12
		6.0m	1.4	6.0m	0.1	6.0m	1.42	6.0m	0.12
		8.0m	0.7	8.0m	0	8.0m	0.72	8.0m	0.02
		10.0m	0.1	10.0m	0	10.0m	0.12	10.0m	0.02
E13	0.01	0m	1.9	0m	0.1	0m	1.91	0m	0.11
		2.0m	1.6	2.0m	0.1	2.0m	1.61	2.0m	0.11
		4.0m	1.3	4.0m	0.1	4.0m	1.31	4.0m	0.11
		6.0m	1	6.0m	0.1	6.0m	1.01	6.0m	0.11
		8.0m	0.7	8.0m	0	8.0m	0.71	8.0m	0.01
		10.0m	0.3	10.0m	0	10.0m	0.31	10.0m	0.01
E14	0.01	0m	2.3	0m	0.2	0m	2.31	0m	0.21
		2.0m	1.9	2.0m	0.1	2.0m	1.91	2.0m	0.11

		4.0m	1.5	4.0m	0.1	4.0m	**1.51**	4.0m	**0.11**
		6.0m	1.1	6.0m	0	6.0m	**1.11**	6.0m	**0.01**
		8.0m	0.6	8.0m	0	8.0m	**0.61**	8.0m	**0.01**
		10.0m	0.3	10.0m	0	10.0m	**0.31**	10.0m	**0.01**
E15	0.01	0m	2.5	0m	0.1	0m	**2.51**	0m	**0.11**
		2.0m	2.2	2.0m	0.1	2.0m	**2.21**	2.0m	**0.11**
		4.0m	1.7	4.0m	0.1	4.0m	**1.71**	4.0m	**0.11**
		6.0m	1.3	6.0m	0.1	6.0m	**1.31**	6.0m	**0.11**
		8.0m	0.9	8.0m	0	8.0m	**0.91**	8.0m	**0.01**
		10.0m	0.4	10.0m	0	10.0m	**0.41**	10.0m	**0.01**
E16	3.43	0m	0.2	0m	0	0m	**3.63**	0m	**3.43**
		2.0m	0.2	2.0m	0	2.0m	**3.63**	2.0m	**3.43**
		4.0m	0.2	4.0m	0	4.0m	**3.63**	4.0m	**3.43**
		6.0m	0.1	6.0m	0	6.0m	**3.53**	6.0m	**3.43**
		8.0m	0.1	8.0m	0	8.0m	**3.53**	8.0m	**3.43**
		10.0m	0	10.0m	0	10.0m	**3.43**	10.0m	**3.43**
E17	0.01	0m	2.1	0m	0.1	0m	**2.11**	0m	**0.11**
		2.0m	1.8	2.0m	0.1	2.0m	**1.81**	2.0m	**0.11**
		4.0m	1.5	4.0m	0.1	4.0m	**1.51**	4.0m	**0.11**
		6.0m	1.1	6.0m	0.1	6.0m	**1.11**	6.0m	**0.11**
		8.0m	0.8	8.0m	0	8.0m	**0.81**	8.0m	**0.01**
		10.0m	0.4	10.0m	0	10.0m	**0.41**	10.0m	**0.01**
E18	0.01	0m	3.7	0m	0.2	0m	**3.71**	0m	**0.21**
		2.0m	2.7	2.0m	0.2	2.0m	**2.71**	2.0m	**0.21**
		4.0m	1.8	4.0m	0.1	4.0m	**1.81**	4.0m	**0.11**
		6.0m	0.9	6.0m	0	6.0m	**0.91**	6.0m	**0.01**
		8.0m	0.2	8.0m	0	8.0m	**0.21**	8.0m	**0.01**
		10.0m	0.1	10.0m	0	10.0m	**0.11**	10.0m	**0.01**
E19	0.0	0m	1.1	0m	0.1	0m	**1.1**	0m	**0.1**
		2.0m	0.9	2.0m	0.1	2.0m	**0.9**	2.0m	**0.1**
		4.0m	0.6	4.0m	0.1	4.0m	**0.6**	4.0m	**0.1**
		6.0m	0.3	6.0m	0	6.0m	**0.3**	6.0m	**0**
		8.0m	0.1	8.0m	0	8.0m	**0.1**	8.0m	**0**
		10.0m	0	10.0m	0	10.0m	**0**	10.0m	**0**
E20	0.01 (taken as the darkest measured value, excluding temporary security lighting).	0m	2.4	0m	2.41	0m	**0.2**	0m	**0.21**
		2.0m	1.7	2.0m	1.71	2.0m	**0.1**	2.0m	**0.11**
		4.0m	1.1	4.0m	1.11	4.0m	**0.1**	4.0m	**0.11**
		6.0m	0.4	6.0m	0.41	6.0m	**0**	6.0m	**0.01**
		8.0m	0.1	8.0m	0.11	8.0m	**0**	8.0m	**0.01**
		10.0m	0	10.0m	0.01	10.0m	**0**	10.0m	**0.01**
E21	0.0	0m	0.4	0m	0	0m	**0.4**	0m	**0**
		2.0m	0.2	2.0m	0	2.0m	**0.2**	2.0m	**0**
		4.0m	0.1	4.0m	0	4.0m	**0.1**	4.0m	**0**
		6.0m	0	6.0m	0	6.0m	**0**	6.0m	**0**
		8.0m	0	8.0m	0	8.0m	**0**	8.0m	**0**

		10.0m	0	10.0m	0	10.0m	**0**	10.0m	**0**
E22	0.9	0m	0.5	0m	0	0m	**1.4**	0m	**0.9**
		2.0m	0.4	2.0m	0	2.0m	**1.3**	2.0m	**0.9**
		4.0m	0.2	4.0m	0	4.0m	**1.1**	4.0m	**0.9**
		6.0m	0.1	6.0m	0	6.0m	**1**	6.0m	**0.9**
		8.0m	0.1	8.0m	0	8.0m	**1**	8.0m	**0.9**
		10.0m	0	10.0m	0	10.0m	**0.9**	10.0m	**0.9**
E23	0.02	0m	1.5	0m	0.2	0m	**1.52**	0m	**0.22**
		2.0m	1.2	2.0m	0.1	2.0m	**1.22**	2.0m	**0.12**
		4.0m	0.8	4.0m	0.1	4.0m	**0.82**	4.0m	**0.12**
		6.0m	0.4	6.0m	0.1	6.0m	**0.42**	6.0m	**0.12**
		8.0m	0.1	8.0m	0	8.0m	**0.12**	8.0m	**0.02**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E24	0.02	0m	2.2	0m	1.5	0m	**2.22**	0m	**1.52**
		2.0m	1.2	2.0m	0.8	2.0m	**1.22**	2.0m	**0.82**
		4.0m	0.7	4.0m	0.4	4.0m	**0.72**	4.0m	**0.42**
		6.0m	0.4	6.0m	0.2	6.0m	**0.42**	6.0m	**0.22**
		8.0m	0.1	8.0m	0	8.0m	**0.12**	8.0m	**0.02**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E25	0.02	0m	3.6	0m	0.2	0m	**3.62**	0m	**0.22**
		2.0m	2.7	2.0m	0.2	2.0m	**2.72**	2.0m	**0.22**
		4.0m	1.9	4.0m	0.1	4.0m	**1.92**	4.0m	**0.12**
		6.0m	1.2	6.0m	0.1	6.0m	**1.22**	6.0m	**0.12**
		8.0m	0.5	8.0m	0	8.0m	**0.52**	8.0m	**0.02**
		10.0m	0.1	10.0m	0	10.0m	**0.12**	10.0m	**0.02**
E26	0.02	0m	0.6	0m	0	0m	**0.62**	0m	**0.02**
		2.0m	0.4	2.0m	0	2.0m	**0.42**	2.0m	**0.02**
		4.0m	0.2	4.0m	0	4.0m	**0.22**	4.0m	**0.02**
		6.0m	0.1	6.0m	0	6.0m	**0.12**	6.0m	**0.02**
		8.0m	0	8.0m	0	8.0m	**0.02**	8.0m	**0.02**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E27	0.02	0m	7.7	0m	0.4	0m	**7.72**	0m	**0.42**
		2.0m	5.9	2.0m	0.3	2.0m	**5.92**	2.0m	**0.32**
		4.0m	4.1	4.0m	0.2	4.0m	**4.12**	4.0m	**0.22**
		6.0m	2.3	6.0m	0.1	6.0m	**2.32**	6.0m	**0.12**
		8.0m	1.1	8.0m	0.1	8.0m	**1.12**	8.0m	**0.12**
		10.0m	0.1	10.0m	0	10.0m	**0.12**	10.0m	**0.02**
E28	0.02	0m	6	0m	0.3	0m	**6.02**	0m	**0.32**
		2.0m	4	2.0m	0.2	2.0m	**4.02**	2.0m	**0.22**
		4.0m	2.2	4.0m	0.1	4.0m	**2.22**	4.0m	**0.12**
		6.0m	1	6.0m	0.1	6.0m	**1.02**	6.0m	**0.12**
		8.0m	0.1	8.0m	0	8.0m	**0.12**	8.0m	**0.02**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E29	0.02	0m	4.7	0m	0.3	0m	**4.72**	0m	**0.32**
		2.0m	3.3	2.0m	0.2	2.0m	**3.32**	2.0m	**0.22**

		4.0m	2.1	4.0m	0.1	4.0m	**2.12**	4.0m	**0.12**
		6.0m	1.1	6.0m	0.1	6.0m	**1.12**	6.0m	**0.12**
		8.0m	0.4	8.0m	0	8.0m	**0.42**	8.0m	**0.02**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E30	**Removed as part of proposed Land Use Parameters**								

Conclusion:

Currently there is a lack of evidence regarding the light levels below which there are no/reduced effects on bats. Responses of bats to light levels are likely to vary between species and between behaviours. A "light threshold" below which there is little effect on bats may not exist for some species which may be light averse regardless of intensity.

However, in support of the Ecology Assessment, the assessments illustrate where the light level condition is likely to be exceed an example 0.5 Lux.

In summary, during periods of illuminated night time activity (occupied and when operational light levels will be at a maximum), the effects at the majority of perimeter ecology locations have the potential to exceed the example 0.5 Lux threshold.

Although unable to influence baseline conditions at E07, E16 and E22 (due to the current and retained baseline), in order to reduce this potential for adverse effect it is concluded that further mitigation measures (for consideration) should include for localised dimming control based on the reduction of light levels when not required.

This will ensure that the peak values shown (prior to this further mitigation) will be limited in duration and frequencies when based on the potential for scheduled night illuminated activities (occupied and when a localised full light output will be required).

Therefore, further mitigation dimming proposals (during non-occupied operating conditions) for consideration include for:

- Dim down to 10% output capabilities, based on zonal occupancy to Hard Landscaping Zones (incl. Servicing and Parking) ; and
- Dim down to 5% output capabilities, based on zonal occupancy to Build Zones.

From the implementation of these further mitigation measures the effects will be reduced to be within thresholds (<0.5 Lux), the effect towards species etc. is subject to the Ecology assessment.

The single exception is sensitivity E24, which is located on the northern boundary of the western site. Here, the further mitigation measures above are unlikely to be appropriate (occupancy based dimming cannot be fully committed to as being a mitigation measure to highway) and localised light spill levels are likely to continually exceed the thresholds.

However, it should be noted that (from good design practise) potential light spill in excess of 0.5 Lux is limited to being less than 4.0m above ground level and, in addition and subject to development, further beneficial light screening is considered likely from the proposed hedgerow enhancements.

Residential

Table 7.2: Vertical Illuminance and Glare based on Land Use Parameters

Residential	Guidance Pre Curfew / Post Curfew		Existing Vertical Illuminance (Lux) (1.5m AFL)	Calculated Obtrusive Light (maximum value to elevation) as a result of the Development Proposals				Resultant Obtrusive Light (maximum value to elevation incl. current retained baseline)			
	E2 Zone – Lux Vertical Illuminance Max. into Windows (ILP Guidance Notes 2020) (Lux)	E2 Zone – Glare Luminous Intensity (ILP Guidance Notes 2020) (Lux) Calculated for specific receptor location, distance and peak luminaire visible		Maximum (100%) operation		Dimmed by occupancy operation		Maximum (100%) operation		Dimmed by occupancy operation	
				Lux	Glare Kcd	Lux	Glare Kcd	Lux	Glare Kcd	Lux	Glare Kcd
TEXT COLOUR LEGEND Lux Value > Post Curfew Guidance due to retained existing Baseline Condition (Negligible change in Condition) Lux Value > Post Curfew Guidance due to proposed Land Use Parameters Glare > Pre and Post Curfew Guidance due to proposed Land Use Parameters Glare > Post Curfew Guidance due to proposed Land Use Parameters											
R1 - Medkre	5 / 1 90m	0.07/ 0.04	0.02	1.46	0.88	0.82	0.88	1.48	0.88	0.84	0.88
R2 – Baynards House	5 / 1 250m	0.22 / 0.11	Not accessible. 0.02 (taken as the darkest measured value, excluding private lighting).	0.6	0.47	0.08	0.47	0.62	0.47	0.1	0.47
R3 – The Cottages	5 / 1	0.10 / 0.05	0.01	1.61	0.56	0.14	0.13	1.62	0.56	0.15	0.13
R4 – Baynards Green Farm	5 / 1	0.26 / 0.13	Not accessible 0.02 Lux (taken as the darkest measured value).	0.19	0.35	0.04	0.2	0.21	0.35	0.06	0.2
R5 - Hotel	5 / 1	0.24 / 0.1	Various levels Typically – 2.8 Lux.	1.26	0.98	0.07	0.05	4.06	0.98	2.87	0.05
R6 – Padbury Lodge	5 / 1	0.94 / 0.48	Various lighting conditions up to E3 (Medium District Brightness). However, fall outside of the calculated zone of influence and is only subject to glare.	0	0.15	0	0.02	As Existing	0.15	As Existing	0.02
R7 – Park Farm	5 / 1	1.0 / 0.51	As above.	0	0.13	0	0.01	As Existing	0.13	As Existing	0.01
R8 – Oxford Lodge	5 / 1	0.88 / 0.45	As above.	0	0.14	0	0.01	As Existing	0.14	As Existing	0.01
R9 – Horwell	5 / 1	0.92 / 0.45	As above.	0	0.12	0	0.01	As Existing	0.12	As Existing	0.01
R10 – Green Farm	5 / 1	1.08 / 0.55	As above.	0	0.12	0	0.01	As Existing	0.12	As Existing	0.01
R11 – Fritwell Village	5 / 1	0.95 / 0.48	As above.	0	0.12	0	0.01	As Existing	0.12	As Existing	0.01
R12 – Willowbank Farm	5 / 1	0.72 / 0.37	As above.	0	0.15	0	0.02	As Existing	0.15	As Existing	0.02
R13 – Fewcott Village	5 / 1	0.74 / 0.37	As above.	0	0.17	0	0.01	As Existing	0.17	As Existing	0.01
R14 – Ardley Village	5 / 1	0.88 / 0.45	As above.	0	0.14	0	0.01	As Existing	0.14	As Existing	0.01

R15 – The Barn House	5 / 1	1.23 / 0.63	**As above.**	0	0.13	0	0.01	As Existing	**0.13**	As Existing	**0.01**
R16 – Woodbine Cottage	5 / 1	1.48 / 0.76	**As above.**	0	0.0	0	0.0	As Existing	**0.0**	As Existing	**0.0**
R17 – Swift House	5 / 1	1.20 / 0.61	**As above.**	0	0.14	0	0.01	As Existing	**0.14**	As Existing	**0.01**
R18 – The Branch	5 / 1	1.39 / 0.70	**As above.**	0	0.14	0	0.01	As Existing	**0.14**	As Existing	**0.01**
R19 – Stoke Lyne Village	5 / 1	1.49 / 0.76	**As above.**	0	0.14	0	0.01	As Existing	**0.14**	As Existing	**0.01**
R20 – The Cottage	5 / 1	1.46 / 0.74	**As above.**	0	0.17	0	0.02	As Existing	**0.17**	As Existing	**0.02**
R21 – Lone Barn	5 / 1	1.01 / 0.51	**As above.**	0	0.17	0	0.02	As Existing	**0.17**	As Existing	**0.02**

Conclusion:

The majority of surrounding residential receptors are considered not to be affected significantly by obtrusive light spill or glare from the proposed Land Use Parameters. This is principally, due to distance (the existing condition is retained) and potential glare is controlled by the luminaire body or obscured by terrain change.

However, the residential locations within a closer proximity (R1, R2, R3, R4 and R5) have been calculated to experience increased and non-compliant levels of light to the vertical elevations with the potential visibility of glare.

Although unable to influence baseline conditions at R5, in order to reduce the adverse potential light spill effect to perimeter locations and as per the Ecology conclusion it is recommended that further mitigation measures (for consideration) should include for occupancy dimming control.

This will ensure that the peak values shown (prior to this further mitigation) will be limited in duration and frequencies when based on the potential for scheduled night illuminated activities (occupied and when a localised full light output will be required).

The further mitigation dimming proposals (during non-occupied conditions) include for:

- Dim down to 10% output capabilities, based on zonal occupancy to Hard Landscaping Zones (incl. Servicing and Parking); and
- Dim down to 5% output capabilities, based on zonal occupancy to Build Zones.

Furthermore, to control potential glare, shields should be located at relevant luminaire positions (including all proposed non-dimmed new access roadway / highway lighting locations).

From the implementation of these further mitigation measures the potential effects (Light spill and Glare) are controlled to comply with relevant guidance criteria for an E2 zone during non-occupied operation (subject to limited to occupancy based durations / frequencies).

Dark Sky

For the purposes of skyglow assessment the current sky glow region is considered to be representative Environmental Zone classification of being an E2/E3: Low / Mid district brightness.

Considering CIE150 and ILP Guidance Notes for the Reduction of Obtrusive Light (2021) the limiting sky glow percentage for amenity installations has been interpolated as (6+12)/2 = 9%

Following the calculation of the upwards and downward ratio the UFR% for the proposed Development is:

- **Sample Area UFR = 5.35% < 9%**

Table 7.3: Direct Sky Glow

Dark Sky	**Sky Glow**		
	Existing Condition	**Sky Glow UFR (Max. %) (interpolated for amenity E2 to E3)**	**Calculated UFR %**
SG01	Low/Mid sky glow category (typical for an E2 / E3 environment	9%	**5.35**

Conclusion:

From the implementation of embedded mitigation and ensuring landscape and build reluctances are minimised (<8% ground, <20% build), sky glow is controlled to comply with relevant guidance criteria for an E2/E3 zone during all periods of potential operation. In essence, maintaining a no change condition.

8 Bibliography

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Appendix 1.0 – Baseline Survey

X1.0 – BASELINE SURVEY SUMMARY

The Application Sites lay within Cherwell administrative boundary and on a local scale the adjacent to Junction 10 of the M40 motorway.

The area terrain falls from West to East, ranging between 130m and 110m AOD. This could potentially result in future visibility and glare from unscreened and poorly orientated luminaires (especially from lower laying locations to the East). This principally relates to occupied residential development, where glare and luminaire source intensity should be controlled to the Environmental Zone classification.

The surrounding residential development areas typically lay in excess of 0.6km from the Application Sites boundaries (e.g. Fewcott, Ardley), with further afield development (e.g. Fritwell, Stoke Lyne) being approximately 1.5km.

Baynards Green and other residential development lays immediately adjacent to and North of the Application Site. This location is currently proximity illuminated as a consequence of A43 highway lighting.

Laying adjacent to the M40 Junction 10 / A43 and situated in proximity to Baynards Green the Application Sites are principally unlit farmland. However, the adjacent A43, roundabouts and junctions (which separate the Sites from North to South) are currently lit to highway requirements.

Situated Southeast of the Application Site, M40 Cherwell Valley motorway services is currently also illuminated on a 24 hour operated basis, although limited in expanse this location can be considered as being an E3 Environmental Zone (medium district brightness).

Further afield, towards the Southwest of the Application Sites (>2km) lays the Upper Heywood USAF Station which comprises of residential, expansive vehicle parking and a runway, which is artificially illuminated for operational uses.

In terms of landscape, natural and potentially ecology habitat (e.g. bats) this includes hedgerows, trees and natural features within and in proximity to the Application Sites. With notable woodland (Stoke Woods) located 0.35km to the South East of the Application Sites and beyond the illuminated motorways services.

Figure X1 – Night View across the Sites and Illuminated Roadway (A43)

Environmental Zone Classification

Assessment of the designation, use, habitat and external lighting condition dictates the classification of Environmental Zones across the Sites and surrounding areas. The Environmental Zones relate to limiting guidance published by the Institute of Lighting Professionals ILP for obtrusive light (residential and highway) - ILP Guidance Notes for the Reduction of Obtrusive Light (2021).

With lighting generally being limited to adjacent highway, the Sites and their surroundings are considered representative of being an E2 Zone (Low district brightness areas – Village or relatively dark outer suburban locations) with lit highway and adjacent commercial premises being comparable to that of an E3 Zone (medium brightness).

Therefore, on a precautionary approach LightPaD's interpretation of the Environmental Zones to the Sites and their surroundings are:

- **E2 Zone (Rural surroundings, low district brightness areas)**

Although, in terms of skyglow, the current Sites and their surroundings can be associated with an environment that is typical for an E2 / E3 environment. This is a result of the poorly controlled highway lighting (high pressure sodium).

X1.1 – BASELINE SURVEY METHODOLOGY

This survey reviews the existing lighting environment to the Application Sites and adjacent surroundings. Comment is made regarding the resulting lighting levels found, with regard to conditions experienced, where relevant. Ecological locations were surveyed with regard to their present individual lighting conditions to enable a future assessment to be made of the potential impact the Proposed Developments may have.

The survey was undertaken between the dates of 14th to 16th June between 22:30 and 02:00. The Moon was visible in the sky (Waxing Gibbous) when lighting measurements were taken. The unscreened moonlight condition measured as 0.01 Lux (Horizontal) and 0.02 Lux (Vertical).

Light Readings (illuminance levels in Lux) were taken using a calibrated handheld Minolta T-10A illuminance meter. All horizontal lux readings were taken on the ground; all vertical lux readings were taken at arm's length from a standing position; approximately 1.5m above ground.

Advised by desktop survey and with input from the Applicant design team, the following Data sheets illustrate the current lighting conditions at:

- Existing Lighting Locations
- Ecology Locations
- Residential Locations
- Aerodrome
- Dark Sky

These support the understanding of the Environmental Zone and lighting condition currently experienced and also provide reference for the future Development Proposal assessment locations.

X1.2.1.0 – Existing Lighting Locations

To support the understanding of the Environmental Zone and lighting condition currently experienced survey was undertaken at the locations shown within **Figure X2**.

These locations are discussed further within subsequent datasheets.

Figure X2 – Existing Lighting Locations

L1 – M40 Cherwell Valley Motorway Services and Hotel
L2 – Cherwell Roundabout and Access
L3 – Padbury Brook Roundabout
L4 – A43 Highway and Verges
L5 – Baynards Green Roundabout
L6 – Private Residential
L7 – Private Residential
L8 – Petrol Station and McDonalds Restaurant
L9 – Ardley Playing Fields (Ardley United FC) and Surrounding Highway
L10 – Fritwell Surrounding Highway
L11 – Stoke Lyne Surrounding Highway
L12 – Ardley Energy Recovery Facility (approx. 3km South)
L13 – Upper Hayford USAF Station (approx. 3km South West)

X1.2.1.1 - Data Sheet – Existing Lighting

Location	L1 – M40 Cherwell Valley Motorway Services and Hotel
Artificial Lighting	Column mounted LED lanterns, building mounted, LED screen and internal light emissions (Neutral/cool white)
Horizontal Measured Illuminance (Lux @ Ground)	Area Average – 10 Lux Peak – 19.3 Lux
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	Area noticeable skyglow and glare

X1.2.1.2 - Data Sheet – Existing Lighting

Location	L2 – Cherwell Roundabout and Access
Artificial Lighting	Column mounted LED and HPS lanterns, some failures
Horizontal Measured Illuminance (Lux @ Ground)	Average – 7.9 to 34.3 Lux
Environmental Zone Characteristic	E2 (Low district brightness) and E3 (Localised Medium district brightness)
Notes:	Area noticeable skyglow and light spill to adjacent treezones Vertical light spill to adjacent treezones (outside edge) – 14.9 Lux Average

X1.2.1.3 - Data Sheet – Existing Lighting

Location	L3 – Padbury Brook Roundabout
Artificial Lighting	Column mounted HPS lanterns
Horizontal Measured Illuminance (Lux @ Ground)	Average – 39 Lux
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	Area noticeable skyglow and light spill to adjacent treezones Vertical light spill to adjacent treezones (outside edge) – 21.8 Lux Average

X1.2.1.4 - Data Sheet – Existing Lighting

Location	L4 – A43 Highway and Verges
Artificial Lighting	Column mounted HPS lanterns
Horizontal Measured Illuminance (Lux @ Ground)	Average – 19.82 Lux 4.45 to 49.7 Lux
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	Area noticeable skyglow and light spill to adjacent treezones Vertical light spill to adjacent verges / treezones (outside edge) – Ranges between 3.5 Lux (South) to 6.21 Lux (Mid) to 11.02 Lux (North)

X1.2.1.5 - Data Sheet – Existing Lighting

Location	L5 – Baynards Green Roundabout
Artificial Lighting	Column mounted HPS lanterns
Horizontal Measured Illuminance (Lux @ Ground)	Average – 35.6 Lux
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	Area noticeable skyglow and light spill to adjacent treezones Vertical light spill to adjacent treezones (outside edge) – 9.4 Lux Average

X1.2.1.6 - Data Sheet – Existing Lighting

Location	L6 – Private Residential
Artificial Lighting	Building mounted luminaires
Horizontal Measured Illuminance (Lux @ Ground)	Access to peak measurements was not possible, however light spill to the adjacent footpath and treezone was notable - 0.7 Lux
Environmental Zone Characteristic	E2 (Low district brightness)
Notes:	Light spill, glare and upwards light

X1.2.1.7 - Data Sheet – Existing Lighting

Location	L7 – Private Residential
Artificial Lighting	Occupancy sensing security lighting (cool LED)
Horizontal Measured Illuminance (Lux @ Ground)	Not accessible
Environmental Zone Characteristic	E2 (Low district brightness)
Notes:	Notable light spill, sky glow and glare when occupied

X1.2.1.8 - Data Sheet – Existing Lighting

Location	L8 – Petrol Station and McDonalds Restaurant
Artificial Lighting	Column, under canopy, and signage (Neutral white)
Horizontal Measured Illuminance (Lux @ Ground)	Petrol Station – 30.1 to 246.9 Lux Average McDonalds – 30.3
Environmental Zone Characteristic	E3 zone
Notes:	Area noticeable skyglow and glare

X1.2.1.9 - Data Sheet – Existing Lighting

Location	L9 – Ardley Playing Fields (Ardley United FC) and Surrounding Highway
Artificial Lighting	Column Mounted Floodlighting (Fields), and private residential
Horizontal Measured Illuminance (Lux @ Ground)	Not in operation at time of survey Professional judgement approx. – 50 Lux
Environmental Zone Characteristic	E2 (Low district brightness) when not occupied, changing to an E3 zone when operational
Notes:	Predicted light spill, glare and skyglow

X1.2.1.10 - Data Sheet – Existing Lighting

Location	L10 – Fritwell Surrounding Highway
Artificial Lighting	Column Mounted LPS lanterns at key junctions and private residential
Horizontal Measured Illuminance (Lux @ Ground)	Varies from natural darkness to 12 Lux (average at column locations)
Environmental Zone Characteristic	E2 (Low district brightness)
Notes:	Localised light spill and upwards light from poorly controlled lanterns

X1.2.1.11 - Data Sheet – Existing Lighting

Location	L11 – Stoke Lyne Surrounding Highway
Artificial Lighting	Column Mounted LPS lanterns at key junctions and private residential
Horizontal Measured Illuminance (Lux @ Ground)	Varies from natural darkness to 12 Lux (average at column locations)
Environmental Zone Characteristic	E2 (Low district brightness)
Notes:	Localised light spill and upwards light from poorly controlled lanterns

X1.2.1.12 - Data Sheet – Existing Lighting

Location	L12 – Ardley Energy Recovery Facility (approx. 3km South)
Artificial Lighting	Notable Brightness
Horizontal Measured Illuminance (Lux @ Ground)	Not measured
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	A variety of external column and building mounted luminaires creating a visual night time prominence.

X1.2.1.13 - Data Sheet – Existing Lighting

Location	L13 – Upper Hayford USAF Station (approx. 3km South West)
Artificial Lighting	Column mounted LED lanterns (Neutral)
Horizontal Measured Illuminance (Lux @ Ground)	19.7 Lux
Environmental Zone Characteristic	E3 (Localised Medium district brightness)
Notes:	

X1.2.2.0 – Baseline Survey Locations

Ecology

Ecological locations may become subject to light spill and were surveyed with regards to their present individual lighting conditions to enable a future assessment to be made of the potential effects the Proposed Developments may create.

Residential

Residential locations may become subject to light spill and glare. Light spill is typically limited to a 50m zone of influence, however, glare can be disruptive to distances beyond this zone.

Aerodrome

Air traffic and aerodromes can be adversely affected in terms of glare, light patterns and light colours. Therefore, guidance is referred to for assessment.

Dark Sky

Sky glow cannot be measured accurately, therefore reference is made to existing satellite data sets of upwards light which provide an overview of the area.

X1.2.2.1 - Data Sheet – Baseline Survey Locations – Ecology East

Location	E1 to E12 – Ecology Locations (Figure X3)		
	Horizontal Lux @ Ground	**Vertical Lux @ 1.5m**	**Notes**
E1	0.00	0.01	Natural Darkness
E2	0.00	0.01	Natural Darkness
E3	0.00	0.01	Natural Darkness
E4	0.01	0.02	Natural Darkness
E5	0.01	0.02	Natural Darkness
E6	0.01	0.02	Natural Darkness
E7	1.49	2.3	Part screened light spill from A43 0.5 Lux at 50m from perimeter Vertical light spill to adjacent treezones – 9.4 Lux Average
E8	0.01 (at treeline inside face)	0.00 (at treeline inside face)	Part screened light spill from A43 0.5 Lux at 26m from perimeter
E9	0.04 (at treeline inside face)	0.05 (at treeline inside face)	Part screened light spill from A43 (treeline outside face – 4.86 Lux Average)
E10	0.06	0.25	32m from perimeter
E11	0.09 (at treeline inside face)	0.01 (at treeline inside face)	Part screened light spill from A43 1.56 Lux at 8m from perimeter 0.5 Lux at 29m from perimeter
E12	0.00 (at treeline inside face)	0.02 (at treeline inside face)	Vertical light spill to adjacent treezones (treeline outside face – 21.8 Lux Average)
E13 – Park & Stream	0.00	0.01	Natural Darkness
E14 - Park	0.00	0.01	Natural Darkness
E15 - Park	0.00	0.01	Natural Darkness

Figure X3 – Ecology Receptor Locations - East

X1.2.2.2 - Data Sheet – Baseline Survey Locations – Ecology West

Location	E13 to E28 – Ecology Locations (Figure X4)		
	Horizontal Lux @ Ground	**Vertical Lux @ 1.5m**	**Notes**
E16	0.00	3.43	Part screened light spill from A43 0.5 Lux at 40m from perimeter (treeline outside face – 21.8 Lux Average)
E17	0.00	0.01	Natural Darkness (treeline outside face – 3.5 Lux Average) 3.5 Lux (South) to 6.21 Lux (Mid) to 11.02 Lux (North)
E18	0.00	0.01	Natural Darkness
E19	0.00	0.00	Natural Darkness (treeline outside face – 6.21 Lux Average)
E20	0.00 (taken as the darkest measured value, excluding temporary security lighting).	0.01 (taken as the darkest measured value, excluding temporary security lighting).	Occupancy sensing security lighting (cool LED)
E21	0.00	0.00	Natural Darkness (treeline outside face – 11.02 Lux Average)
E22	0.7	0.9	Private building mounted luminaires (treeline outside face – 9.4 Lux Average)
E23	0.01	0.02	Natural Darkness
E24	0.01	0.02	Natural Darkness
E25	0.01	0.02	Natural Darkness
E26	0.01	0.02	Natural Darkness
E27	0.01	0.02	Natural Darkness
E28	0.01	0.02	Natural Darkness Varies from 0.04 to 0.51 Lux from passing vehicle headlights
E29	0.01	0.02	Natural Darkness Varies from 0.04 to 0.51 Lux from passing vehicle headlights
E30	0.01	0.02	Natural Darkness
E31	0.03	0.16	Partial Light Spill from Highways

Figure X4 – Ecology Receptor Locations – West

X1.2.2.3 - Data Sheet – Baseline Survey Locations – Residential

Location	**R1 TO R21 – Residential Locations (Figure X5)**		
	Horizontal Lux @ Ground	**Vertical Lux @ 1.5m**	**Notes**
R1 - Medkre	0.01	0.02	Natural Darkness.
R2 – Baynards House	Not accessible. 0.01 (taken as the darkest measured value, excluding private lighting).	Not accessible. 0.02 (taken as the darkest measured value, excluding private lighting).	Private rear floodlighting. Default darkness value taken to demonstrate a worst case condition.
R3 – The Cottages	0.00 (taken as the darkest measured value, excluding temporary security lighting).	0.01 (taken as the darkest measured value, excluding temporary security lighting).	Occupancy sensing security lighting – temporary and limited in operation (cool LED).
R4 – Baynards Green Farm	Not Accessible 0.01 Lux (taken as the darkest measured value).	Not accessible 0.02 Lux (taken as the darkest measured value).	Default darkness value taken to demonstrate a worst case condition.
R5 – Hotel	Various levels Typically – 4.7 Lux.	Various levels Typically – 2.8 Lux.	Baseline condition currently exceeds guidance.
R6 TO R21	Not relevant due to being outside of the calculated zone of influence.	Not relevant due to being outside of the calculated zone of influence.	Various lighting conditions up to E3 (Medium District Brightness). However, fall outside of the calculated zone of influence and is only subject to glare.

Figure X5 – Residential Receptor Locations

X1.2.2.4 - Data Sheet – Baseline Survey Locations - Aerodrome

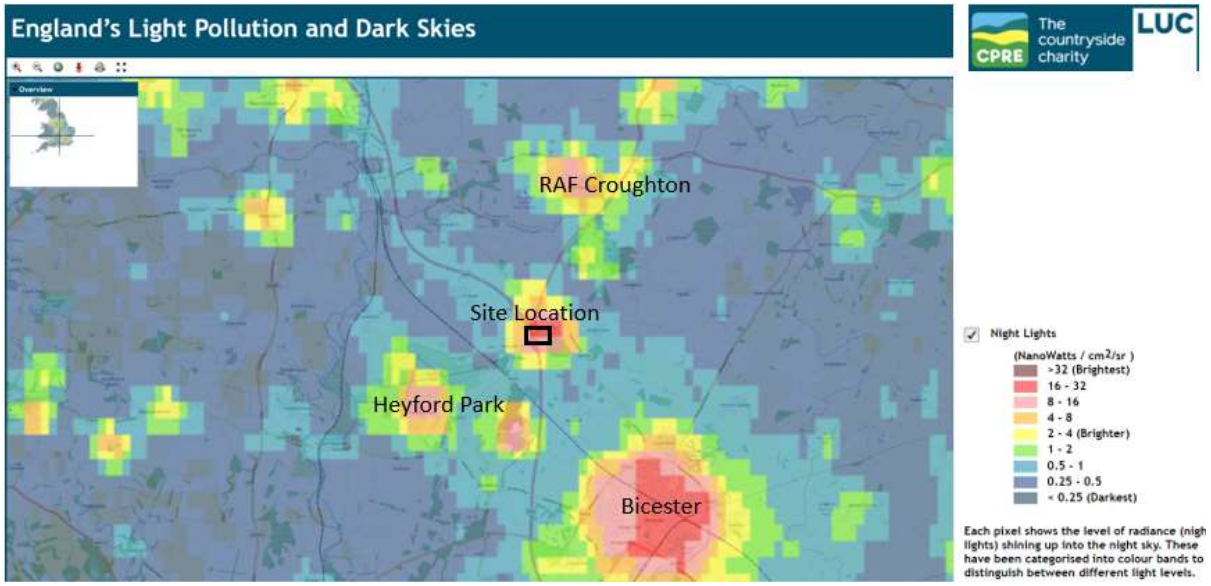
Location	A1 - Aerodrome Locations (Figure X6)		
	Horizontal Lux @ Ground	**Vertical Lux @ 1.5m**	**Notes**
A1 – Upper Heyford USAF Station	NA	NA	Various lighting conditions up to E3 (Medium District Brightness).

Figure X6 – Aerodrome Receptor Location

X1.2.2.5 - Data Sheet – Dark Sky

Location	**Site wide (Figure X7)**
Use	Natural
External Lighting Condition	NA
Horizontal Measured Illuminance (Lux @ Ground)	NA
Vertical Measured Illuminance (Lux @ 1.5m)	NA
Existing Obtrusive Light Scenario (Receptor Cause)	NA
Current Obtrusive Light Impact to Receptor	The current light scenario demonstrates a sky glow that can be associated with an environment that is typical for an E2 / E3 environment. This particularly emanates from surrounding highway lighting (high pressure sodium).
Notes:	

Figure X7 – Dark Sky Satellite Data



Appendix 2.0 – External Lighting Parameters

X2.0 – INTRODUCTION

External Lighting Parameters have been prepared for the purposes of this application. These are in tandem with the preliminary lighting layout prepared to support the illustrative masterplan and is assessed independently within **Appendix 3.0**.

Including for the External Lighting Parameters and mitigation recommended within this report, it is the intent that a detailed lighting design will be prepared for approval as part of a future reserved matters applications.

The future detailed lighting design should consider best practice standards and technology, as appropriate. The external lighting specification(s) and design(s) for the future proposed development of the Application Sites should be prepared by a specialist lighting engineer with due regard to the sensitivities of surrounding receptors. The lighting specification should include the appropriate selection of column heights, light fittings and luminaire design to ensure that the intensity and direction of the lighting is controlled through retaining tilting angles close to the horizontal to ensure that the effects of light spill, glare and sky glow are minimised. Consideration should be given, where applicable, to the measures in appropriate best practice guidance and standards.

- The British Standards Institution *BS 5489-1: 2020 – Design of road lighting – Part 1: Lighting of roads and public amenity areas*, BSI Standards, London;
- The British Standards Institution / CEN (2015) *BS EN 13201-2: 2015 – Road lighting – Part 2: Performance requirements,* BSI Standards, London;
- The British Standards Institution / CEN (2014) *BS EN 12464-2:2014 – Lighting of Work Places – Part 2: Outdoor work places*, BSI Standards, London; and
- Bat Conservation Trust / ILP (2018) *Guidance Note - 8/18 - Bats and Artificial Lighting in the UK* Bat Conservation Trust, London / ILP, Warwickshire.

The following pages provide the External Lighting Parameters and associated embedded mitigation measures:

With respect to the External Lighting Parameters the following good practice embedded measures are included within the assessment, which are intended as being the base principals for the future lighting developments of the Sites:

- Wherever possible, ensuring the use of controlled light distribution, optimised optics (flat glass - controlled light distribution below the horizontal) minimal inclination and considered luminaire positioning / minimal heights are employed (maximum 6m at inwards facing perimeter with 5° inclination and maximum 10m (0°) to build and hard landscaped areas);
- Rear back shield employed at all perimeter locations;
- Where possible, modern LED luminaires should be employed throughout to minimise the obtrusive light spill footprint and be as energy efficient as possible;
- All luminaires used around the perimeter should be mounted within the Sites (at a reduced height where practicable), in order that the main photometric distribution of the luminaire will be towards the task area, keeping all light within the boundary of the development and preventing artificial light spilling outside of this;
- Adopting a light quality that minimises disruption to existing ecological systems in the form of ‘LED’ light sources (<3000K and >550 nm) which emit minimal UV and blue light; and

- Minimising surface reflectances (minimising reflected uplight) – Ground and Landscape <8%, Build <20%.

A comprehensive lighting design for the proposed development of the Application Sites will be prepared at the relevant future design stages.

Environmental Zone Classification

Assessment of the designation, use, habitat and external lighting condition dictates the classification of Environmental Zones across the Sites and their surrounding areas. The Environmental Zones relate to limiting guidance published by the Institute of Lighting Professionals ILP for obtrusive light (residential and highway) - ILP Guidance Notes for the Reduction of Obtrusive Light (2021).

With lighting generally being limited to adjacent highway, the Site and surroundings are considered representative of being an E2 Zone (Rural surroundings, low district brightness areas – Village or relatively dark outer suburban locations) with lit highway and adjacent commercial premises being comparable to that of an E3 Zone (medium brightness).

Therefore, on a precautionary approach LightPaD's interpretation of the Environmental Zones to the Sites and surroundings are:

- **E2 Zone (Rural surroundings, low district brightness areas)**

Although, in terms of skyglow, the Sites and surroundings can be associated with an environment that is typical for an E2 / E3 environment. This is a result of the poorly controlled highway lighting (high pressure sodium).

External Lighting Parameters

Being 24-hour operation, the primary functional uses of the proposed Land use Parameters have been identified below.

These are supported by datasheets defining the precautionary lighting equipment and relevant design criteria (advised by Applicant standards).

- Site Access - Typical Access Road (Local Authority)
- Site Access - Typical Unit Access Road
- Build Areas - Typical Gate House
- Build Areas - Typical Service Yard
- Build Areas - Typical Yard Link Road
- Hard Landscaping - Typical Car Park
- Hard Landscaping - Typical Unit Walkway

X2.1.1 – External Lighting Parameters Data Sheet

Typical Access Road (Local Authority)

Typical Equipment

- Holophane Europe Limited
- V-Max Street lighting luminaire with a Type III - Medium distribution
- Flat glass, zero tilt and zero uplight
- 10m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Dusk till dawn operation
- Glare shield options

Typical Design Criteria (TBC)

- BS 5489-1 2020 & BS EN 13201-2
- Conflict area C3
- BS EN 13201-2, 5, Table 2
- 15 Lux (average maintained), 40% uniformity

X2.1.2 – External Lighting Parameters Data Sheet

Typical Unit Access Road

Typical Equipment

- Holophane Europe Limited
- D Series 1
- Flat glass, zero tilt and zero uplight
- 8/10m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Rear back shields where applicable
- Dusk till dawn operation
- Glare shield options

Typical Design Criteria

- BS 5489-1 2020 & BS EN 13201-2
- 20 Lux (average maintained), 40% uniformity

X2.1.3 – External Lighting Parameters Data Sheet

Typical Gate House

Typical Equipment

- Holophane Europe Limited
- D Series 1
- Flat glass, zero tilt and zero uplight
- 10m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Dusk till dawn operation
- Glare shield options
- Dim down to 5% output capabilities, based on zonal occupancy

Typical Design Criteria

- 20 Lux (average maintained), 40% uniformity

X2.1.4 – External Lighting Parameters Data Sheet

Typical Service Yard

Typical Equipment

- Holophane Europe Limited
- D Series 1 (10m high) and Wall Pack (5m high mounting)
- Flat glass, zero tilt and zero uplight
- 10m mounting height, column and wall mounted
- Rear back shields where applicable
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Dusk till dawn operation
- Glare shield options
- Dim down to 5% output capabilities, based on zonal occupancy

Typical Design Criteria

- 50 Lux (average maintained), 40% uniformity

X2.1.5 – External Lighting Parameters Data Sheet

Typical Yard Link Road

Typical Equipment

- Holophane Europe Limited
- D Series 1
- Flat glass, zero tilt and zero uplight
- 8m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Rear back shields where applicable
- Dusk till dawn operation
- Glare shield options
- Dim down to 5% output capabilities, based on zonal occupancy

Typical Design Criteria

- BS 5489-1 2020 & BS EN 13201-2
- 20 Lux (average maintained), 40% uniformity

X2.1.6 – External Lighting Parameters Data Sheet

Typical Car / Cycle Park

Typical Equipment

- Holophane Europe Limited
- D Series 1
- Flat glass, typically at zero tilt (inwards facing perimeters at 5°) and zero uplight
- 6m (perimeters) to 8m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Rear back shields where applicable
- Dusk till dawn operation
- Glare shield options
- Dim down to 5% output capabilities, based on zonal occupancy

Typical Design Criteria

- BS 5489-1 2020 & BS EN 13201-2
- 20 Lux (average maintained), 25% uniformity

X2.1.7 – External Lighting Parameters Data Sheet

Typical Unit Walk Way

Typical Equipment

- Holophane Europe Limited
- Denver iD Wall
- Flat glass, zero tilt and zero uplight
- 2.7m mounting height
- Minimum UV / Blue Light
- CCT 3000K, >550 nm Peak (BCT guidance 2018)
- Occupancy sense, Dusk till dawn operation
- Glare shield options
- Dim down to 5% output capabilities, based on zonal occupancy

Typical Design Criteria

- 10 Lux (average maintained), 25% uniformity

Appendix 3.0 – Sample Assessment in support of the Illustrative Masterplan.

X3.0 Assessment

The following provides the obtrusive light assessment, which provides assessment of the exterior operational lighting parameters towards the surrounding environment for the preliminary lighting layout prepared to support the illustrative masterplan

The intention of the assessment is to convey how illumination for the External Lighting Parameters will fit into the existing Illumination profile of the area and how that will comply with relevant legislation requirements and best practise Design Guidance.

Overview

Alongside baseline data provided within **Appendix 1.0,** the illustrated horizontal illuminance effect contours within **Figures X3.1 and X3.2** are provided to inform the application.

Obtrusive Light Effects to Sensitive Receptors

- **Ecology**

The data represented with **Table X3.1** is relevant to identified **Ecology** where, with reference to the baseline and a resultant value, assessment is provided on the peak vertical effect condition for representative ecology zones.

- **Residential**

The data represented within **Table X3.2** is relevant to identified **Residential Locations** where vertical illuminance to facing elevations and luminaire source intensity (glare) are the recognised key indicators.

- **Aerodrome**

Being part of Upper Heyford USAF Station, although not quantitatively assessed, the embedded mitigation and lighting parameters take into account BS5489-1: 2020 guidance for lighting within the proximity of aerodromes. Where the future external lighting proposals will consider the pattern of lights, and/or their colour, intensity and visibility from an aircraft.

Consequently, further mitigation is not considered to be a future requirement.

- **Dark Sky**

On a sample area identified (which reflects the Sites and provides assessment for the most onerous variants of luminaire types). In accordance with CIE 150, the Upward Flux Ratio (UFR %) is calculated. The data represented in **Table X3.3** is relevant to identified **Sky Glow** where the calculated UFR % is assessed as the key indicator.

Figure X3.1: Graphical representation of horizontal illuminance (Preliminary Lighting Layout prepared to support the Illustrative Masterplan with Embedded Mitigation)

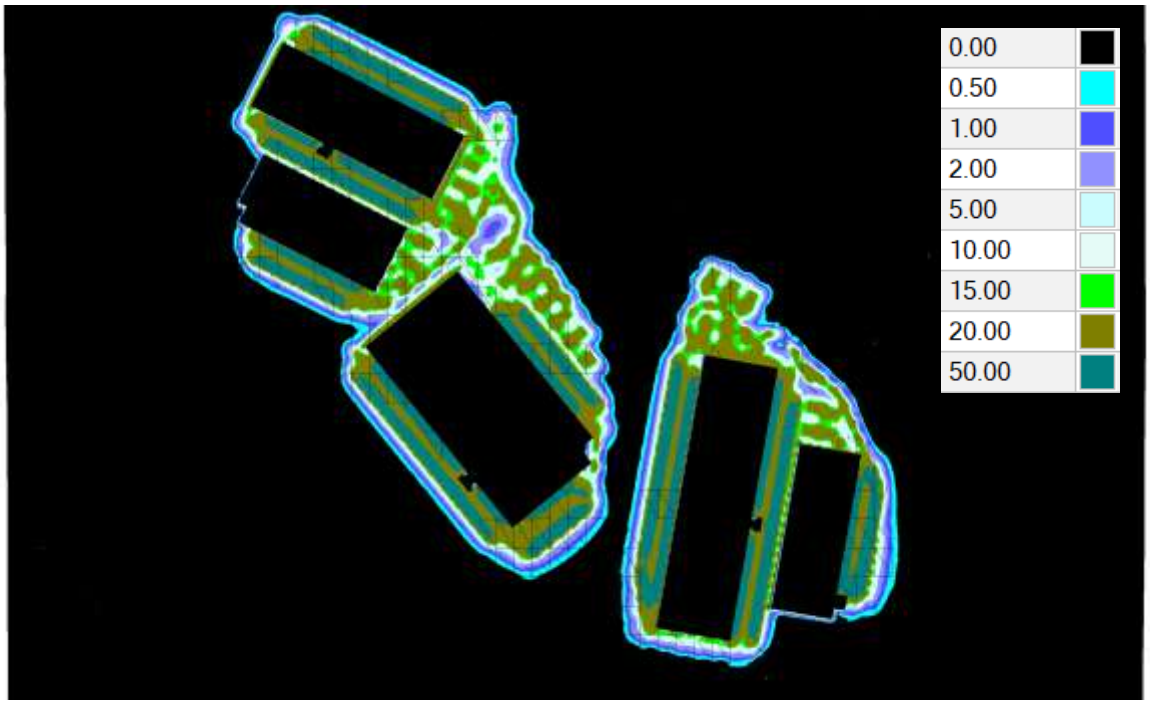
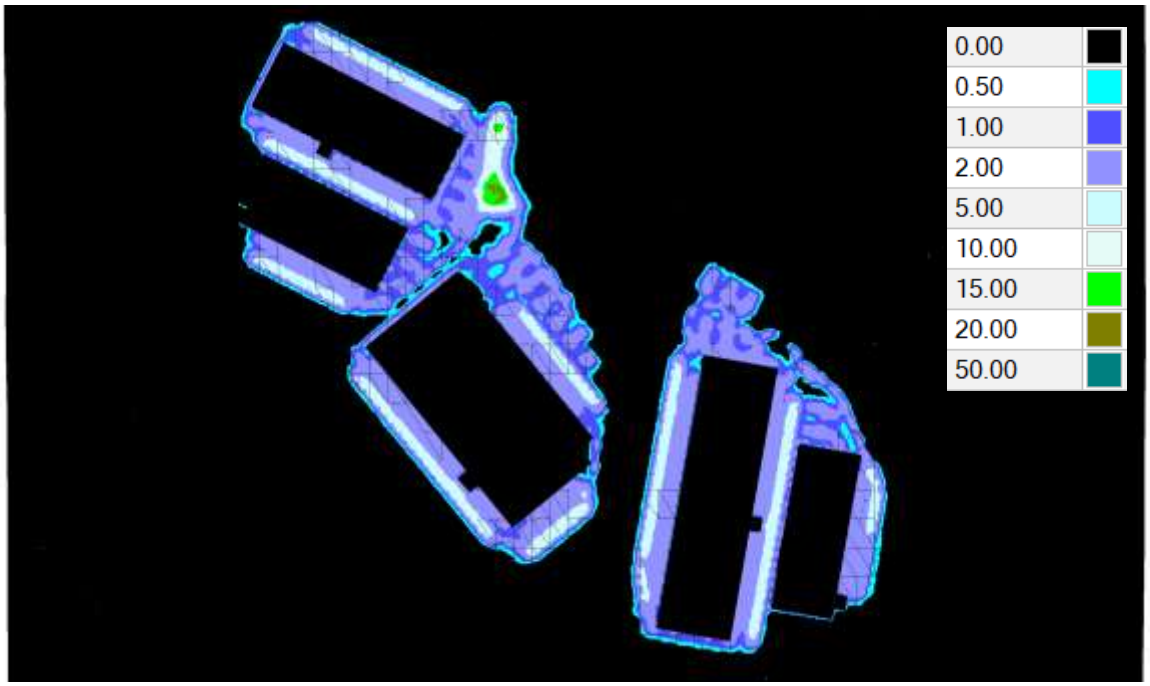


Figure X3.2: Graphical representation of horizontal illuminance (Preliminary Lighting Layout prepared to support the Illustrative Masterplan with Embedded Mitigation and Further Mitigation)



Note:

Maintenance Factor – 1.0.

Direct illuminance at ground level, excludestrees.

Refer to tables for vertical impact to identified receptor locations.

Ecology – Light Sensitive (Bat)

Table X3.1: Vertical Illuminance (Lux) based on the Illustrative Masterplan

Ecology	Existing Illuminance (Lux)	Light Spill - Vertical Plane (Lux) Height				Resultant Max. Vertical Illuminance (Lux) (maximum value incl. current retained baseline)			
		Maximum (100%) operation (embedded mitigation)		Dimmed by occupancy operation (further mitigation)		Maximum (100%) operation (embedded mitigation)		Dimmed by occupancy operation (further mitigation)	
		Height above ground	Lux	Height above ground	Lux	Height above ground	Lux	Height above ground	Lux
TEXT COLOUR LEGEND **Lux Value > 0.5 Lux due to retained existing Baseline Condition (Negligible change in Condition)** **Lux Value >0.5 Lux due to proposed 'Illustrative Masterplan'**									
E01	0.01	0m	0.7	0m	0.1	0m	**0.71**	0m	**0.11**
		2.0m	0.6	2.0m	0.0	2.0m	**0.61**	2.0m	**0.01**
		4.0m	0.5	4.0m	0.0	4.0m	**0.51**	4.0m	**0.01**
		6.0m	0.3	6.0m	0.0	6.0m	**0.31**	6.0m	**0.01**
		8.0m	0.2	8.0m	0.0	8.0m	**0.21**	8.0m	**0.01**
		10.0m	0.1	10.0m	0.0	10.0m	**0.11**	10.0m	**0.01**
E02	0.01	0m	1.7	0m	0.1	0m	**1.71**	0m	**0.11**
		2.0m	1.2	2.0m	0.1	2.0m	**1.21**	2.0m	**0.11**
		4.0m	0.8	4.0m	0.0	4.0m	**0.81**	4.0m	**0.01**
		6.0m	0.5	6.0m	0.0	6.0m	**0.51**	6.0m	**0.01**
		8.0m	0.2	8.0m	0.0	8.0m	**0.21**	8.0m	**0.01**
		10.0m	0.1	10.0m	0.0	10.0m	**0.11**	10.0m	**0.01**
E03	0.01	0m	0.3	0m	0.0	0m	**0.31**	0m	**0.01**
		2.0m	0.2	2.0m	0.0	2.0m	**0.21**	2.0m	**0.01**
		4.0m	0.1	4.0m	0.0	4.0m	**0.12**	4.0m	**0.01**
		6.0m	0.1	6.0m	0.0	6.0m	**0.12**	6.0m	**0.01**
		8.0m	0	8.0m	0.0	8.0m	**0.01**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E04	0.02	0m	3.3	0m	0.2	0m	**3.32**	0m	**0.22**
		2.0m	2.7	2.0m	0.1	2.0m	**2.72**	2.0m	**0.12**
		4.0m	2.1	4.0m	0.1	4.0m	**2.12**	4.0m	**0.12**
		6.0m	1.5	6.0m	0.1	6.0m	**1.52**	6.0m	**0.12**
		8.0m	0.9	8.0m	0.0	8.0m	**0.92**	8.0m	**0.02**
		10.0m	0.1	10.0m	0.0	10.0m	**0.12**	10.0m	**0.02**
E05	0.02	0m	7.2	0m	0.6	0m	**7.22**	0m	**0.62**
		2.0m	6.1	2.0m	0.5	2.0m	**6.12**	2.0m	**0.52**
		4.0m	4.2	4.0m	0.4	4.0m	**4.22**	4.0m	**0.42**
		6.0m	1.9	6.0m	0.1	6.0m	**1.92**	6.0m	**0.12**
		8.0m	0.7	8.0m	0.0	8.0m	**0.72**	8.0m	**0.02**
		10.0m	0.2	10.0m	0.0	10.0m	**0.22**	10.0m	**0.02**

E06	0.02	0m	0.1	0m	0.3	0m	**0.12**	0m	**0.02**
		2.0m	0.8	2.0m	0.0	2.0m	**0.82**	2.0m	**0.02**
		4.0m	0.6	4.0m	0.0	4.0m	**0.62**	4.0m	**0.02**
		6.0m	0.4	6.0m	0.0	6.0m	**0.42**	6.0m	**0.02**
		8.0m	0.2	8.0m	0.0	8.0m	**0.22**	8.0m	**0.02**
		10.0m	0.1	10.0m	0.0	10.0m	**0.12**	10.0m	**0.02**
E07	2.3	0m	2	0m	0.2	0m	**4.3**	0m	**2.5**
		2.0m	1.3	2.0m	0.1	2.0m	**3.3**	2.0m	**2.4**
		4.0m	0.7	4.0m	0.1	4.0m	**3.0**	4.0m	**2.4**
		6.0m	0.2	6.0m	0.0	6.0m	**2.5**	6.0m	**2.3**
		8.0m	0	8.0m	0.0	8.0m	**2.3**	8.0m	**2.3**
		10.0m	0	10.0m	0.0	10.0m	**2.3**	10.0m	**2.3**
E08	0.0	0m	1.3	0m	0.1	0m	**1.3**	0m	0.1
		2.0m	0.9	2.0m	0.1	2.0m	**0.9**	2.0m	0.1
		4.0m	0.5	4.0m	0.0	4.0m	**0.5**	4.0m	0.0
		6.0m	0.2	6.0m	0.0	6.0m	**0.2**	6.0m	0.0
		8.0m	0.1	8.0m	0.0	8.0m	**0.1**	8.0m	0.0
		10.0m	0	10.0m	0.0	10.0m	**0**	10.0m	0.0
E09	0.05	0m	2.99	0m	0.2	0m	**3.04**	0m	**0.25**
		2.0m	2.2	2.0m	0.2	2.0m	**2.25**	2.0m	**0.25**
		4.0m	1.2	4.0m	0.1	4.0m	**1.25**	4.0m	**0.15**
		6.0m	0.4	6.0m	0.0	6.0m	**0.09**	6.0m	**0.05**
		8.0m	0.1	8.0m	0.0	8.0m	**0.15**	8.0m	**0.05**
		10.0m	0	10.0m	0.0	10.0m	**0.05**	10.0m	**0.05**
E10	**Removed as part of 'Illustrative Masterplan'**								
E11	0.01	0m	3.2	0m	0.2	0m	**3.21**	0m	**0.21**
		2.0m	2.3	2.0m	0.2	2.0m	**2.31**	2.0m	**0.21**
		4.0m	1.4	4.0m	0.1	4.0m	**1.41**	4.0m	**0.11**
		6.0m	0.5	6.0m	0.0	6.0m	**0.51**	6.0m	**0.01**
		8.0m	0.2	8.0m	0.0	8.0m	**0.21**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E12	0.02	0m	27.8	0m	1.6	0m	**27.82**	0m	**1.62**
		2.0m	19	2.0m	1.2	2.0m	**19.02**	2.0m	**1.22**
		4.0m	15.6	4.0m	1.2	4.0m	**15.62**	4.0m	**1.22**
		6.0m	26.2	6.0m	2.5	6.0m	**26.22**	6.0m	**2.52**
		8.0m	68.7	8.0m	6.8	8.0m	**68.72**	8.0m	**6.82**
		10.0m	106.7	10.0m	10.7	10.0m	**106.72**	10.0m	**10.72**
E13	0.01	0m	0.2	0m	0.0	0m	**0.21**	0m	**0.01**
		2.0m	0.2	2.0m	0.0	2.0m	**0.21**	2.0m	**0.01**
		4.0m	0.1	4.0m	0.0	4.0m	**0.11**	4.0m	**0.01**
		6.0m	0.1	6.0m	0.0	6.0m	**0.11**	6.0m	**0.01**
		8.0m	0	8.0m	0.0	8.0m	**0.01**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E14	0.01	0m	0.7	0m	0.0	0m	**0.71**	0m	**0.01**
		2.0m	0.5	2.0m	0.0	2.0m	**0.51**	2.0m	**0.01**

		4.0m	0.4	4.0m	0.0	4.0m	**0.41**	4.0m	**0.01**
		6.0m	0.2	6.0m	0.0	6.0m	**0.21**	6.0m	**0.01**
		8.0m	0.1	8.0m	0.0	8.0m	**0.11**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E15	0.01	0m	0.6	0m	0.0	0m	**0.61**	0m	**0.01**
		2.0m	0.5	2.0m	0.0	2.0m	**0.51**	2.0m	**0.01**
		4.0m	0.4	4.0m	0.0	4.0m	**0.41**	4.0m	**0.01**
		6.0m	0.3	6.0m	0.0	6.0m	**0.31**	6.0m	**0.01**
		8.0m	0.2	8.0m	0.0	8.0m	**0.21**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E16	3.43	0m	0.1	0m	0.0	0m	**3.53**	0m	**3.43**
		2.0m	0.1	2.0m	0.0	2.0m	**3.53**	2.0m	**3.43**
		4.0m	0.1	4.0m	0.0	4.0m	**3.53**	4.0m	**3.43**
		6.0m	0.1	6.0m	0.0	6.0m	**3.53**	6.0m	**3.43**
		8.0m	0.1	8.0m	0.0	8.0m	**3.53**	8.0m	**3.43**
		10.0m	0.1	10.0m	0.0	10.0m	**3.53**	10.0m	**3.43**
E17	0.01	0m	0.97	0m	0.1	0m	**0.98**	0m	**0.11**
		2.0m	0.7	2.0m	0.1	2.0m	**0.71**	2.0m	**0.11**
		4.0m	0.5	4.0m	0.0	4.0m	**0.51**	4.0m	**0.01**
		6.0m	0.4	6.0m	0.0	6.0m	**0.41**	6.0m	**0.01**
		8.0m	0.3	8.0m	0.0	8.0m	**0.31**	8.0m	**0.01**
		10.0m	0.2	10.0m	0.0	10.0m	**0.21**	10.0m	**0.01**
E18	0.01	0m	6.6	0m	0.5	0m	**6.61**	0m	**0.51**
		2.0m	4.1	2.0m	0.3	2.0m	**4.11**	2.0m	**0.31**
		4.0m	2.9	4.0m	0.2	4.0m	**2.91**	4.0m	**0.21**
		6.0m	1.6	6.0m	0.1	6.0m	**1.61**	6.0m	**0.11**
		8.0m	0.5	8.0m	0.0	8.0m	**0.51**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E19	0.0	0m	0.4	0m	0.0	0m	**0.4**	0m	**0.0**
		2.0m	0.3	2.0m	0.0	2.0m	**0.3**	2.0m	**0.0**
		4.0m	0.2	4.0m	0.0	4.0m	**0.2**	4.0m	**0.0**
		6.0m	0.1	6.0m	0.0	6.0m	**0.1**	6.0m	**0.0**
		8.0m	0.1	8.0m	0.0	8.0m	**0.1**	8.0m	**0.0**
		10.0m	0	10.0m	0.0	10.0m	**0**	10.0m	**0.0**
E20	0.01 (taken as the darkest measured value, excluding temporary security lighting).	0m	1	0m	0.1	0m	**1.01**	0m	**0.21**
		2.0m	0.7	2.0m	0.1	2.0m	**0.71**	2.0m	**0.11**
		4.0m	0.4	4.0m	0.0	4.0m	**0.41**	4.0m	**0.01**
		6.0m	0.2	6.0m	0.0	6.0m	**0.21**	6.0m	**0.01**
		8.0m	0	8.0m	0.0	8.0m	**0.01**	8.0m	**0.01**
		10.0m	0	10.0m	0.0	10.0m	**0.01**	10.0m	**0.01**
E21	0.0	0m	0	0m	0.0	0m	**0.4**	0m	**0**
		2.0m	0.2	2.0m	0.0	2.0m	**0.2**	2.0m	**0**
		4.0m	0.1	4.0m	0.0	4.0m	**0.1**	4.0m	**0**
		6.0m	0	6.0m	0.0	6.0m	**0**	6.0m	**0**
		8.0m	0	8.0m	0.0	8.0m	**0**	8.0m	**0**

		10.0m	0	10.0m	0	10.0m	**0**	10.0m	**0**
E22	0.9	0m	0.1	0m	0.0	0m	**1.0**	0m	**0.9**
		2.0m	0.1	2.0m	0.0	2.0m	**1.0**	2.0m	**0.9**
		4.0m	0	4.0m	0.0	4.0m	**0.9**	4.0m	**0.9**
		6.0m	0	6.0m	0.0	6.0m	**0.9**	6.0m	**0.9**
		8.0m	0	8.0m	0.0	8.0m	**0.9**	8.0m	**0.9**
		10.0m	0	10.0m	0.0	10.0m	**0.9**	10.0m	**0.9**
E23	0.02	0m	0.48	0m	0.1	0m	**0.5**	0m	**0.12**
		2.0m	0.4	2.0m	0.0	2.0m	**0.42**	2.0m	**0.02**
		4.0m	0.3	4.0m	0.8	4.0m	**0.32**	4.0m	**0.82**
		6.0m	0.1	6.0m	0.4	6.0m	**0.12**	6.0m	**0.42**
		8.0m	0	8.0m	0.1	8.0m	**0.02**	8.0m	**0.12**
		10.0m	0	10.0m	0	10.0m	**0.02**	10.0m	**0.02**
E24	0.02	0m	0.2	0m	0.0	0m	**0.22**	0m	**0.02**
		2.0m	0.1	2.0m	0.0	2.0m	**0.12**	2.0m	**0.02**
		4.0m	0.1	4.0m	0.0	4.0m	**0.12**	4.0m	**0.02**
		6.0m	0	6.0m	0.0	6.0m	**0.02**	6.0m	**0.02**
		8.0m	0	8.0m	0.0	8.0m	**0.02**	8.0m	**0.02**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E25	0.02	0m	2.8	0m	0.2	0m	**2.82**	0m	**0.22**
		2.0m	2	2.0m	0.2	2.0m	**2.02**	2.0m	**0.22**
		4.0m	1.2	4.0m	0.1	4.0m	**1.22**	4.0m	**0.12**
		6.0m	0.5	6.0m	0.0	6.0m	**0.52**	6.0m	**0.02**
		8.0m	0.2	8.0m	0.0	8.0m	**0.22**	8.0m	**0.02**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E26	0.02	0m	0.02	0m	0.0	0m	**0.04**	0m	**0.02**
		2.0m	0.01	2.0m	0.0	2.0m	**0.03**	2.0m	**0.02**
		4.0m	0	4.0m	0.0	4.0m	**0.02**	4.0m	**0.02**
		6.0m	0	6.0m	0.0	6.0m	**0.02**	6.0m	**0.02**
		8.0m	0	8.0m	0.0	8.0m	**0.02**	8.0m	**0.02**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E27	0.02	0m	0	0m	0.0	0m	**0.02**	0m	**0.02**
		2.0m	0	2.0m	0.0	2.0m	**0.02**	2.0m	**0.02**
		4.0m	0	4.0m	0.0	4.0m	**0.02**	4.0m	**0.02**
		6.0m	0	6.0m	0.0	6.0m	**0.02**	6.0m	**0.02**
		8.0m	0	8.0m	0.0	8.0m	**0.02**	8.0m	**0.02**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E28	0.02	0m	0	0m	0.0	0m	**0.02**	0m	**0.02**
		2.0m	0	2.0m	0.0	2.0m	**0.02**	2.0m	**0.02**
		4.0m	0	4.0m	0.0	4.0m	**0.02**	4.0m	**0.02**
		6.0m	0	6.0m	0.0	6.0m	**0.02**	6.0m	**0.02**
		8.0m	0	8.0m	0.0	8.0m	**0.02**	8.0m	**0.02**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E29	0.02	0m	7.5	0m	0.7	0m	**7.52**	0m	**0.72**
		2.0m	5.3	2.0m	0.5	2.0m	**5.32**	2.0m	**0.52**

		4.0m	4.4	4.0m	0.4	4.0m	**4.42**	4.0m	**0.42**
		6.0m	3.2	6.0m	0.3	6.0m	**3.22**	6.0m	**0.32**
		8.0m	0.3	8.0m	0.4	8.0m	**0.32**	8.0m	**0.42**
		10.0m	0	10.0m	0.0	10.0m	**0.02**	10.0m	**0.02**
E30	**Removed as part of 'Illustrative Masterplan'**								

Conclusion:

Currently there is a lack of evidence regarding the light levels below which there are no/reduced effects on bats. Responses of bats to light levels are likely to vary between species and between behaviours. A "light threshold" below which there is little effect on bats may not exist for some species which may be light averse regardless of intensity.

However, in support of the Ecology Assessment, the assessments illustrate where the light level condition is likely to be exceed an example 0.5 Lux.

Being similar in effect characteristics to the proposed 'Land Use Parameter' assessment, during periods of illuminated night time activity (occupied and when operational light levels will be at a maximum), the effects at perimeter ecology locations have the potential to exceed the example 0.5 Lux threshold.

Therefore, to avoid this effect towards ecology, the following lists the further mitigation measures that should be applied (in addition to / as a change to the preliminary design measures, set out within preliminary drawing **Appendix 3.0 - External Lighting - 1717-ESC-00-ZZ-DR-E-2100:**

Site Access - Typical Access Road (Local Authority), Site Access - Typical Unit Access Road

- Rear back shields to all luminaire positions.

Build Areas - Typical Gate House, Typical Service Yard, Typical Yard Link Road

- Dim down to 5% output capabilities, based on zonal occupancy to Build Zone Parameters;
- Rear back shields to relevant luminaire positions.

Hard Landscaping - Typical Car Park, Typical Unit Walkway

- Dim down to 10% output capabilities, based on zonal occupancy to Hard Landscaping Zone (incl. Servicing and Parking) Parameters;
- Reduced mounting heights at perimeters (6m), originally 8m;
- Angled 5° tilt to inwards facing luminaires; and
- Rear back shields to all perimeter luminaires.

From the implementation of these further mitigation measures the effects will be reduced to be within thresholds (<0.5 Lux), the effect towards species is subject to the Ecology assessment.

Residential

Table X3.2: Vertical Illuminance and Glare (Lux) based on Illustrative Masterplan

Residential Refer to Appendix 1.0	Guidance Pre Curfew / Post Curfew		Existing Vertical Illuminance (Lux) (1.5m AFL)	Calculated Obtrusive Light (maximum value to elevation) as a result of the Development Proposals				Resultant Obtrusive Light (maximum value to elevation incl. current retained baseline)			
	E2 Zone – Lux Vertical Illuminance Max. into Windows (ILP Guidance Notes 2020) (Lux)	E2 Zone – Glare Luminous Intensity (ILP Guidance Notes 2020) (Lux) Calculated for specific receptor location, distance and peak luminaire visible		Maximum (100%) operation		Dimmed by occupancy operation		Maximum (100%) operation		Dimmed by occupancy operation	
				Lux	Glare kcd	Lux	Glare kcd	Lux	Glare kcd	Lux	Glare kcd
TEXT COLOUR LEGEND Lux Value > Post Curfew Guidance due to retained existing Baseline Condition (Negligible change in Condition) Lux Value > Post Curfew Guidance due to Illustrative Masterplan Glare > Pre and Post Curfew Guidance due to Illustrative Masterplan Glare > Post Curfew Guidance due to proposed Illustrative Masterplan											
R1 - Medkre	5 / 1	0.20 / 0.1	**0.02**	0.22		0.09		**0.24**	**0.58**	**0.11**	**0.35**
R2 – Baynards House	5 / 1	0.32 / 0.15	Not accessible. 0.02 (taken as the darkest measured value, excluding private lighting).	0.14		0.02		**0.16**	**0.50**	**0.04**	**0.17**
R3 – The Cottages	5 / 1	0.39 / 0.19	**0.01**	0.61		0.06		**0.62**	**0.61**	**0.07**	**0.10**
R4 – Baynards Green Farm	5 / 1	0.37 / 0.18	Not accessible 0.02 Lux (taken as the darkest measured value).	0.04		0.01		**0.06**	**0.37**	**0.03**	**0.07**
R5 - Hotel	5 / 1	0.23 / 0.11	Various levels Typically – 2.8 Lux.	0.23		0.01		**3.03**	**0.88**	**2.81**	**0.04**
R6 – Padbury Lodge	5 / 1	0.93/ 0.47	Various lighting conditions up to E3 (Medium District Brightness). However, fall outside of the calculated zone of influence and is only subject to glare.	0	0	0	0	As Existing	**0.05**	As Existing	**0.00**
R7 – Park Farm	5 / 1	1.1 / 0.56	**As above.**	0	0	0	0	As Existing	**0.06**	As Existing	**0.00**
R8 – Oxford Lodge	5 / 1	0.73 / 0.37	**As above.**	0	0	0	0	As Existing	**0.12**	As Existing	**0.01**
R9 – Horwell	5 / 1	0.69 / 0.34	**As above.**	0	0	0	0	As Existing	**0.06**	As Existing	**0.00**
R10 – Green Farm	5 / 1	0.79 / 0.38	**As above.**	0	0	0	0	As Existing	**0.01**	As Existing	**0.00**
R11 – Fritwell Village	5 / 1	1.06 / 0.54	**As above.**	0	0	0	0	As Existing	**0.07**	As Existing	**0.00**
R12 – Willowbank Farm	5 / 1	0.56 / 0.29	**As above.**	0	0	0	0	As Existing	**0.11**	As Existing	**0.01**
R13 – Fewcott Village	5 / 1	0.46 / 0.23	**As above.**	0	0	0	0	As Existing	**0.21**	As Existing	**0.01**
R14 – Ardley Village	5 / 1	0.92 / 0.47	**As above.**	0	0	0	0	As Existing	**0.06**	As Existing	**0.00**

R15 – The Barn House	5 / 1	1.17 / 0.59	**As above.**	0	0	0	0	As Existing	**0.07**	As Existing	**0.00**
R16 – Woodbine Cottage	5 / 1	1.35 / 0.69	**As above.**	0	0	0	0	As Existing	**0**	As Existing	**0.00**
R17 – Swift House	5 / 1	0.47 / 0.24	**As above.**	0	0	0	0	As Existing	**0.07**	As Existing	**0.00**
R18 – The Branch	5 / 1	1.02 / 0.52	**As above.**	0	0	0	0	As Existing	**0.05**	As Existing	**0.00**
R19 – Stoke Lyne Village	5 / 1	1.21 / 0.62	**As above.**	0	0	0	0	As Existing	**0.06**	As Existing	**0.00**
R20 – The Cottage	5 / 1	1.18 / 0.30	**As above.**	0	0	0	0	As Existing	**0.16**	As Existing	**0.01**
R21 – Lone Barn	5 / 1	0.71 / 0.36	**As above.**	0	0	0	0	As Existing	**0.14**	As Existing	**0.01**

Conclusion:

Being similar in effect characteristics to the proposed 'Land Use Parameter' assessment, during periods of illuminated night time activity (occupied and when operational light levels will be at a maximum) the residential locations within a closer proximity (R1, R2, R3, R4 and R5) experience the potential visibility of non-compliant glare.

In addition to and excluding R5 (where the current baseline exceeds guidance) all light spill values to facing residential elevations have been calculated to comply with guidance thresholds for the Environmental Zone.

Therefore, to ensure glare is controlled within guidance, in addition to further mitigation measures previously mentioned as per the Ecology assessment, glare shields should be located at relevant luminaire positions (including all proposed non-dimmed new access roadway / highway lighting locations).

From the implementation of these further mitigation measures the potential effects (Glare) are controlled to comply with relevant guidance criteria for an E2 zone during non-occupied operation (subject to limited to occupancy based durations / frequencies).

Dark Sky

For the purposes of skyglow assessment the current sky glow region is considered to be representative Environmental Zone classification of being an E2/E3: Low / Mid district brightness.

Considering CIE150 and ILP Guidance Notes for the Reduction of Obtrusive Light (2021) the limiting sky glow percentage for amenity installations has been interpolated as (6+12)/2 = 9%

Following the calculation of the upwards and downward ratio the UFR% for the proposed Development is:

- **Sample Area UFR = 8.23% < 9%**

Table X3.3: Direct Sky Glow

Dark Sky	**Sky Glow**		
	Existing Condition	**Sky Glow UFR (Max. %) (interpolated for amenity E2 to E3)**	**Calculated UFR %**
SG01	Low/Mid sky glow category (typical for an E2 / E3 environment	9%	**8.23%**

Conclusion:

From the implementation of embedded mitigation and ensuring landscape and build reluctances are minimised (<8% ground, <20% build), sky glow is controlled to comply with relevant guidance criteria for an E2/E3 zone during all periods of potential operation. In essence, maintaining a no change condition.

Preliminary Lighting Layout (Illustrative Masterplan)

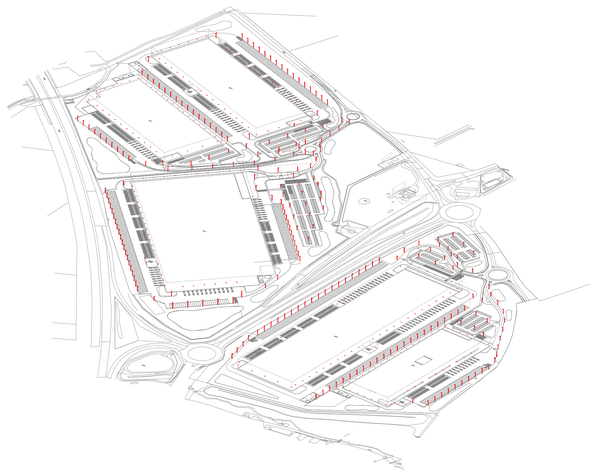
- External Lighting - 1717-ESC-00-ZZ-DR-E-2100.

QM S ISO 9001 REGISTERED FIRM

RESIDUAL RISK REGISTER			
NO.	DESCRIPTION OF HAZARD	CONTROL MEASURES	ACTION BY
1	UNKNOWN BURIED SERVICES AND SERVICES IDENTIFIED IN WRONG LOCATION.	IDENTIFICATION OF EXISTING UNDERGROUND SERVICES USING UTILITY RECORD DRAWINGS AND CAT SCANNING OF GROUND. CAREFUL EXCAVATION, USING SLOT TRENCHES AND CAT SCANNING OF GROUND.	CONTRACTOR

NOTES

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER ENGINEERING SERVICES CONSULTANCY LIMITED DRAWINGS
2. THE EXTERNAL LIGHTING SHALL BE DESIGNED TO ENSURE THAT REQUIRED LIGHTING LEVELS ARE ACHIEVED WHILST MINIMISING GLARE AND LIGHT SPILLAGE TO THE SURROUNDING AREAS AND TO ENSURE THERE IS NO DIRECT CONTRIBUTION TO UPWARD LIGHT POLLUTION.
3. THE EXTERNAL LIGHTING SCHEME SHALL BE PROVIDED IN ACCORDANCE WITH THE LOCAL PLANNING AUTHORITIES REQUIREMENTS/RESTRICTIONS.
4. WHERE COLUMNS ARE POSITIONED NEAR TO NEIGHBOURING PROPERTIES, OR LOCATED ON THE PERIMETER OF THE SITE, THEY SHALL BE COMPLETE WITH SUITABLE BACK-SHIELDS TO PREVENT LIGHT SPILL.
5. ALL COLUMNS SHALL HAVE A FLEXIBLE DUCT PASSING INTO THE BASE, THROUGH THE CONCRETE, TO ENSURE THAT FUTURE REWIRING OF THE CIRCUITS IS POSSIBLE.
6. WHERE LUMINAIRES ARE FIXED DIRECTLY TO THE EXTERNAL BUILDING FABRIC, THE LUMINAIRES SHALL BE THE SAME RAL COLOUR AS THE CLADDING PANELS. ALL LUMINAIRE FIXING BOLTS ETC. SHALL BE THE SAME COLOUR AS THE LUMINAIRE.
7. GENERALLY, THE COLUMNS SHALL BE GALVANISED STEEL CONSTRUCTION. THE ELECTRICAL CONTRACTOR SHALL LIAISE WITH THE ARCHITECT TO ASCERTAIN THE RAL COLOUR OF THE COLUMNS. THE COLUMN HEADS SHALL MATCH THE RAL COLOUR OF THE COLUMN.
8. WHERE SERVICES NEED TO BE INSTALLED WITHIN DUCTS / TRENCHES, THE ELECTRICAL CONTRACTOR SHALL SUPPLY THE MAIN CONTRACTOR WITH DETAILS OF REQUIRED DUCT ROUTES AND DRAW PIT LOCATIONS.
9. DURING INSTALLATION OF THE EXTERNAL LIGHTING A DRAW WIRE SHALL BE PULLED THROUGH WITH THE CABLING TO PROVIDE A MEANS OF INSTALLING FUTURE SERVICES



South East View

Statistics

Description	Symbol	Avg	Min	Min/Avg
Unit 1 - Cycles	+	17 lux	8 lux	0.47
Unit 1 - Service Yard NE 50/0.40Uo	+	50 lux	21 lux	0.42
Unit 1 - Service Yard SE 50/0.40Uo	+	52 lux	21 lux	0.40
Unit 1 - Service Yard SW 50/0.40Uo	+	50 lux	21 lux	0.42
Unit 1 - Yards Link Road - 20/8	+	29 lux	22 lux	0.76
Unit 1 - Yards Link Road - 20/8	+	21 lux	10 lux	0.48
Unit 2 - Access Road - 20/8	+	23 lux	10 lux	0.43
Unit 2 - Car Park 20/0.25Uo	+	20 lux	6 lux	0.30
Unit 2 - Cycles	+	24 lux	16 lux	0.67
Unit 2 - Rear Walkways 10/0.25Uo	+	10 lux	3 lux	0.30
Unit 2 - Service Yard 50/0.40Uo	+	50 lux	21 lux	0.42
Unit 3 - Access Road 20/0.40Uo	+	23 lux	13 lux	0.57
Unit 3 - Cycles	+	20 lux	12 lux	0.60
Unit 3 - Service Yard NE 50/0.40Uo	+	50 lux	23 lux	0.46
Unit 3 - Service Yard SW 50/0.40Uo	+	50 lux	22 lux	0.44
Unit 3 - Yards Link Road - 20/8	+	20 lux	8 lux	0.40
Access Road - 20/8	+	22 lux	12 lux	0.55
Access Road Local Authority (C3 15/0.40Uo) TBC	+	16 lux	7 lux	0.44
Unit 1 - Access Road - 20/8	+	20 lux	8 lux	0.40
Unit 1 - Car Park 20/0.25Uo	+	22 lux	6 lux	0.27
Unit 3 - Car Park 20/0.25Uo	+	20 lux	8 lux	0.40
Unit 4 - Access Road - 20/8	+	24 lux	10 lux	0.42
Unit 4 - Car Park 20/0.25Uo	+	21 lux	8 lux	0.38
Unit 4 - Car Park 20/0.25Uo	+	22 lux	10 lux	0.45
Unit 4 - Cycles	+	23 lux	14 lux	0.61
Unit 4 - Service Yard E 50/0.40Uo	+	50 lux	20 lux	0.40
Unit 4 - Service Yard W 50/0.40Uo	+	50 lux	22 lux	0.44
Unit 4 - Yards Link Road - 20/8	+	21 lux	9 lux	0.43
Unit 5 - Access Road - 20/8	+	22 lux	7 lux	0.32
Unit 5 - Car Park 20/0.25Uo	+	22 lux	7 lux	0.32
Unit 5 - Cycles	+	22 lux	15 lux	0.68
Unit 5 - Rear Walkways 10/0.25Uo	+	16 lux	4 lux	0.25
Unit 5 - Service Yard W 50/0.40Uo	+	50 lux	21 lux	0.42

Schedule D

Symbol	Label	Quantity	Manufacturer	Catalog Number	Description	Wattage
	A1s	5	HOLOPHANE EUROPE LIMITED	1 x HMAO.4.LC803.FW on 12m Column and Backlight Shield. NB PLEASE CONTACT HOLOPHANE FOR COLUMN BASE DETAILS PRIOR TO INSTALLING SLEEVES	High Mast Advanced Optix	501
	B1	8	HOLOPHANE EUROPE LIMITED	1 x DSX2.2.LA363.FW on 10m Column	D-Series 2 Luminaire	328
	B1s	126	HOLOPHANE EUROPE LIMITED	1 x DSX2.2.LA363.FW.BLS on 10m Column and Backlight Shield	D-Series 2 Luminaire with Back light shield	328
	BW	135	HOLOPHANE EUROPE LIMITED	DSX2.2.LA363.FW on Wall Bracket at 10m AFFL	D-Series 2 Luminaire	328
	C1	7	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA223.FW on 10m Column	D-Series 1 Luminaire	200
	D1	10	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA163.FW on 10m Column	D-Series 1 Luminaire	131
	E1	12	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA163.FW on 8m Column	D-Series 1 Luminaire	131
	E1s	7	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA163.FW.BLS on 8m Column and Backlight Shield	D-Series 1 Luminaire with Back light shield	131
	E2	20	HOLOPHANE EUROPE LIMITED	2 x DSX1.2.LA163.FW on 8m Column	D-Series 1 Luminaire	262
	EW	16	HOLOPHANE EUROPE LIMITED	DSX1.2.LA163.FW on Wall Bracket at 8m AFFL	D-Series 1 Luminaire	131
	F1	16	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA163.AY on 8m Column	D-Series 1 Luminaire	131
	F1s	17	HOLOPHANE EUROPE LIMITED	DSX1.2.LA163.AY.BLS on 8m Column and Backlight Shield	D-Series 1 Luminaire with Back light shield	131
	F2	1	HOLOPHANE EUROPE LIMITED	1 x DSX1.2.LA163.AY on 8m Column	D-Series 1 Luminaire	262
	G	24	HOLOPHANE EUROPE LIMITED	DSX0.1.LA103.AY on Wall Bracket at 6m AFFL	D-Series 0 Area luminaire	81
	G1	1	HOLOPHANE EUROPE LIMITED	1 x DSX0.1.LA103.AY on 6m Column	D-Series 0 Area luminaire	81
	H	6	HOLOPHANE EUROPE LIMITED	WAP.1.LA093.FW at 6m AFFL	WALLPACK	81
	I	27	HOLOPHANE EUROPE LIMITED	DWL.1.LA023.HN.W011 at 2.7m AFFL	Denver iD Wall	10.3
	J	34	HOLOPHANE EUROPE LIMITED	DWL.1.LA043.HN.W025 at 2.7m AFFL	Denver iD Wall	25
	Z1	11	HOLOPHANE EUROPE LIMITED	1 x VMX.2.LA103.VZ.D4D4. W089 on 10m Column	V-Max Streetlighting luminaire with a Type III - Medium distribution	69

Resi 1&2

Baynard House

B4100 Resi

Statistics

Description	Symbol	Max	Min/Avg
Baynard House Vertical Spill	+	0 lux	N/A
Baynard House Vertical Spill	+	0 lux	N/A
Baynard House Vertical Spill	+	0 lux	N/A
Residential Vertical House 1&2	+	0 lux	N/A
Residential Vertical House 1&2	+	1 lux	N/A
Resis off B4100	+	0 lux	N/A
Resis off B4100	+	0 lux	N/A

10m SCALE 1:2000

THIS DRAWING IS FOR INFORMATION ONLY TO DEMONSTRATE DESIGN INTENT AND REPRESENTS THE AGREED SERVICING STRATEGY AND MINIMUM STANDARDS TO BE ACHIEVED. WHERE ADDITIONAL DETAILS HAVE BEEN SHOWN, THIS HAS BEEN PROVIDED IN ORDER TO CONVEY GREATER UNDERSTANDING OF THE CONCEPTUAL REQUIREMENTS AND SHALL NOT BE TAKEN AS DETAILED DESIGN.

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THE CONTRACTOR WILL BE RESPONSIBLE FOR THE DESIGN OF THE ENGINEERING SERVICES IN ACCORDANCE WITH THE DESIGN AND BUILD CONTRACT. PLANT SIZING IS INDICATIVE AND THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE DETAILED DESIGN OF ALL PLANT AND EQUIPMENT

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL CONTRACT DOCUMENTS, PROJECT SPECIFICATIONS AND DRAWINGS

Rev.	Date	Details	Initials
P1	27.08.21	Issued for planning	CP

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Client

ALBION LAND

Project

M40 Junction 10

Drawing Title

External Lighting Layout

Purpose

PLANNING

Drawn	Engineer	Approved
DM	CP	CP

Project No.	Date	Scale @ A0
1717	Aug 2021	1:2000

Drawing No. 1717-ESC-00-ZZ-DR-E-2100 Revision P1

Revision	Description	Issued by	Date	Checked by
-	Draft Issue	LG	26/08/21	Design Team
A	Draft Issue to MB Comments	LG	31/08/21	Design Team
B	Final Issue to MB Comments	LG	02/08/21	Design Team
C	Final Issue	LG	09/09/21	Design Team

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