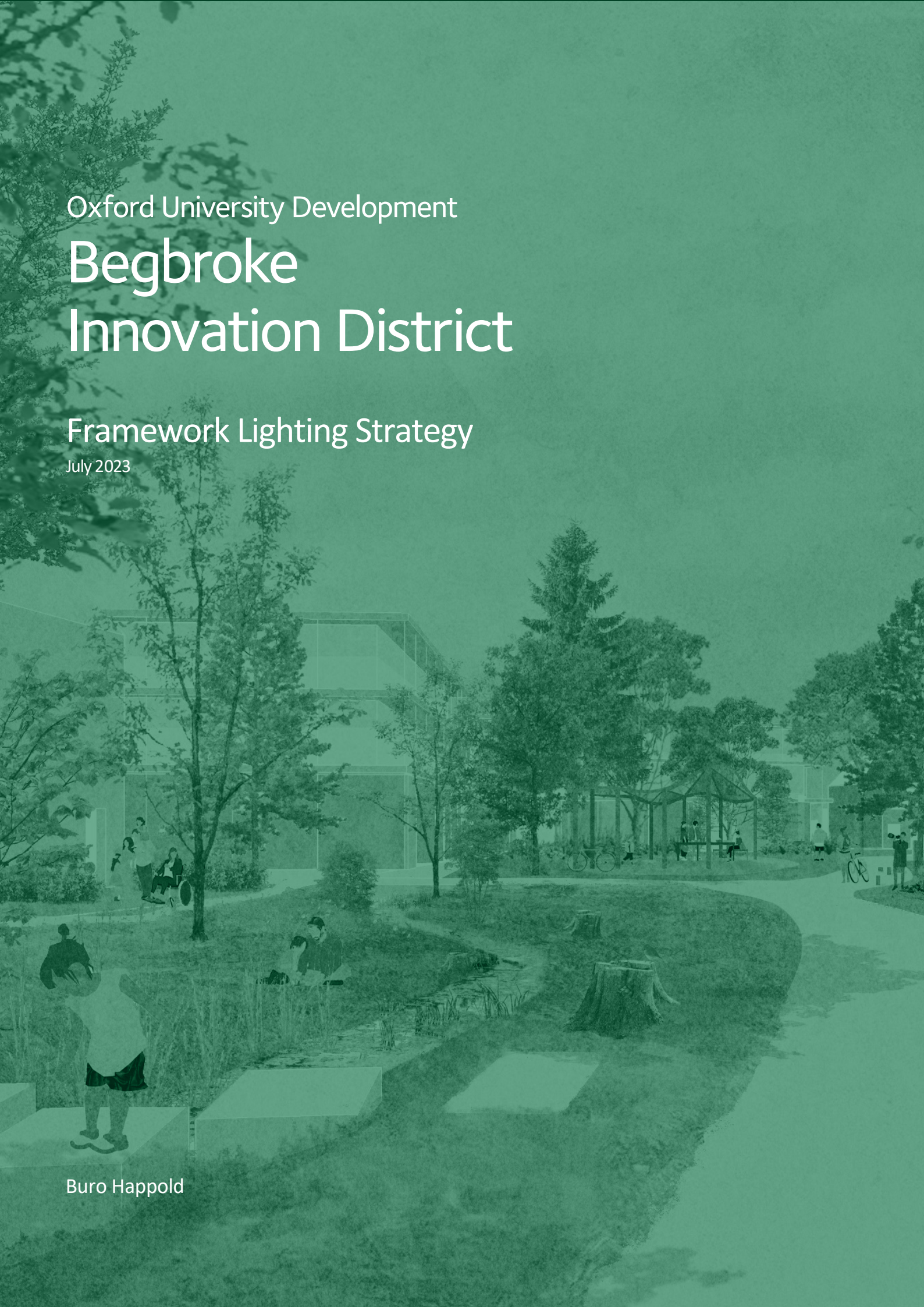
Oxford University Development

Begbroke Innovation District

Framework Lighting Strategy

July 2023



Buro Happold

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Begbroke Innovation District
Framework Lighting Strategy

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Project Number

18 July 2023

Revision P03

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Contents

Glossary

Term	Definition
Ave	Average value
Colour Rendering (Ra)	An indicator of how accurately colours can be distinguished under different light sources. The colour rendering index (measured in Ra) compares the ability of different light sources to render colours accurately. This measures the ability of a light source to render colours naturally, without distorting the hues seen under a full spectrum radiator (like daylight). The colour rendering index (CRI) ranges from 0 to 100. Colour rendering index CRI
Colour Temperature	The colour temperature provides an indication of the light colour and is expressed in Kelvin (K). Lamps are generally rated between 2700K (warm), 4000K (neutral) and 6500K (cool). Unit: kelvin, K.
Control Gear	A 'package' of electrical or electronic components including ballast, power factor correction capacitor and starter. High frequency electronic control gear may include other components to allow dimming, etc.
Curfew	A time defined by the local authority when outdoor lighting is reduced or switched off.
Glare	The uncomfortable brightness of a light source against a darker background which results in dazzling the observer or may cause nuisance. Condition of vision in which there is discomfort or a reduction in the ability to see significant objects, or both, due to an unsuitable distribution or range of luminance.
Glare Rating (GR)	Glare Rating values may be calculated for sports and area lighting applications to indicate the amount of glare present for an observer within the lighted area. GR values range from 10 to 90 (regardless of US or Metric units), where a value of 10 indicates unnoticeable glare and a value of 90 indicates unbearable glare. For most applications, the CIE (International Commission on Illumination) recommends that the maximum amount of glare allowed should be less than 45 to 55, depending on the application.
Horizontal Illuminance (E, Eh)	Illuminance incident on the horizontal surface. Unit: lux (lx) = lm/m^2 Symbol: E, Eh
Illuminance	The amount of light falling on a surface of unit area. The unit of illuminance is the lux, equal to one lumen per square metre. Unit: lux (lx) = lm/m^2
LED	Light Emitting Diode used as a light source. Solid-state semiconductor device that converts electrical energy directly into light of a specific colour or even white light.
Light Output Ratio (LOR)	Ratio of the total light emitted by a luminaire to the total light output of the lamp(s) it contains measured at standard operating conditions.
Light Spill	The unwanted spillage of light onto adjacent areas which may affect sensitive receptors, particularly residential properties and ecological Sites.
Light Trespass	The spilling of light beyond the boundary of a property which may cause nuisance to others, particularly when spilling into windows of neighbouring properties.
Lumen	Unit of luminous flux, used to describe the amount of light produced by a lamp or falling on a surface.
Lumen Depreciation	The decline in the light output of a light source during its lifetime.
Luminaire	The correct term for a light fitting. An apparatus which controls the light from a lamp and includes all components for fixing and protecting the lamps or light source, as well as connecting them to an electrical supply.
Maintained Illuminance (luminance)	Value below which the average illuminance on the specified surface is not allowed to fall. The maintained illuminance is specified at the end of the maintenance cycle, taking into consideration the maintenance factor. It is one of the main specification elements for the lighting designer. In the various slighting standards, the maintained illuminance is specified for various areas/activities. Unit: lux. Symbol: Em. (Eave)
Maintenance Factor	Correction factor used in lighting design to compensate for the rate of lumen depreciation, caused by lamp ageing (lumen depreciation and lamp failure) and dirt accumulation (luminaire and environment). It determines the maintenance cycle needed to ensure that illuminance does not fall below the maintained value.
Sky Glow	The upward spill of light into the sky which can cause a glowing effect and is often seen above cities when viewed from a dark area.
Source Intensity	This is the brightness of the source of the luminaires and applies to each source in the potentially obtrusive direction, outside of the area being lit.
Uniformity Ratio	Ratio of the minimum over the average illuminance for a specified area (Emin/Eave). When defined as such, the uniformity ratio is also the ratio of the minimum over the maximum illuminance for a specified surface area (Emin/Emax).
Vertical Illuminance	Illuminance incident on the vertical surface. Unit: lux (lx) = lm/m^2 Symbol: Ev

1 Executive summary

1.1 Proposed Development

The Proposed Development is located in Oxfordshire, five miles northwest of Oxford, in between the villages of Begbroke, Kidlington and Yarnton (the Site). The existing Site predominantly comprises of greenfield land with the existing Begbroke Science Park located at the centre. Several individual dwellings are within the Site envelope (though do not fall within the application's red line boundary), the Yarnton Home and Garden Centre are also located within proximity of the Site.

The development of the Begbroke Innovation District will bring together a variety of uses and users, including residential, academic, commercial and educational functions, in an attractive and stimulating working environment. Sustainability is at the heart of the proposals, as is responding to the unique natural features of the existing Site such as the canal and existing landscape.

1.2 Role of Buro Happold Specialist Lighting Services

Buro Happold has been appointed to provide a Lighting Impact Assessment for the purposes of supporting the outline planning application for the Proposed Development on behalf of the applicant Oxford University Development Ltd (OUD).

Our report includes details of a Site survey in which the existing baseline lighting conditions are established. These details, together with available open-source information, are used to identify any potential impact of the Proposed Development.

1.3 Lighting Statement Objective

The objectives of this environmental lighting statement are to

- Support the outline planning application for planning consent
- Provide a record of the existing baseline lighting conditions and sensitive receptors
- Provide guidance and design criteria for future lighting designs to mitigate risk to the local environment and ecology
- Provide guidance and design criteria for any future lighting installation in alignment with the required British Standard, regulations, and best practice for lighting.
- Provide Site specific lighting recommendations to achieve the above

The lighting guidance relevant to this specific Site shall:

- Limit the impact of obtrusive light and undue light spill on to surrounding areas, protected natural environments and sensitive receptors which include:
    - Bat roosts within the existing Begbroke Farmhouse
    - Badgers within the greenspace
    - Rushy meadows Site of Special Scientific Interest (SSSI)
    - Key dark links around the Site
    - Greenspaces
    - Oxford canal
- Detail the lighting character for each type of lighting application and function, these generally include for:
    - Vehicular access routes
    - Shared surface routes (vehicular, cycle, pedestrian)
    - Ecologically sensitive paths
    - Open car parking
- Design criterion including:
    - Acceptable levels of permissible light spill outside the Site boundary and onto the sensitive receptors
    - Recommendations for the prevention of obtrusive light.

1.4 Key Risks

The main areas of environmental risk from the future developments' exterior lighting will be:

- The bat roosts within the existing Begbroke Farmhouse and the greenspace adjacent which currently has been identified as an area of bat roosting and connectivity.
- The dark link between the bat roost and Sandy lane. The link is used for foraging and connectivity by bats and will require to be maintained as per existing conditions.
- The dark link along Rowel Brook the near the northern Site boundary perimeter. The brook is also used for bat foraging and connectivity.
- The greenspace at landfill Site and the potential relocation of badgers.
- The Oxford canal.

The lighting guidance has been co-ordinated with the landscape designers and the ecology consultants to meet both functional requirement and to minimise any adverse impact from the external lighting.

1.5 Executive Summary

The existing lighting treatments and lighting conditions within the Science Park would be modified as necessary to enhance and improve the existing lighting applications where appropriate.

The illumination is of the exterior vehicular access routes within the Science Park, are well controlled with minimal light spill onto the surrounding land.

The required illumination of the future development will have minimal impact on sensitive receptors providing future lighting strategy follows the guidance in this report.

The incorporation of the exterior lighting within the areas of agricultural land surrounding Science Park would have a visual impact on the existing conditions, as these are currently unilluminated with no existing lighting exterior lighting applications.

2 Project Description

2.1 Project Site Location and Context

The Proposed Development is located in Oxfordshire, five miles northwest of Oxford, in between the villages of Begbroke, Kidlington and Yarnton. The Site is bound by the A44 to the west, Rowel Brook to the north and Oxford Canal to the East. The Cherwell Valley railway line intersects the Site from north to south along the east of the Site.

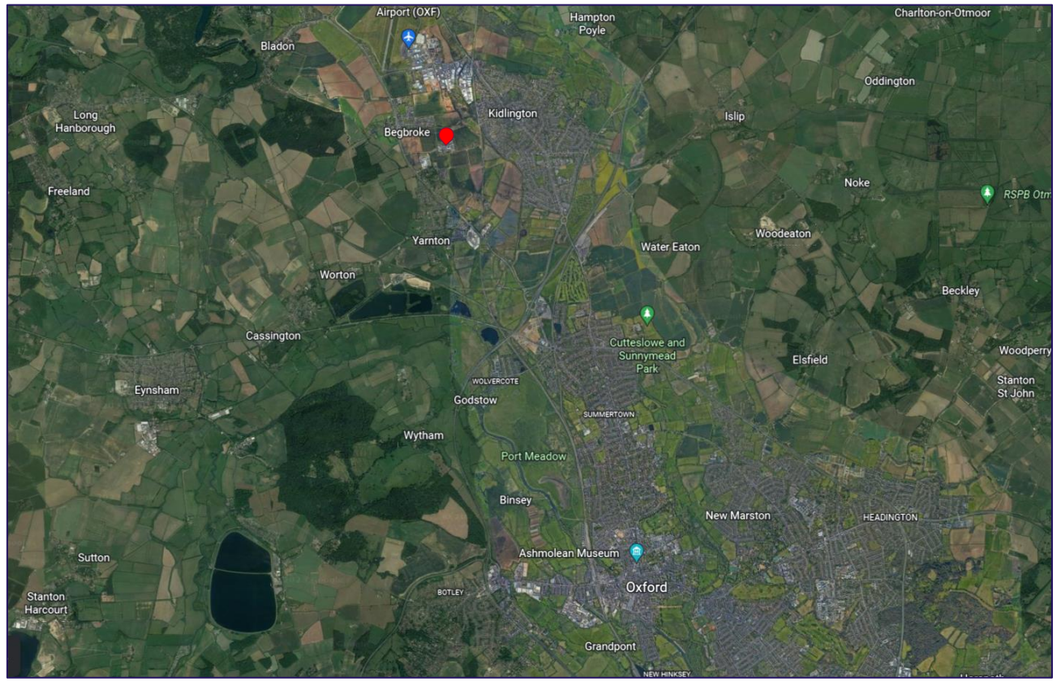

Figure 1—1 - Location Map. Image Google Maps 2023

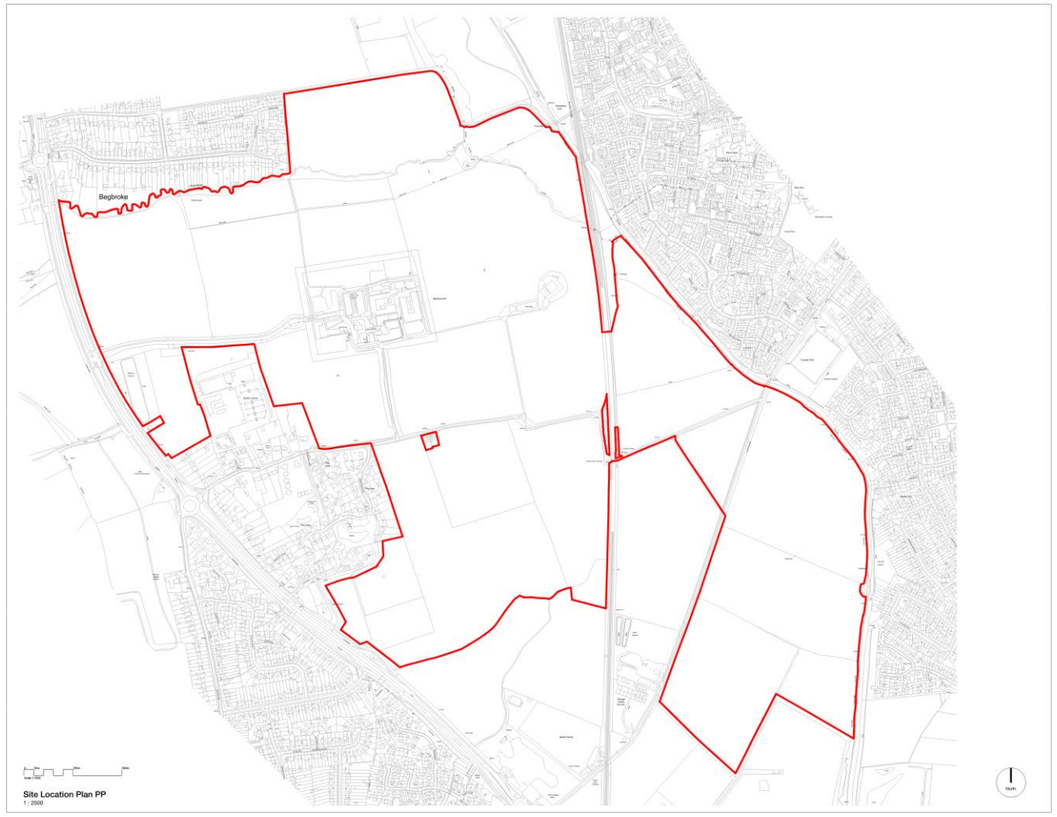

Figure 1—2 – Site Boundary Taken from 15/05/23 Hawkins Brown Parameter Plans

2.2 Project description

Begbroke Science Park is to be transformed into an innovation district to foster a community for research, education and entrepreneurship within a culturally animated urban quarter. Additionally, it will provide homes for university staff and members of the wider community.

The project aims to:

- Change the use of the land from rural/agricultural into residential housing.
- Expand the existing Science Park to provide additional laboratory, faculty and office facilities.
- Encourage active travel whilst allowing vehicular movement across the Site, to promote sustainable modes of transport.
- Support nature and encourage more sustainable ways of living
- Future proof through flexibility of space
- Promote social and personal wellbeing through open spaces, enhanced landscaped areas and public realm areas of different scales and quality.

The project will comprise the following elements:

- Residential properties
- Faculty, academic, research and commercial buildings
- Educational buildings
- Public realm, retail and communities' spaces
- Nature conservation areas and nature reserve

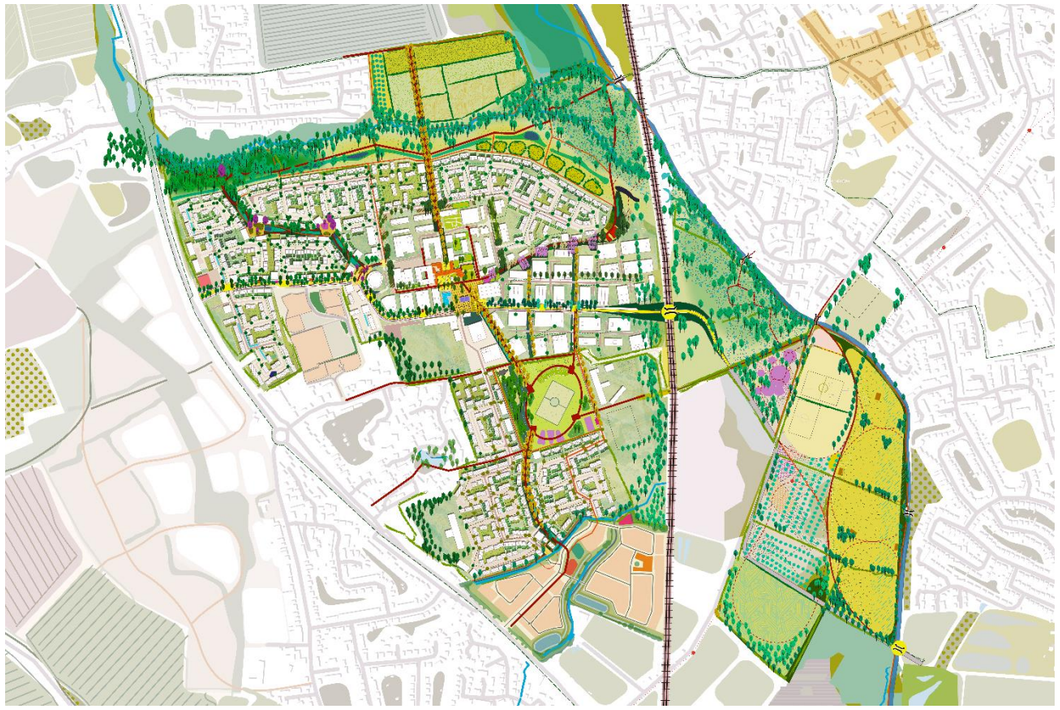

Figure 1—4 – Proposed Illustrative Masterplan

The outline planning application comprises a series of parameter plans, a Development Specification and a Strategic Design Guide that will establish a framework for future development on the Site. Figure 1-4 shows the Illustrative Masterplan – this indicates just one way in which the outline planning application could deliver high quality development. The greenspace and vegetation along the northern side of the site and east of the railway line will be retained and enhanced. The Science Park is to be expanded to include more R&D buildings. New residential neighbourhoods will spread out around the Science Park.

2.3 Existing baseline lighting conditions

This section provides information on baseline existing artificial lighting conditions present within the areas of the project.

The existing artificial lighting conditions were established with a Site survey to determine the day and night-time characteristics for the area of the Proposed Development and its immediate surroundings.

The information on existing artificial lighting focuses on external areas within and surrounding the Begbroke Science Park, Begbroke Hill Road and alongside the A44. No readings to the North of the Science Park were taken due to access issues and temporary construction lighting fittings.

The Ecological Impact Assessment details (Doc Ref: BEG-BSG-XX-XX-SU-EE-00001 to 00021) published ESG Consultants, shall be referenced for further details of the existing environment and ecological details.

2.3.1 Site survey conditions

Photographs and measurements were taken under the following conditions:

The Site visit was carried out between the hours of 15.30hrs and 19.00hrs on 1st February 2023.
Sky conditions: Overcast/Cloudy.
Sunset: 16:53hrs

Moon conditions
Phase: Waxing Gibbous; Illumination: 87%
Moon Age: 11 days; Moon Angle: 0.49º; Moon Distance: 401,025.38 km
Sun Angle: 0.54º; Sun Distance: 147,417,821.9 km

Camera settings:
Make: Nikon D90 Digital SLR
Lens: Nikon AF-S 18-105mm f/3.5-5.6, f/22-36.
Aperture: F5.6

SONY Galaxy S21 FE, Auto Night-time Setting.

Light meter:
Make: Konica Minolta Luminance Meter LS-100,
Type or meter: T-10;
Last calibrated: 11th January 2023.

2.3.2 Existing Site Conditions

The following provides details of visual observations of the existing external lighting applications within the Site.

General observations on the existing base line lighting conditions include:

- The external area surrounding Begbroke Science Park is generally unilluminated. Much of the light distributed from Begbroke Science Park is limited from distribution outside the outer perimeter onto the rural surrounding areas. The tree lined perimeter trees surrounding the science parks assist to limit the distribution of light with low illumination level present beyond this tree lined perimeter.
- The illumination of vehicular access routes around the science park is provided by 4m high lighting columns and light is generally limited to the areas required with minimal light spill. The exterior car park is illuminated utilising 4m high double headed lighting columns with light distribution limited to the car park and generally within the boundaries of the car park.
- A range of wall mounted fittings surrounding Begbroke farmhouse illuminate the area to higher light levels, causing light spill onto the bat roost sensitive receptors.
- No light spill on Site is caused from the residential properties located around the Site perimeter.
- Begbroke Hill Road has had temporary solar powered lighting bollards installed to aid feelings of safety for the construction workers.

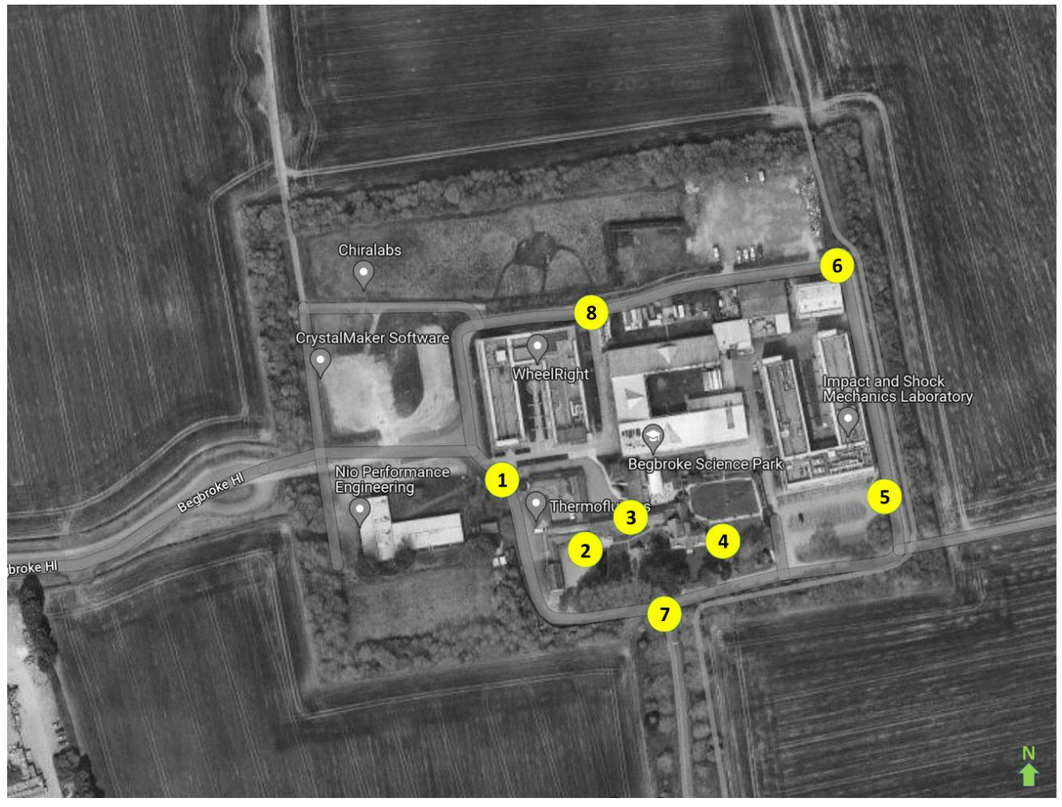

Figure 2.1 – Location of points of view for photographs across Site.

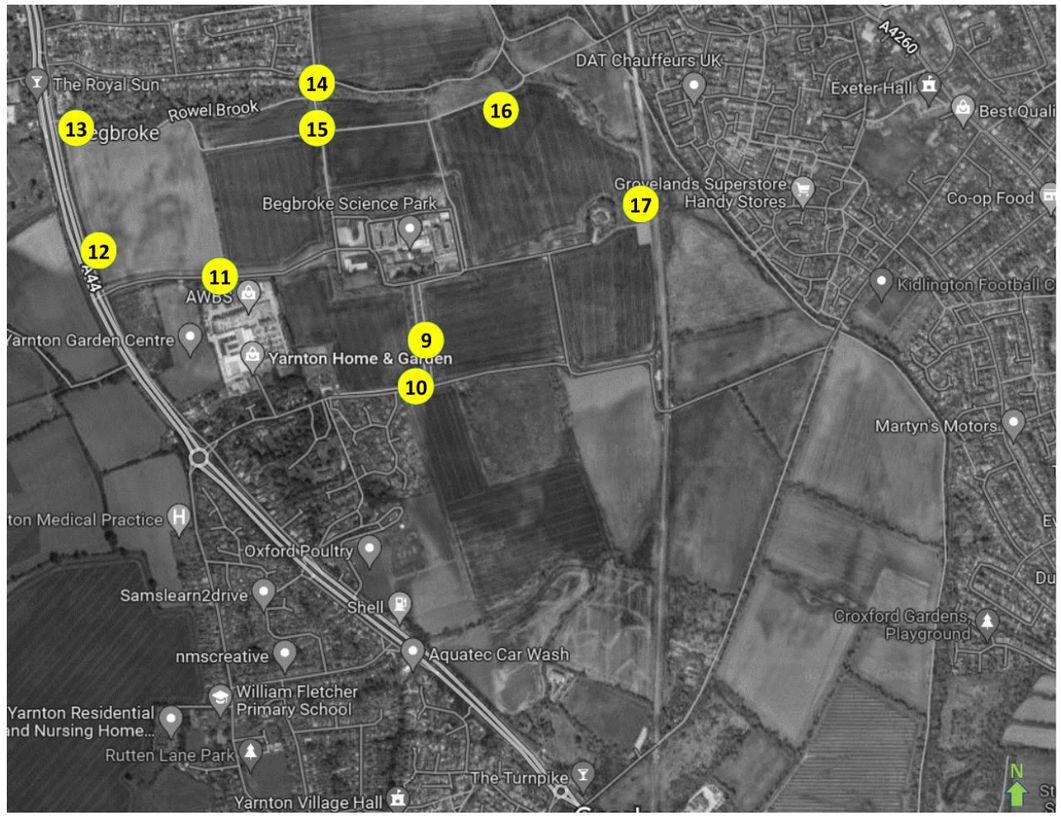

Figure 2.2 – Location of points of view for photographs across Site.

Figure 2.3 – View 1, North – Begbroke farmhouse.

The external illumination of the farmhouse and associated building are addressed via wall mounted luminaires.

Figure 2.4 – View 2 East – Begbroke farmhouse.

Figure 2.6– View 3, South – Begbroke farmhouse.

Figure 2.7– View 4, South – Begbroke farmhouse, courtyard.

The courtyard is currently illuminated with use of wall mounted LED flood lights. The trajectory of light emits producing excessive glare and uncontrolled distribution of light. The review of the lighting in this area is recommended given the presence of bats located within the vicinity.

Figure 2.8 – View 5, Northwest – External car park and access roadway.

Figure 2.9 – View 4, Northwest – External car park.

The car parks are illuminated with lighting columns with LED lamps, the distribution of light is well controlled and distribute light onto the required areas with limited light spill onto adjacent areas.

Figure 2.10 – View 6, West – Construction area.

The area north of the Science Park at the time of survey was cordoned with no access permissible and currently supports a construction Site with temporary lighting.

Figure 2.11 – View 8, South – Science Park research and laboratory buildings.

The external areas surrounding the buildings are illuminated with use of wall mounted luminaires and low-level lighting columns.

Figure 2.12 – View 7, South – Access route to Sandy Lane.

The access route to Sandy Lane is unilluminated and provides access to pedestrians and cyclist.

Figure 2.13 – View 8, East

The area surrounding the Science Park is predominately unilluminated support rural open agricultural fields.

Figure 2.14 – View 10, West – Sandy Lane

Sandy Lane is predominantly unilluminated, with section of interjections at Broad Field Road and Sandycroft Close supporting street lighting columns.

Figure 2.15 – View 11, West – Begbroke Hill

Begbroke Hill currently supports solar powered low-level bollards which are motion activated. We understand these are in place to support the safe navigation of pedestrians during the hours of darkness to address concerns from users of the facility accessing the A44 from the Site. A permanent solution is recommended as the current measures are inadequate with poor illumination performance.

Figure 2.16 – View 12, South and North – A44

The A44 is illuminated with use of lighting columns. The distribution of light is generally shielded into the Site boundary with presence of the hedge lined perimeter to the east.

Figure 2.16 – View 13, East – Rowel Brook pathway.

The Rowel Brook pedestrian pathway and areas of open filed adjacent are unilluminated and do not currently support lighting external lighting treatments.

Figure 2.17 – View 14, Northeast – Rowel Brook pathway.

The Rowel Brook pedestrian pathway and areas of open filed adjacent are unilluminated and do not currently support lighting external lighting treatments.

Figure 2.18 – View 15, South.

Figure 2.19 – View 16, South and Southwest.

Figure 2.20 – View 18, South – Roundham Lock.

The Roundham Lock located to the northwest of the Site boundary is generally visually shielded from with trees and hedges lining the perimeter along the Site boundary and waterways.

2.3.3 Baseline Light levels

The illumination readings noted on the following layout locations were obtained during the Site visit and are in units of LUX.

As most of the Site is unilluminated, the illumination readings were taken predominantly around the lit areas of the Site; Begbroke science park, the A44 road and Begbroke Hill road. Additional spot readings were taken in the unilluminated fields which boarder the science park. Particular attention was given to the bat roost sensitive receptor within the Begbroke Farmhouse and adjacent dark link as this lay within the illuminated science park.

Figure 2.16 – Existing Illumination levels outside of Begbroke science park noted in values of Lux.

Figure 2.17 – Existing Illumination levels within Begbroke science park noted in values of Lux.

2.4 Identified Sensitive receptors

In the wider ecological sense, sensitive receptors include the occupants of an areas (whether they are people, animals, or vegetation) that are more susceptible to the adverse effects of exposure to pollutants.

For the purposes of this report, the sensitive receptors are human receptors and animal and vegetation habitats that have the potential of impact from the application of artificial lighting from the Proposed Development.

Sensitive receptors specific to the Site are:

No.	Receptor category	Location	Purpose
1a	Bat roost	Begbroke Science Park (in Jacobean farmhouse and adjacent stone building)	ROOST and CONNECTIVITY
1b	Greenspace	Adjacent pond, greenspace and trees	ROOST and CONNECTIVITY
2	Dark link	Between Begbroke Science Park roost north to Rowel Brook	CONNECTIVITY
3	Dark link	Between Begbroke Science Park roost south to Sandy Lane	CONNECTIVITY
4	Dark link	Sandy Lane and its hedgerows/trees	CONNECTIVITY and FORAGING
5	Dark link	Yarnton Lane and its hedgerows/trees	CONNECTIVITY and FORAGING
6	Dark link	Oxford Canal (including crossings)	CONNECTIVITY and FORAGING
7	Dark link	Rowel Brook and its tributary	CONNECTIVITY and FORAGING
8	SSSI	Rushy Meadows SSSI (adjacent to NE of Site)	FORAGING, also INVERTEBRATES
9	Dark link	Begbroke Lane (along the northern boundary of the Site) and its hedgerows/trees and link to the canal	CONNECTIVITY AND FORAGING
10	Hedgerow	Retained hedgerow network at the site – not mapped	CONNECTIVITY
11	Greenspace	Indicated on PR8 policy map	FORAGING
12	Greenspace	Restored landfill site, plus links to Sandy Lane	FORAGING

The location of the sensitive receptors was informed by the ecological surveys carried out by BSG Ecology.

Refer the Ecological report for identification of sensitive receptors locations for bat habitats and roosting.

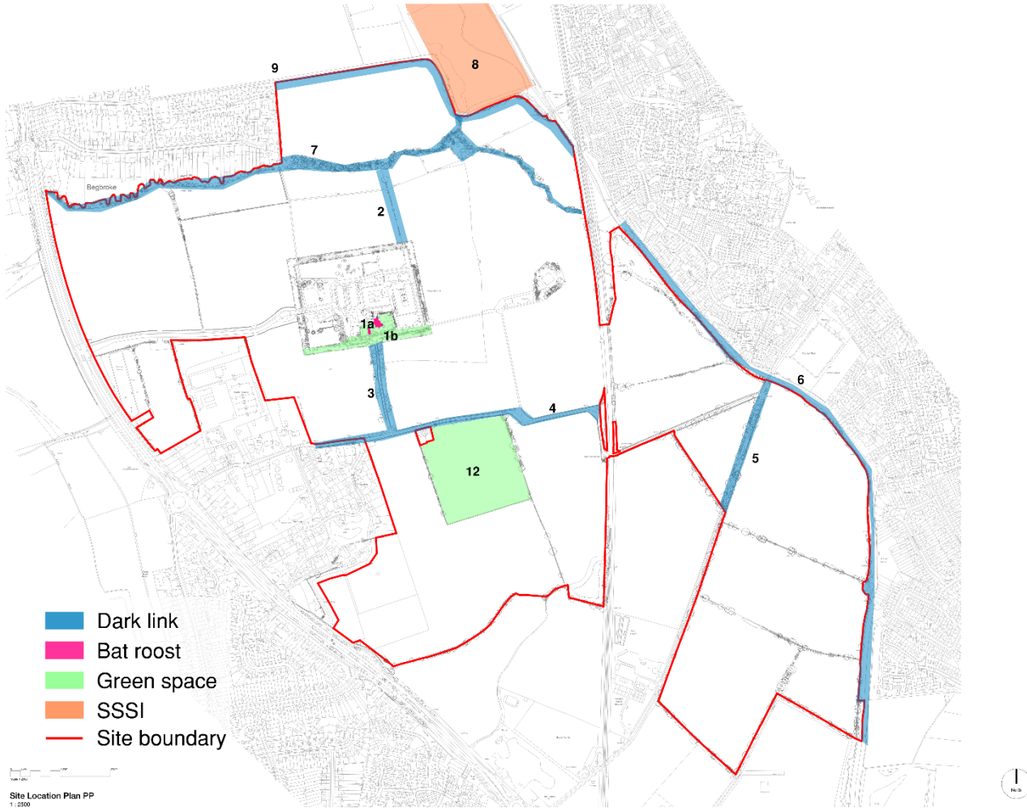

Figure 2.18 – Areas of sensitive receptors

Bat roost - Begbroke Farmhouse

The Begbroke Farmhouse has been identified as prominent for bat activity and foraging. The existing baseline conditions are to be retained, however can be further improvements with use of light shields or replacement of some of the existing flood lights with luminaires providing improved light shielding or control light distribution is recommended. The southern tree/hedge perimeter is to be retained as this acts as a natural barrier to preventing light spill onto the surrounding areas as well as visual shielding.

Green space

The restored landfill Site has been identified as an area of foraging for badgers. Whilst badgers are less sensitive to light, the emissions of light directly onto their habitat can be of detrimental impact. Any direct light distribution towards the area of badger habitat shall be mitigated. The lighting mitigation measures shall include for directing any lighting columns facing away from the areas of badger habitat and where appropriate back shield deflectors to be installed or as integral part of the lighting columns to limit rearward light distribution.

Dark links (2&3)

The dark link connecting Begbroke Science Park to Sandy Lane on the South is key for bat connectivity. Lighting with use of warmer colour temperatures (2200K or 2700K) will be implemented for the section of the primary vehicular route which crosses the dark link. The use of 4M high lighting columns are to be utilised, together with suitable coverings/shielding of lamps to limit direct visibility of the light source.

Dark links (5,6,9)

Dark link 5,6 and 9 are deemed to be suitably far away from the Proposed Development and are designed to be within a green belt, intended to have the qualities of countryside living. To reflect lighting treatment introduced would be limited low level applications in this area to support agricultural use and allotments to the north of Rowel Brookes.

Begbroke Lane providing pedestrian and cycle access to the Roundham Bridge runs through an area designed to be rewilding marshes. Application of any lighting treatments for the Begbroke Lane for access to the Roundham Bridge shall consist of low-level lighting applications (i.e. lighting bollards) with shielded light sources and the direction of light distribution to be facing away from Rowel Brook and generally distributed south of Rowel Brook and west of Roundham Lock.

It is understood that any lighting applications for Begbroke Lane would adhere to the principles noted within the lighting strategy and any lighting applications to be applied at low levels and light distribution to be facing in the opposite direction of sensitive receptors.

SSSI

The SSSI is generally of suitable distance from any current or potential future lighting treatments. The area of Site boundary on the east perimeter is closest to the SSSI. It is understood that the client does not intend to have any additional lighting treatment to that which is existing in this area therefore it is not considered to be at risk.

3 Regulatory Framework, Lighting Standards, Legislation and Guidance

3.1 Legislative framework

The Clean Neighbourhoods and Environment Act 2005 provides local authorities and the Environment Agency additional powers to deal with a wide range of issues by classifying light pollution as a statutory nuisance.

The statutory nuisance regime does not include light emitted from light sources which are used for transport purposes and other premises where high levels of light are required for safety and security reasons.

It is expected that the following sources are those with greatest potential to generate issues relating to artificial lighting:

- Industrial and commercial security lights
- Industrial and commercial external operational lights
- External floodlit facilities
- Exterior lighting of buildings.

3.2 Planning policy

The National Planning Policy Framework 2021 (NPPF) by the Ministry of Housing, Communities and Local Government which seeks to minimise the negative effects of artificial lighting.

Paragraph 185 of the NPPF states, *"Planning policies and decisions should also ensure that new development is appropriate for its location considering 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: (excerpt C) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation".*

The NPPF is supported by Planning Practice Guidance (PPG), which provides further guidance and makes the following references to light pollution:

- Paragraph 001 (Reference ID 31-001-20191101) states, *"Artificial light provides valuable benefits to society, including through extending opportunities for sport and recreation, and can be essential to a new development. 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, undermine enjoyment of the countryside or detract from enjoyment of the night sky. 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".*

- Paragraph 001 (Reference ID: 31-002-20191101) states, *"Is a proposal likely to have a significant impact on a protected Site or species? This could be a particular concern where forms of artificial light with a potentially high impact on wildlife and ecosystems (e.g. white or ultraviolet light) are being proposed close to protected Sites, sensitive wildlife receptors or areas, including where the light is likely to shine on water where bats feed".*

- Paragraph 002 (Reference ID: 31-001-20191101) states, *"Light intrusion occurs when the light 'spills' beyond the boundary of the area being lit. These adverse effects can usually be avoided with careful lamp and luminaire selection and positioning".*

- Paragraph 003 (Reference ID: 31-001-20191101) states, *"The use of lighting only when the light is required can have a number of benefits, including minimising light pollution, reducing energy consumption, reducing harm to wildlife and improving people's ability to enjoy the night sky. Impacts on sensitive ecological receptors throughout the year, or at particular times (e.g. during bird migrations) may be mitigated by the design of the lighting or by turning it off or down at sensitive times".*

- Paragraph 005 (Reference ID: 31-001-20191101) of the PPG considers the character of the area and surrounding environment with reference to how these may affect what is an appropriate level of lighting for that type of development proposed. It cautions to avoid glare and an appropriate selection of lighting so that it fulfils its purpose without over-lighting.

3.3 Cherwell plan

Cherwell Plan Part 1 Adopted 20 July 2015 (incorporating Policy Bicester 13 re-adopted on 19 December 2016), set out the Cherwell District proposals to support the local economy and our communities over the next few decades and shall be referenced for the implementation of the Proposed Development.

It is noted that the Cherwell Plan seeks to draw in investment tailored to the current and future needs of the District and to Cherwell's social and economic position in Oxfordshire and the south-east Midlands to include Kidlington. The aim to create jobs and significantly boost housing supply in targeted, sustainable locations with emphasis to mitigate and adapt to climate change, secure sustainable designs, and achieve net gains in biodiversity.

The Local Plan is a key document to provide guidance for the change in use of land with three central themes:-

1. Policies for Developing a Sustainable Local Economy
2. Policies for Building Sustainable Communities
3. Policies for Ensuring Sustainable Development.

The Cherwell Plan shall be reviewed in full and recommendations together with the policies noted shall be adopted for the Proposed Development.

A copy of the plan can be obtained online on the following web link: Adopted Cherwell Local Plan 2011-2031 Part 1 (incorporating Policy Bicester 13 re-adopted on 19 December 2016) | Cherwell District Council

The following being key policies applicable for the Site.

Policy BSC2: The Effective and Efficient Use of Land – Brownfield Land and Housing Density – Whilst the density of new housing should be provided at a net density of at least 30 dwellings per hectare, the density and associated lighting for the development shall reflect the character and appearance of the individual localities and development principles that are appropriate to the individual circumstances of sites.

Policy BSC3: Affordable Housing - B.111 notes an 'Affordable Housing Viability Study has been produced to assess the levels of affordable housing that could reasonably be required from new housing developments. In general, the higher land values in rural areas and at Kidlington allow for higher affordable housing requirements per site than at Banbury and Bicester where land values are lower'. The lighting strategy to cater to a suitable lit environment advocates the use of lighting colour temperature of 3000 Kelvin and below to accommodate for residential areas and support a more suitable lighting treatment to cater for the human circadian cycle and be less disruptive to sleep patterns as well and reduced impact onto the ecology and environment.

Policy BSC4: Housing Mix **-** B.120 state 'The Local Plan aims not only to increase supply of housing but to encourage a mix that can help improve the functioning of the housing market system, make it more fluid, and enable households to more easily find and move to housing which they can afford, and which better suits their circumstances.'

Policy ESD 10: Protection and Enhancement of Biodiversity and the Natural Environment - B.233 States 'Development proposals likely to affect a site of international ecological importance will need to be accompanied by a thorough Habitats Regulations Assessment of the potential effects of the development on that site of international importance, to enable the Council to determine whether the development would result in significant adverse effects on the integrity of the site.'
The proposed lighting strategy addresses the areas of ecological and environmental sensitivity with mitigation measure and applications to minimise the impact of lighting to protect and maintain existing areas of sensitive receptor to include the areas of SSSI northeast of the Site boundary.

C.4: Kidlington - C.218 States 'Kidlington is both an urban area and a village. Its built-up area includes part of Gosford and Water Eaton Parish. Its village centre is the smallest of the three urban centres in the District, and primarily serves the local area.
C.225 – States **'**There is potential for Kidlington to have a significant role in Cherwell diversifying its economic base. The District can take advantage of its location on the hi-tech corridor between London and Cambridge, and the proximity to Oxford University and Silverstone which is actively investing in the High Performance Engineering sector. Most growth will be directed to Bicester but Kidlington, with a number of unique economic attractors, has the potential to capture some of this investment.'

C.226 - States: **'**A recent Employment Land Review (2012) identified a need for additional employment land in the Kidlington area. It is not anticipated that this land can be accommodated on sites within the built-up limits of Kidlington. A specific need has also been identified at the Langford Lane area and the Science Park at Begbroke. Therefore, exceptional circumstances are considered to exist to justify a small-scale local review of the Green Belt to meet employment needs (see PolicyKidlington1: Accommodating High Value Employment Needs).'

C.230 – States: 'The University of Oxford plays a significant and leading role in research both in the UK and worldwide and in this context Begbroke Science Park is a vital site. The University is moving towards delivery of the remaining phase of its core site; however, once complete, further grow this constrained by the Oxford Green Belt. The amount of scientific research however continues to expand. There are two exceptional circumstances that just if a small scale review of Green Belt boundaries around the Science Park; the location of the Science Park, given the importance of being directly linked to University facilities and the research environment; and the potential for the Science Park to deliver wider benefits for the immediate locale through support for the development of a high-tech cluster and through the wider District with expected growth in scientific research, connecting with local businesses, nurturing enterprise and drawing investment in to the District.'

3.4 International Dark-Sky Association

The International Dark-Sky Association is an organisation that provides guidelines for the creation of dark-sky reserves around the world. Its aim is to preserve and protect the night-time environment and our heritage of dark skies through environmentally responsible outdoor lighting.

The general lighting principles of the IDA should be followed to ensure good lighting that reduces light pollution and its impact on dark skies. Some of the principles established are as follows:

- New lighting should not adversely degrade the sky quality beyond the immediate area to be lit.
- Angle light downward always. No unnecessary light above or near the horizontal.
- Luminaires should be aimed towards where the light is needed, carefully considering the spill on the natural environment and neighbouring properties.
- Luminaires should be switched off when not needed. The use of smart control systems is highly recommended.
- Do not over illuminate
- Avoid bright white and cooler temperature LED's (anything above 3000K)
- Install luminaires at lowest possible height to achieve lighting levels

Figure 3.1 - Example of luminaire types approved by the IDA - (Source IDA)

3.5 Impact of light pollution

The IDA guidance notes also contain information about the impact of light pollution in other areas. The impact of light pollution is not only confined to the visibility of stars at night and obtrusive light. It also affects the following animals which are present on Site according to EDP's Landscape Strategy (document ref xx).

3.5.1 Bats

As nocturnal specialists, most bat species are susceptible to artificial light. Due to the decline in numbers, all bat species are protected by the Wildlife & Countryside Act (1981) and the Conservations Regulations (1994). This makes it illegal to kill, capture or disturb bats, obstruct access to roosts or damage/destroy roosts. Lighting in the vicinity of bat roosts causing disturbance could constitute an offence. When working in an area where there are bat habitats, developers should:

- Refer to Ecological report for identification of sensitive locations for bat habitats and roosting
- Not directly illuminate bat roosts
- Avoid illuminating foraging areas and route

3.5.2 Birds

Evidence shows that artificial light can reduce sleep in birds, which disrupts the long-term circadian rhythm that dictates the onset of breeding. Birds are likely to be disrupted by changes to insect behaviour due to artificial lights.

In general:

- Do not directly illuminate important areas for nesting birds.

3.5.3 Invertebrates

Artificial light, particularly blue UV rich, significantly impacts invertebrates, disturbing feeding, breeding and movement which may reduce and fragment populations. It is estimated that a third of insects that are attracted to lights will die as a result of their encounter. Evidence also shows that pollination rates in illuminated plans can be reduced by 62% - (Knop et al 2017. Nature 548). In general:

- Avoid illuminating water or reflective surfaces
- Do not illuminate ecologically sensitive areas
- Use colour temperature, CCTs of less than 3000K
- Use narrow band minimal UV source

3.6 The ILP (Institute of Lighting Professionals) notes for the reduction of obtrusive light GN01

The Institute of Lighting Professionals (ILP) has produced the '*Guidance Notes for the Reduction of Obtrusive Light* (Guidance Note GN01:20), along with the '*SLL Code for Lighting 2012*' provide guidance for local authorities with a recommendation that they are incorporated at the local plan level. The guidance defines various forms of light pollution and describes a series of environmental zones and how to provide external lighting in each of these zones to mitigate unwanted light. The ILP guidance notes provide suitable criteria against which the effects of artificial lighting can be assessed and have been used in this assessment

The main potential issues with artificial lighting within a Site of this environmental context are:

- poorly controlled sources;
- where light is not directed into the required area and is lit with excessive amounts of light; and
- where an area is lit too brightly for its purpose, and excess light is reflected upwards.

Figure 3.2 shows the key characteristics of how the artificial lighting design for a development should be developed – 'Useful Light' (as required for functional use), 'Spill Light', and 'Light Trespass' (Light that is not wanted or required. This light may be a nuisance to others, a waste of energy, and an unnecessary source of greenhouse gases).

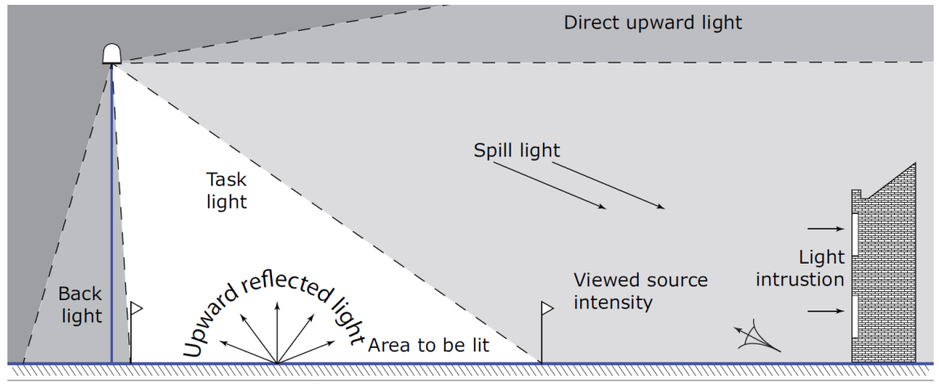

Figure 3.2 – Different types of light obtrusion

The external artificial lighting for the Proposed Development shall be based on British design standards and the relevant guidance and codes.

These shall include, following, but not limited to these:

British Standards

- BS EN 5489-1:2020 Road Lighting
- BS EN 13201- 1/2/3/5 2015/2014 Road Lighting
- BS EN 12464-2: Outdoor workplaces
- BS EN 60598-1: 2004 – Luminaire General requirement
- Electricity at Work Regulations
- BS 8300-1, 2018 Design of an accessible and inclusive, Part 1 The Exterior Environment
- Health and Safety at Work Act

Main Building Services Related Guidance Documentations

- CIBSE Lighting Guides LG6 – The outdoor Environment
- CIBSE – SLL Code for Lighting
- CIBSE LG14 – Control of electric lighting
- BRE DG498: Selecting lighting controls
- BRE IP2/99: Photoelectric control of lighting design
- CIE Publication 129 (1998) - Guide for lighting exterior work areas

Installation

- CIE Publication 154 (2003) - The Maintenance of outdoor lighting systems (2003)
- CIE Publication 136 (2000) – Guide to the lighting of urban areas
- CIBSE - SLL Code for Lighting
- Construction Design and Management Regulations 2015 - HSE
- Secured by Design – Guidance for lighting against crime

Environmental guidance

- ILP GN01:2021 Guidance Notes for reduction of obtrusive light
- International Dark Sky Association – Recommendation for the protection of night dark skies
- CIE Publication 126 (1997) - Guidance for minimizing sky glow
- CIE Publication 150 (2017) - Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting
- BS 42020, 2013 Biodiversity Code of Practice
- ILP GN08, 2018 Bats and artificial-lighting and Bat Conservation Trust
- PL G04 Guidance on undertaking Environmental Lighting Impact assessment
- ILP PLG05, 2014 The brightness of illuminated advertisements

4 Lighting Objectives

4.1 Lighting objectives

The Begbroke Innovation District lighting should aim to be appropriate to the local context and mitigate lighting impacts upon identified habitats, neighbouring occupiers and the wider landscape.

The vision and mission are as follows and any future lighting should be developed to help the client and the design team meet these goals.

Specific Objectives (for the external areas)	Lighting Strategy Objectives
Improve cycle and pedestrian connectivity	• Provide appropriate illumination of new roads, cycle paths and pedestrian pavements • Avoid over illuminating and light spill onto the adjacent natural environment. • Provide a secure and safe environment, accessible and easy to navigate through illumination of turning points and junctions
Enhancement of external landscape	• Provide for safe use during hours of darkness • Avoid undue light spill and obtrusive light. • Direct upward light distribution shall be mitigated to preserve the dark skies. • Visually comfortable exterior spaces that cater for the use of staff and visitors.
Upgrade existing parking facilities though incorporation of a decked car park.	• Limit light distributed onto the area of woodland located north of the proposed location to minimise impact on bats using the woodlands for foraging. • Provide and circulation lighting for pedestrians and vehicles
Continued well-being and safety of staff and visitors	• Provide an overall sense of security supporting both active and general passive surveillance. • Lighting should provide adequate recognition and modelling of people where required. • Support the needs of all people visiting, working, and passing through after dark. Avoidance of high contrasts, direct and reflected sources of glare, and confusing upward lighting. • Provide positive definition of potential hazards such as level changes and borders, and the adequate illumination of areas where pedestrians are likely to encounter moving vehicles should take priority in the lighting design for the external areas of the Site.

4.1.1 Environmental impact

Good lighting can bring both social and economic benefits, but the use of artificial lighting comes with environmental consequences. This not only includes power consumption, but also the risk of light spill, light pollution, excessive glare and over illumination all of which can have a detrimental impact on the well-being of neighbouring communities and existing ecology. Therefore, the quantity of light and the equipment should be kept to a minimum in those areas that need the least amount of light. The specification of the luminaires should consider optical control, efficacy and whole lifetime cost to keep energy consumption to a minimum and the light distribution only to where it is needed.

Obtrusive light, light spill and glare

As permanent and construction lighting can impact existing ecology, mitigation measures should be assessed and implemented for all future lighting installations throughout the Proposed Development. Buro Happold Lighting Team has recommended that all exterior lighting elements should follow the guidance of the relevant documents from the Society of Light and Lighting (SLL-CIBSE) and in compliance with the Institution of Lighting Professionals (ILP) Guidance Notes for the Reduction of Obtrusive Light - GN01:2011, deemed as international best-practice for projects of this type.

The following elements must be considered:

- **Light sources:** The lighting proposal should minimise the blue light spectral power of the light source and carefully balance the needs of task lighting with its impact on fauna, flora, and the night sky.
- **Luminaires:** The selection of luminaires with the right optical distribution, these include the light distribution characteristics such as asymmetrical distribution for roadways and paths, limitation of backward light distribution and optically controlled light distribution to illuminate only areas intended and avoid any undue light spill or obtrusive light together with limiting any direct upward light contributions toward the sky. Shielding to be located at the right mounting height is critical to minimising light spill and obtrusive light effects while providing the right lighting performance on the exterior task areas. Orientation of each luminaire should also be considered, as the right aiming angle will determine the amount of spilt light received by the surrounding areas.
- **National and local planning frameworks:** the consideration of national and local policies will aid with the correct selection of a lighting strategy that meets the needs of a particular area within its local context.

4.1.2 Social impact

Effective and safe lighting can help create a positive environment for people and the natural surroundings. Appropriate lighting can help create greater interaction between the local communities and the Proposed Development by promoting a respectful use of lighting that is not obtrusive into any neighbouring community. Careful consideration of the lit character of each part of Proposed Development will also benefit the whole Site, by example providing areas of greater activity by night within the areas surrounding the building and areas of low activity within the natural zones.

Social impact issues to consider:

- **Safety:** The lighting should be designed to keep a safe environment by allowing the positive definition of potential hazards such as level changes and borders, and the adequate illumination of areas where pedestrians are likely to encounter moving vehicles.
- **Security:** The lighting development for the Proposed Development should be designed to provide an overall sense of security supporting both active and general passive surveillance. Lighting should provide adequate recognition of people where required.
- **Accessibility:** The design of the lighting must support the needs of all staff and people visiting the Proposed Development. Design measures shall avoid high contrasts, direct and reflected sources of glare, and confusing upward lighting.
- **Legibility:** Key physical elements such as beacons and other parts of the urban realm should be careful and positively illuminated to aid wayfinding and create a mental map in visitors and staff. The lighting of key feature elements such as paths, meeting places, boundaries, gateways, and landmarks will also help to enhance people's sense of safety and security.
- **Identity:** The experience of the Proposed Development at night will play an important role in forming the image and memory of it in all its visitors and staff. A proper identity can be created by the careful and considered lighting approach that helps to enhance the character and legibility of the whole area.

4.1.3 Technological opportunities

Smart lighting control systems applied to the lighting equipment installed throughout the public realm in the Proposed Development can help to reduce energy consumption and operate the lighting schemes in a more efficient way. These systems can be linked to meteorological measurement devices, data collection and artificial intelligence development centres to create smart operation cycles that will keep non-essential lighting off working 24 hours to minimise energy consumption and reduce lighting levels of essential illumination equipment whilst maintaining safe levels of illuminance overnight.

Advanced lighting technology can limit the operating hours of lighting equipment to reduce running costs and limit environmental impact by setting scenes, curfew times, and dimming levels and times.

5 Lighting design criteria

5.1 Criteria summary

The primary lighting criteria have been identified below in a summary table.

Criteria	Design criteria recommendations	Further detail
Light spill / obtrusive light	Zone E3	Section 5.2
Colour temp	Area specific refer to section 5.X	
CRI	80 CRI min.	Section 5.4
Lighting classification	Area specific refer to section 5.X	
Mounting height and shielding	Area specific refer to section 5.X	
Lighting control	Dali control with astronomical time clock	Section 6.3

5.2 Lighting Environmental Zones

The classification of Lighting Environmental Zones, in the UK, are established within the documents GN01/21, 'Guidance notes for the reduction of obtrusive light' published by the Institute of Lighting Professionals (ILP).

The identification of four environmental zones have been established as a basis for outdoor lighting regulations.
The environmental zone rating can be used to help ensure that the lighting goals of an environment are appropriately defined and met, considering the context and relevant surroundings.

Table 3.1 denotes the valuation of environmental zones for the Site based upon the ILP GN01:21. The final confirmation of Environmental Zones are to be determined by the Local Planning Authorities.

The areas of Begbroke Innovation District development, is assessed to be within an Environmental Lighting Zone Classification of E3, which forms the criteria upon which maximum permissible levels of light spill and obtrusive light are limited, with the main purpose of protecting the natural environment and neighbouring communities.

Table 5.1 - Extract table on guidance for the reduction of obtrusive lighting – (Source: ILP GN01/21)

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

Table 5.2 – Permissible level of light spill beyond the Site boundary – (Source: ILP GN01/21)

Environmental Zone	Sky Glow ULR (Max %)	Maximum values of vertical illuminance on properties		Luminaire Intensity I (cd)		Building Luminance (pre-curfew)
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L (cd/m2)
E3	5	10	2	10,000	1000	10

The ILP has produced guidance on the maximum permissible light spill into windows of adjacent properties, before and after the curfew time, based on the environmental zone the development is located within. Table 3.2 above illustrates the various lighting design criteria associated with meeting the recommendations set out in achieving lighting compliance.

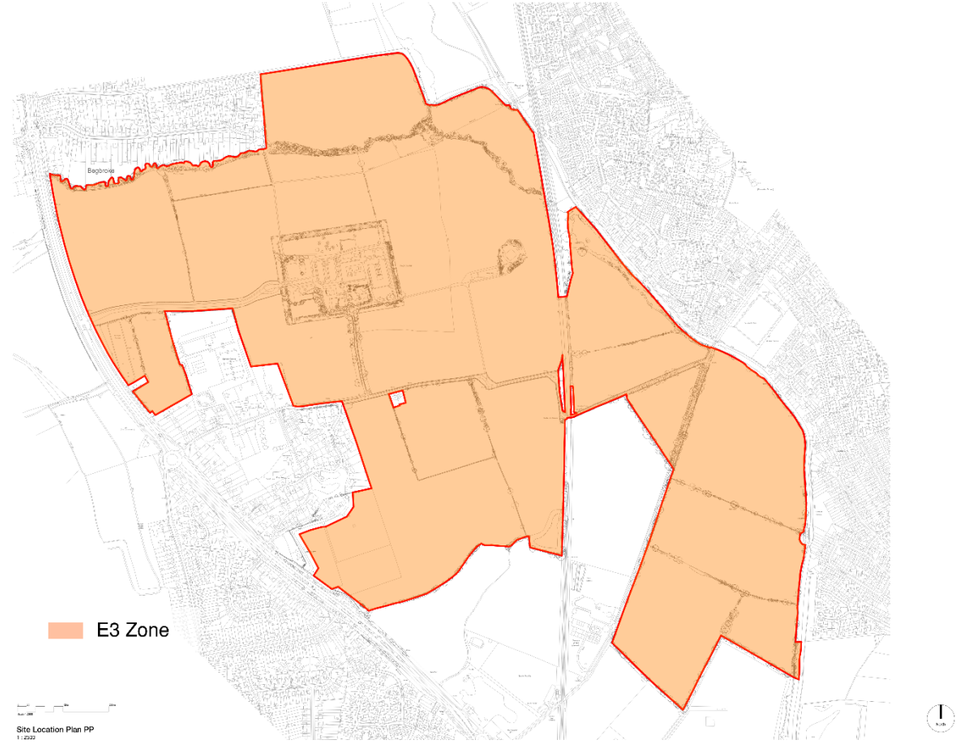

Figure 5.2 –Lighting Environmental Classification for the Proposed Development.

For areas of sensitive receptor, no more than 2 lux horizontal light spill shall be permitted onto these areas.

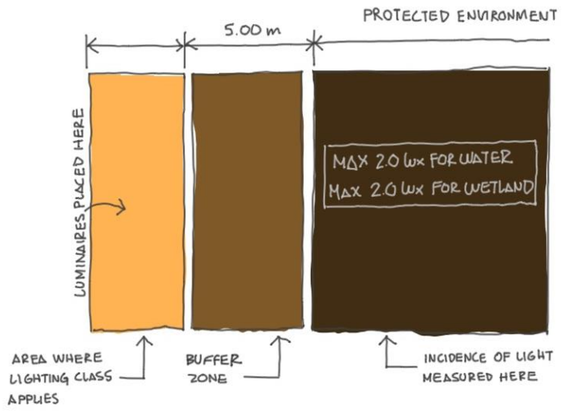

Figure 5.2 – Maximum permissible horizontal light spill onto protected areas with sensitive receptors

6 Lighting Strategy

6.1 Lighting intensity and classification

The intensity of light across the project Site must be appropriately considered from the brightest thoroughfares to the dimmest landscaped areas, both for the area in question, and in relation to adjacent areas.

Users' safety, security and comfort is of primary importance and a considered approach to the amount of light employed across the Proposed Development will help improve all these measures. Varied levels of light intensity will act to increase the legibility of the Proposed Development improving peoples' orientation as they move through the Site.

It is suggested that the levels of illumination should be at their highest when spaces are shared by vehicles and pedestrians, and when the speed of their movements are highest. When the movement of people is slower, though, or when there is less interaction with motorised traffic, the lighting levels can be much lower, while still providing an appropriate level of safety, and comfort.

The different levels of light that apply to each area in the project are defined by the type of usage and classification of roadways for vehicular and pedestrian access.

The application of lighting is categorised based upon the BS5489-1:2020 Design of road lighting Part 1: Lighting of roads and public amenity areas — Code of practice and the BS EN 13201-2:2015 Road lighting Part 2: Performance requirements. The lighting performance criteria for the areas particular to Site are noted on table

Table 5.3 – Lighting performance criteria and lighting classification

Area/Route type	Lighting classification	Average horizontal illuminance	Uniformity (Uo)	Colour temperature	Notes
Primary Vehicular Routes	P3	7.5 lux	0.20	3000K	4m AGL (column mounted luminaire)
Secondary vehicular – (residential access)	P4	5 lux	0.20	2700K	4m AGL (column mounted luminaire)
Secondary vehicular – (commercial access)	P4	5 lux	0.20	3000K	4m AGL (column mounted luminaire)
Pedestrian and cycle access routes	P5	3 lux	0.20	2700K	4m 3m AGL (column mounted luminaire)
Paths within ecologically sensitive area	P6	2 lux	0.20	2200K	<1m AGL bollards
Open Car Parking	N/A	5 lux	0.25	3000K	4m AGL (column mounted luminaire)

Suggested classification above should be reviewed at the start of the design process to ensure co-ordination and appropriateness with the most current proposed Site development and vehicular/pedestrian parameters.

Please note the allocated road classifications are currently under review as the Secondary Vehicular route leading east will change to a lower category of road lighting.

Figure 5.6 – Illustrative lighting classification

6.2 Light colour temperature

The light colour temperature defines the colour appearance of the light. It is a quality to which people are subconsciously sensitive. Colour Temperature is measured in the unit Kelvin and is the standard method for measuring the colour of light emitted from a lamp.

Warm and neutral light is proposed to be used across Proposed Development with special importance with and adjacent areas of sensitive receptors for the following reasons:

- Warm light is mentally associated with safety, history, communion, relaxation, and intimacy, which are pivotal elements in the natural visitor experience around the Proposed Development.
- Any type of light could suppress the secretion of melatonin in human beings and different animals, however the exposure to blue light at night does so more powerfully as retina is more sensitive to blue light wavelength. Red light has very small impact on the melanopsin receptors, and they do no stimulate wakefulness. Warm light has higher quantities of red light, therefore is the appropriate light to generate a relaxed environment.
- Red, amber, and yellow light, and light up to 2200K have a shorter wavelength than 3000K, 4000K light. This is beneficial for the animals as they are less attracted to this type of light therefore generating less disturbance on the natural environment at night.
- According to different scientific studies and the International Dark Sky Association (IDA) blue light brightens the night sky more than any other colour of light, so it is important to minimize the amount emitted.

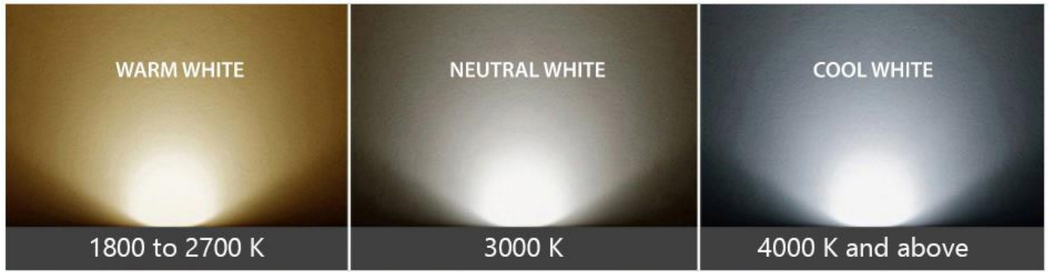

Figure 5.3 - Light colour temperature example chart

Figure 5.4. – Illustrative lighting colour temperature strategy

6.3 Mounting height and shielding

The mounting height of the lighting equipment will contribute to the perceived scale of spaces.

This project requires different mounting heights because light must be provided to narrow and open areas of industrial character. Shielding is required in certain lighting fixtures to minimise the amount of light that can spill onto the night sky and the surrounding natural environment

In principle luminaires across the Proposed Development area should:

- Have integrated or integrated and additional external shielding
- Always point downwards
- Have forward-throwing light distribution with a reduced kickback

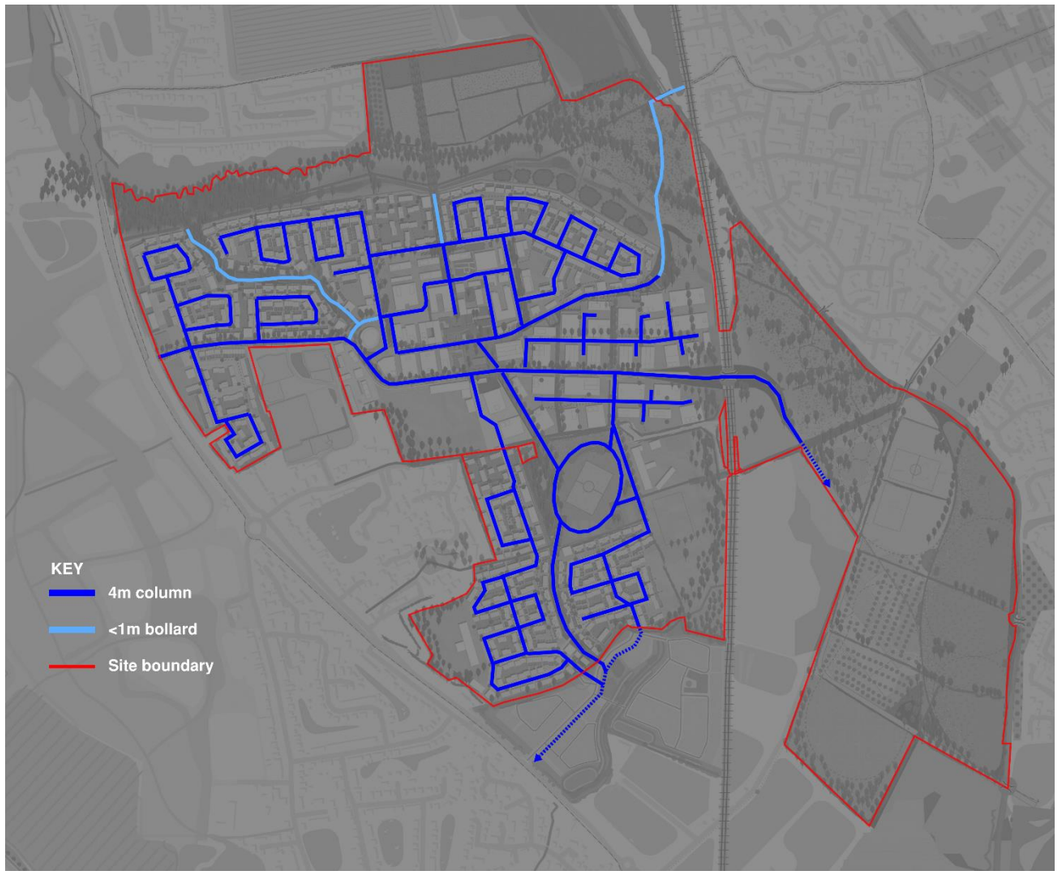

Figure 5.6 – Illustrative light source mounting heights

6.3.1 Integrated shielding

A full cut-off shielded light fixture has an integrated solid barrier at the top, located over the light source (lamp) such that it is covered. The solid housing should not have any translucent parts or diffused materials which will allow for lighting escaping towards the dark sky. These luminaires allow light to be accurately cast downwards into the desired area without major levels of light spill. Spread lenses, snoots, internal/external louvres, honeycomb louvres and other glare mitigation and light control measures can be used in these luminaires to further limit the spread of light beyond a targeted area.

Refer to section 3.1.4 for more information about cut-off

6.3.2 Integrated and external shielding

Where lighting is required in close proximity to sensitive receptors. Light source shielding can be achieved using physical landscape and architectural barriers (such as: dense shrubs and trees and dense low-level vegetation, dunes, bunds, berms, etc.) and, furniture-integrated (or otherwise recessed) luminaires, solid balustrade, solid or very dense screens, and others, in combination with full cut-off fixtures.

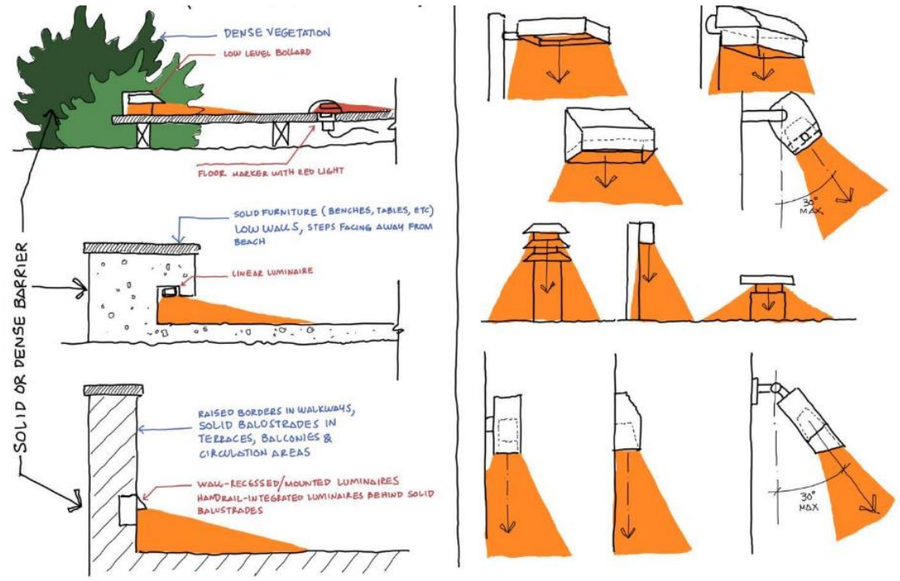

Figure 5.7 – Integrated and external shielding methods

Figure 5.7 - Sketches on the left on the above figure show examples of luminaires with integrated shielding and external shielding. The sketches on the right show luminaires with only integrated shielding.

Figure 5.11 – Typical example for lighting columns with read shield deflector to avoid backward light distribution.

Figure 4.9 illustrates the use of integrated rear light shields (DW Windsor Daytona lighting columns) and aftermarket attachments (Pudsey Diamond UK – Tespa Banded Shields), which shall be considered for the lighting columns along the primary vehicular path which crosses the Southern bat roost dark link (Sensitive Receptor 3) to limit light spill onto the dark link.

6.4 Light shielding and height at vehicular routes

The illumination vehicular access roads within the Site shall adhere to the same treatment as per existing areas with use of 4-metre-high LED street lighting columns. Where pedestrian and cycle paths run adjacent to the road (such as Begbroke Hill Road) an additional LED light source will be mounted at 3 metre high.

Figure 5.12 – Typical Street lighting columns

Figure 4.9 provide typical application of street lighting columns from manufactures DW Windsor and Thorn, those with IDA approval limit the extent of light distributed towards the sky to maintain dark skies and limit light pollution onto the sky. The above illustration are of the Thorn 'Isaro' ranges of luminaires and DW Windsor 'Daytona' range.

Figure 5.13 - Precedent images for low level bollard luminaires.

The medium flow pedestrian access routes shall be generally addressed with the use of low-level lighting bollards to illuminate the areas of pathway and avoid any undue light spill onto adjacent areas. Low level bollards with 180-degree light distribution towards the pathway shall generally be utilised.

6.5 Lighting strategy

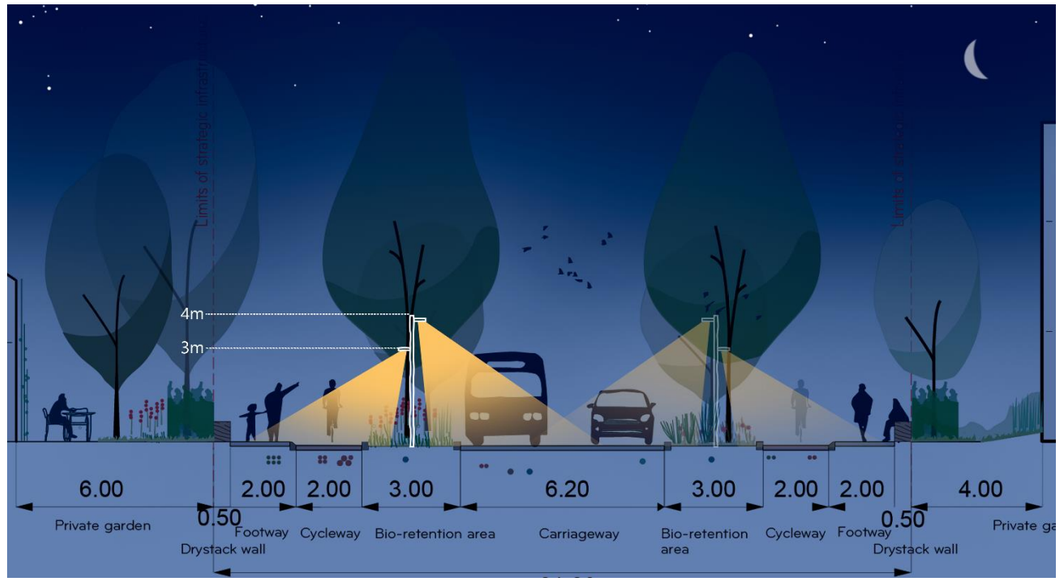

Figure 5.6 – Lighting strategy for Begbroke Hill Road

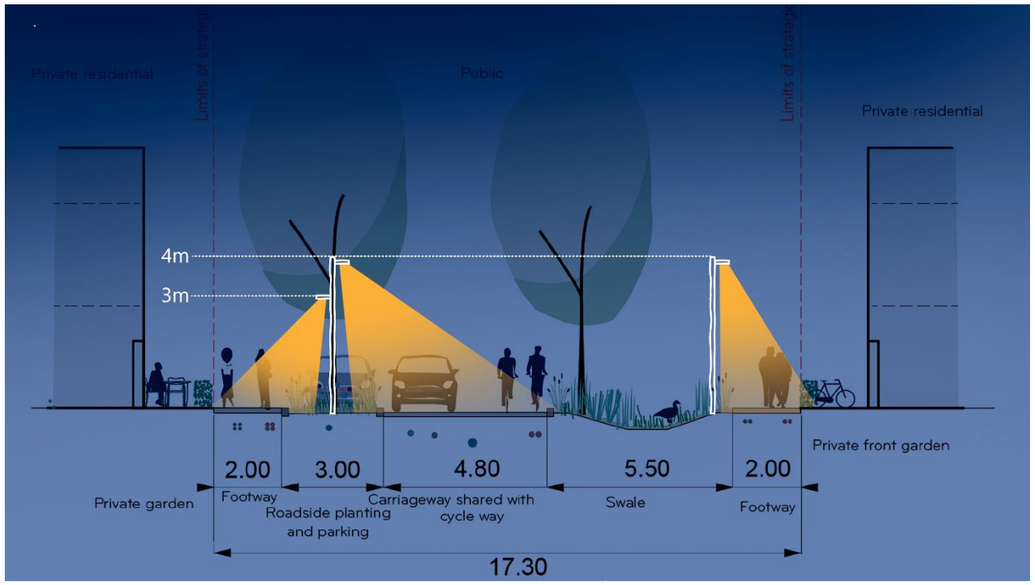

Figure 5.6 –Lighting strategy for a typical secondary street with swale

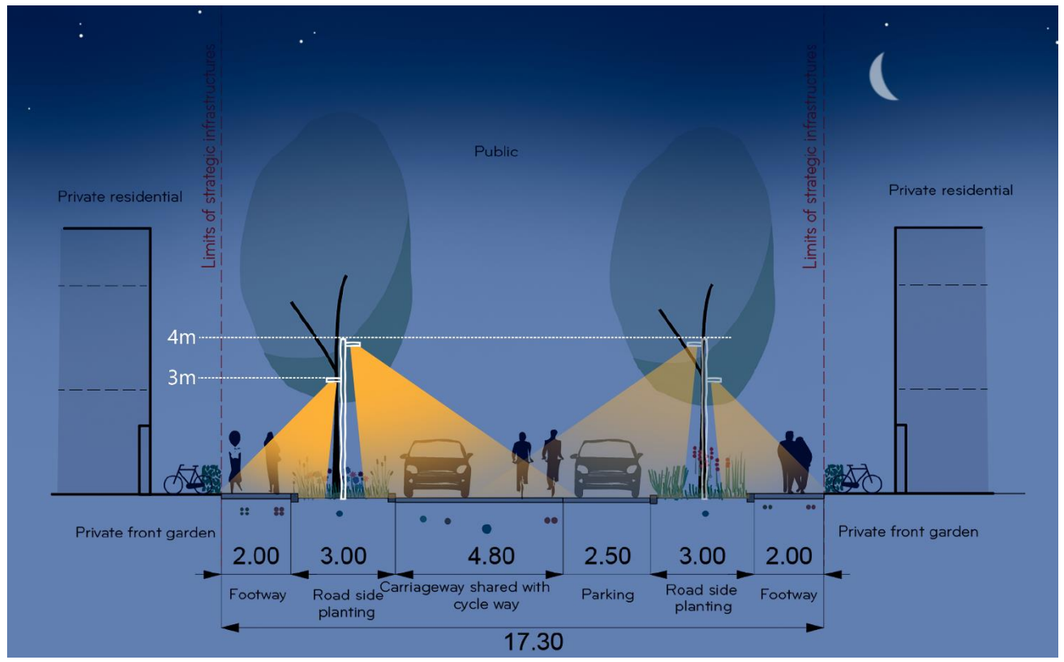

Figure 5.6 – Lighting strategy for a typical secondary street

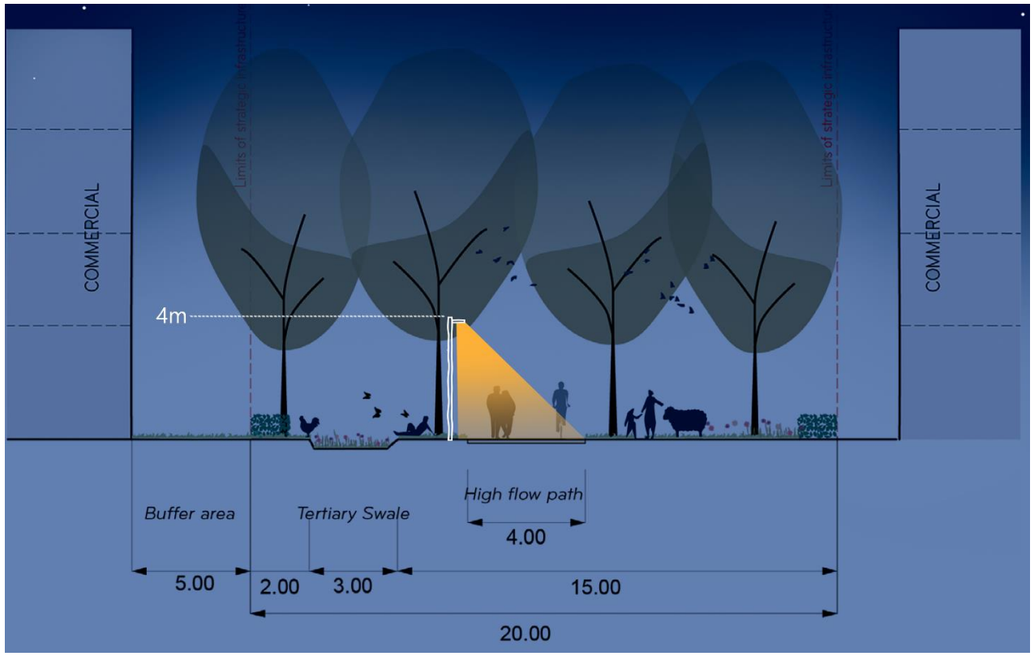

Figure 5.6 –Lighting strategy for a typical high flow shared surface path

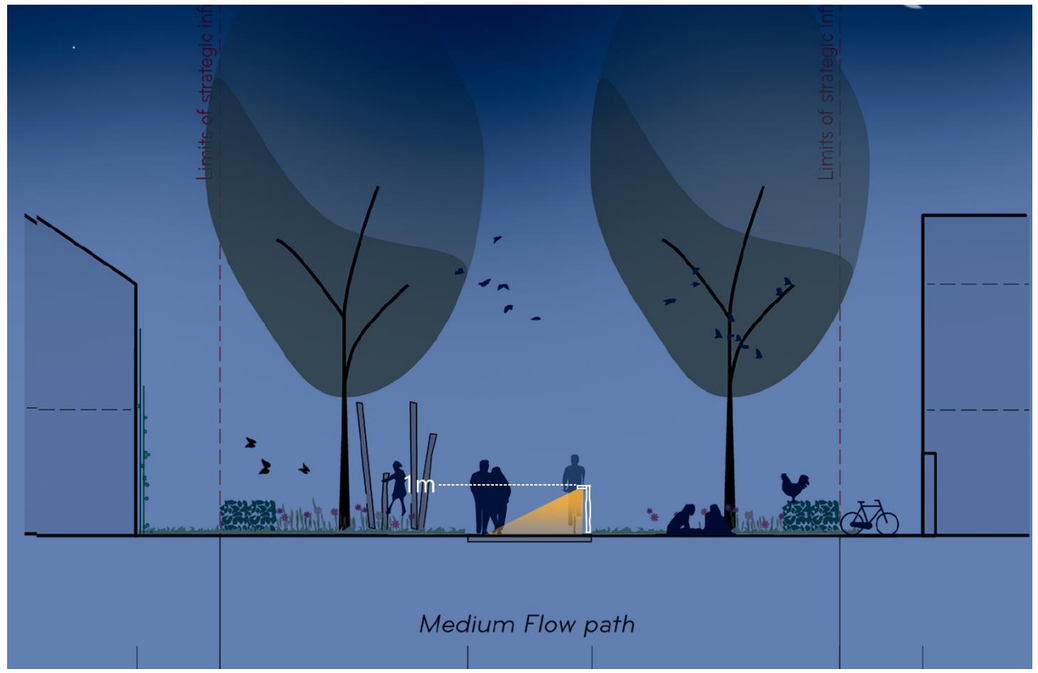

Figure 5.6 –Lighting strategy for medium flow shared surface path

6.6 Colour rendering index

The Colour Rendering Index provides an objective indication of the ability of a light source to render the colours of various objects faithfully, in comparison with a natural light source. The general colour rendering index Ra has been introduced to specify the colour rendering properties of a light source. The maximum value of Ra is 100. This figure decreases with decreasing colour rendering quality.

It is important for visual performance and the feeling of comfort and well-being that colours of objects and of human skin are rendered naturally, correctly and in a way that makes people look attractive and healthy.

In principle, a CRI of minimum 70 is required across this project.

Figure 5.5 - Differences between CRI levels

7 Lighting control

7.1 Recommended control

The lighting shall maintain the existing operational timings and include for automated Dusk till dawn operation and daylight sensing to ensure the lighting operates during hours of darkness and switch off when sufficient daylight contributions are present. If deemed appropriate by safety and security further dimming or switching off should be considered outside of peak hours and triggered on by presence detection.

7.2 Automatic control systems

Astronomical timeclock

Timers with both astronomic and Daylight-Saving Time (DST) functionality automatically adjust to the seasonal day-to-night-time changes throughout the year. An electronic timer with astronomic functionality determines each day's sunrise and sunset times based on geographic location, while the automatic DST functionality resets the clock by one hour in the spring and fall.

Photocells

Photocells are devices that can be incorporated to luminaires or installed remotely and connected to a control system. Photocells can turn lighting on when the ambient light falls below a pre-set level, or automatically adjust the light output of luminaires depending on the amount of natural light available to a maintained illuminance level.

Motion sensors

These devices can be used as energy-saving sensors in exterior and interior areas, turning of lights in empty zones and turning them on when someone moves along the space. Many of these products have adjustable sensing areas, allowing for different coverage areas in specific locations. They can also be integrated into general control systems and can be used to override lighting scenes.

7.3 Programable control system

DALI

The DALI control protocol shall e adopted for the control of the lighting. DALI stands for **Digital Addressable Lighting Interface** and is a manufacturer-independent standard for lighting control in external areas and buildings. It is specifically used in external areas and properties such as offices, shops, restaurants, and hotels, but can perfectly be used in industrial complexes.

It is a communication protocol for building lighting applications and is used for communication between lighting control devices, such as electronic ballasts, brightness sensors or motion detectors and lighting fixtures. It allows the creation and programming of lighting scenes and their triggering times.

The DALI systems can be programmable and connected via wired and wireless systems. They can also receive input from manual switches.

These control mechanisms guarantee that the maximum levels of light can be defined and never be more than 10% of the maximum defined level for specific zones.

8 Conclusions

The majority of the Proposed Development is situated on agricultural land, which is predominantly unilluminated with no lighting infrastructure or lighting applications currently present.

The existing Science Park located centrally within the Site include for artificial lighting treatments as described within this report. The external lighting within the Science Park is limited to within the boundaries of the Science Park with minimal lighting spill or contributions towards the surrounding areas.

The Proposed Development would impact the existing conditions which are currently unilluminated.

The proposed lighting strategy seeks to minimises the impact of the artificial lighting for the Proposed Development. Careful consideration should be applied to the proposed lighting strategy to cater for the existing sensitive receptor within the Site and suitable measures put in place to protect the existing ecology and limit impact onto the surrounding areas beyond the Site boundary.

The area north of Site includes a buffer zone to limit the impact of lighting onto Rowel Brooks to maintain the existing biodiversity and avoid the application of artificial lighting in close proximity to areas of sensitive receptor. The retention for the tree line perimeter of the south of Rowel Brooke also assists to minimise and visual impact to the residential properties located north of Rowel Brook.

Whilst the Proposed Development would change the visual character of the existing conditions, the lighting framework strategy ensures the protection of the existing areas of sensitive receptor and adheres to the criteria of permissible light spill and light pollution as per the ILP recommendations and guidance for the lighting environmental zone applicable to the Site.

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