

EASTLEIGH BOROUGH COUNCIL

One Horton Heath: Appendix 10.11 Ecological Lighting Baseline Survey Appendix 10.11 Ecological Lighting

1 INTRODUCTION

This report presents the results of an ecological lighting baseline survey undertaken in May 2020 by Johns Associates in support of the development proposals and planning application at One Horton Heath.

This baseline lux report has been compiled to provide baseline data on current lux levels on Site, to inform future lighting schemes for the Site that may affect important habitats and ecological features. Specifically, this is to ensure that the new lighting strategy is complicit with legislation and current best practice guidance on the use of artificial lighting on ecological features and with regard to identified ecological receptors.

The report aims to identify and quantify the areas of known light pollution and dark areas to enable a comparison to be drawn between current and predicted light levels associated with the development. This is achieved by identifying current luminaries on and adjacent to the Site (type and location) and the lux levels at various points around these.

This survey is only to provide an ecological lighting baseline assessment and is not to replace a formal lighting assessment carried out by professional lighting specialist.

2 SITE BIODIVERSITY AND SENSITIVITY TO LIGHTING

2.1 HABITATS

2.1.1 Landscape by Day

The Site is associated with an area of grassland, woodland and riparian habitats covering approximately 120 hectares, located to the west of the existing settlement of Horton Heath, Eastleigh Borough, Hampshire.

The Site is characterised by gently undulating agricultural land currently used to produce arable crops in the northern component, close to Fir Tree Lane and cattle grazed grassland in the southern component, adjacent to Chalcroft Farm. The site is bisected by an area of woodland and minor watercourse, running east to west across the Site. An extensive network of hedgerows exists with large mature standard trees present in the northern section. An area of mature deciduous woodland lies in the northern section (Quobleigh Wood) that is complimented by a number of small but mature (some ancient) woodlands located along the northern, western and southern boundaries.

Small watercourses, tributaries of the River Itchen, are present, flowing westwards and northwards. A number of ponds are present within the Chalcroft Farm complex, in the south, and associated with Quobleigh Wood, in the north, that support breeding populations of great crested newts.

The site contains clusters of residential and agricultural buildings, a number of which are now unoccupied. A commercial meat processing facility is currently operational within Chalcroft Farm. A number of these buildings support active bat roosts including maternity and satellite roosts.

Immediately adjacent to the east, lies the settlement of Horton Heath with residential areas and associated gardens and infrastructure. To the south, the commercial development at Chalcroft Business Park lies adjacent to the Site, separating it from the railway. To the west and north lie areas of agricultural land, woodland and small farm and school building complexes. To the north, the Site adjoins woodland.

2.1.2 Landscape by Night

As the Site is located within a more rural environment on the edge of Horton Heath the artificial light from commercial, industrial and residential sources is limited.

At the time of preparing this document, the north of the Site had no artificial light sources. All the properties to the north apart from one are unoccupied and Fir Tree Lane, which cuts across the northern section of the Site, had no street lights present along its length.

The southern section of the Site had intermittent street lights present along Burnetts Lane on the south eastern Site boundary and street lights and commercial lighting around the Chalcroft Farm complex. Apart from this, there were no other identified areas of artificial lighting.

The Site falls into an area that has brighter level of radiance from artificial light between 2-4 Nanowatts as shown from maps produced by Campaign to Protect Rural England (CPRE) which maps England's light pollution levels¹. This is due to the Site lying within relatively close distance to Southampton International Airport, Eastleigh and Hedge End town centres, which produce significant sky glow.

Valuable habitats for nocturnal species within the Site include, woodland, marshy grassland, hedgerows and streams. The Site includes pockets of wet and dry broadleaved woodland that support nocturnal species.

The extensive network of hedgerows denoting the field boundaries provide important foraging and commuting habitat for nocturnal species and serve as wildlife corridors whilst offering refuge and hibernation habitat.

Quobleigh Stream and its tributaries offer a valuable foraging and commuting resource to nocturnal and crepuscular species and offer a wildlife corridor and habitat for fish species. Several ponds are also present, in addition to a number of ephemeral pools associated with the water courses. These provide breeding habitat to amphibians and offer a further foraging resource for nocturnal / crepuscular species.

2.2 SPECIES

Artificial Light at Night (ALAN) in the form of direct illumination due to external lighting, light-spill from internal light sources; or the combined effect of urban lighting resulting in sky glow is estimated to be increasing globally at 3–6% per year (Hölker *et al*, 2010).

ALAN has been shown to have a range of direct impacts on ecosystems and species, from the cellular level to change in behaviour. It has been shown to disturb ecosystem processes by altering species abundance and distribution, modifying ecosystem functioning (Gaston *et al.*, 2014; Bennie *et al.*, 2015; Hölker *et al.*, 2015; Knop *et al.*, 2017); and can directly affect the physiology and behaviour of many organisms by affecting the timing of daily rhythms, hormonal regulation, food intake, metabolism, migration and reproduction.

¹ <https://www.cpre.org.uk/> accessed 10.12.20

The Site supports a number of protected species which are nocturnal and crepuscular, therefore artificial lighting may result in adverse effects on these species by altering patterns of behaviour and breeding activity. The effects on species present within the Site is discussed below;

2.2.1 Bats

Johns Associates have carried out a range of bat surveys across the Site between 2018 and 2020, including; Bat activity surveys (transect surveys and automated (static) detector surveys) which recorded at least seven species of bat foraging on Site; namely common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle *P. pygmaeus*, nathusius pipistrelle *P. nathusii*, long-eared *Plecotus* species (probable brown long-eared), serotine *Eptesicus serotinus*, noctule *Nyctalus noctula* (and *Nyctaloid* species), *Myotis* species and barbastelle *Barbastella barbastellus* (an Annex II species).

The Site also supports the following roosts, as identified during emergence / re-entry surveys of the Site in:

- Brown long-eared (two maternity roosts, on site);
- Three common pipistrelle day roosts;
- Two long-eared bat satellite and day roosts;
- Two brown long-eared maternity roosts (further tree roost adjacent to the Site).
- A noctule mating roost (on site)

Important features for long eared bats were identified as being linear tracks and hedges. The highest bat diversity and activity along the woodland edge and watercourse on the western site boundary and watercourses north and west of the solar farm.

Crossing point surveys recorded bat activity using linear features on Site at heights of 1-20m, with the average height of commuting bats species being recorded between 2-5m. (Institute of Lighting Professionals and the Bat Conservation Trust, 2018).

Many bat species are light adverse and street lighting (high-pressure sodium and white LED lights) used along roads have been shown to deter bats, notably the slow-flying, woodland-adapted species such as *Myotis* and *Plecotus*, from approaching roads (Stone, 2013) (Jones) (Fure A. , 2012) (Fure A. , 2006) (Emery, 2008). Consequently, bat species less tolerant of light are put at a competitive disadvantage and are less able to forage successfully and efficiently. This can have a significant impact upon fitness and breeding success (Stone, 2013).

Illumination of a roost can result in a number of negative effects such as, delaying or preventing emergence from roosts which may lead to abandonment or being entombed in the roost. A delay in emergence times from the roost results in a reduced foraging time and missing the peak time of insect abundance (shortly after dusk). Missing this feeding opportunity can have a severe impact on the species survival rates.

Whilst light can deter a number of bat species it has also been shown to attract others, in particular open-air foraging species such as *Nyctalus* and generalists like *Pipistrellus* (e.g. (Bat Conservation Trust, 2009) (Fure A. , 2006)), since short wavelength light attracts insect prey, concentrating them around lights and increasing bat foraging efficiency. This in itself can cause negative effects. These species, whilst exploiting insect swarms around lights are likely to be at greater risk of collision with traffic. Higher mortality rates have been observed where lights are adjacent to trees.

2.2.2 Birds

The Site supports nesting and foraging barn owl *Tyto alba*. Besides nocturnal species, the Site also supports a range of breeding birds within hedgerows and woodland habitats.

Barn owl eyes are twice as light sensitive compared to human eyesight. Their eyesight is adapted to also work well in daylight and studies by the Barn Owl Trust have not observed this species to be negatively affected by artificial lighting and may even use artificial lighting as an aid to hunting.

2.2.3 Amphibians

The Site supports a breeding population of great crested newts within the pond located within the Chalcroft Farm complex. There is also a population to the north of the Site, which (alongside the Chalcroft population) form part of a wider Quobleigh metapopulation.

Hedgerows, marshy grassland and woodland offer good terrestrial habitat for this species. The Site also supports common and widespread species of amphibian such as common frog and common toad. All species of amphibian are predominantly nocturnal.

The effects of artificial lighting on amphibians, especially great crested newts have not been widely researched but is widely thought to have a negative effect on these species both within aquatic and terrestrial habitats. One study found that the nocturnal activity of breeding male common toads *Bufo bufo* during the breeding season decreased by half after exposure to 5 lux for 20 days; and at 20 lux, decreased by 73% (Touzet *et al.*, 2019); likely impacting on their breeding success owing to their short breeding period.

2.2.4 Dormice

A small dormouse *Muscardinus avellanarius* population was found during surveys conducted by Johns Associates in 2020; an active dormouse and a small number of nests were located in artificial nest tubes located along the woodland belt north of the solar farm.

Dormouse are a nocturnal species which are typically arboreal in habitat.

Research has found that excessive artificial lighting can cause disruption to the diurnal pattern in dormice and can make illuminated habitats untenable to dormice which reduces the likelihood of the habitat being able to support a dormice population.

2.2.5 Badgers

The Site supports a very low level of badger activity.

Badgers are known to be affected by artificial lighting; research has shown that badgers will delay their emergence times from sett entrances due to increased light levels from artificial lighting around setts. Research has also shown that badgers will forage in un-lit areas in preference to lit areas even if there is a higher food abundance in the areas with higher artificial light (IEEM 2008).

3 METHODOLOGY

3.1 LIGHTING SURVEY

3.1.1 Site Assessment

Aerial imagery was used to identify areas of potential light spill within and adjacent to the Site, this informed a visual walkover survey of the Site providing information on the location of artificial luminaries.

3.1.2 Site Survey

A Site survey was undertaken on 8th June 2020, between 22:45 and 00:45pm. Sunset was at 21:21. Weather conditions were dry with little cloud cover (1/8 oktas).

Data was collected using an Amprobe LM-120 light meter which measures lux levels at resolutions of 0.01 lux or lower, which enables accurate recording in darker areas. Light measurements were taken at the average height at which bats have been recorded flying along connective hedgerow habitats, the lux meter was attached to a 4m high pole in order to take standardized lux readings.

Data was collected surrounding the previously identified artificial luminaries and specific habitats where surveys have identified importance to previously identified species. Around artificial luminaries an assessment was made at each location to ascertain the extent of artificial light spill from the source into adjacent habitats. Samples were taken from the luminary to effective levels of 0 lux to plot areas of artificial light spill.

A GPS location of luminaries and light meter results were recorded and mapped using ESRI's Collector which was subsequently digitized using a geographical information system (ArcGIS).

The data collected from this survey highlights the base lighting conditions across the site, illustrating areas of significant light spill.

The data shown in Table 3.1 represents a conservative example of the lux measurements for given conditions found worldwide (values taken from use-IP Ltd (2008)).

Table 3.1: Chart of Example Lux Levels

Lighting Conditions	Lux Level
British summer sunshine	50,000
Overcast sky	5,000
Well-lit office	500
Minimum for easy reading	300
Passageway or outside working area	50
Good main road lighting	5-20
Sunset	10
Typical side road lighting	5
Minimum security lighting	2
Twilight	1
Clear full moon	0.25 to <1
Typical moonlight/cloudy sky	0.1
Typical starlight	0.001
Poor starlight	0.0001

3.2 CONSTRAINTS AND LIMITATIONS

Moonlight can affect illuminance measurements. The survey was conducted the evening after full moon and the moon was in its waning gibbous phase at 91% full. This resulted in an inflated maximum lux reading. To calibrate for the natural lux levels from the full moon all results had the value of 0.05 lux subtracted, to present an accurate assessment of light emitted from artificial sources only. The value of 0.05 lux was obtained by sampling multiple areas of the site where there was no artificial light to establish this baseline value of natural ambient light.

4 RESULTS

Both the desk-based Site assessment and the visual walkover survey of the Site identified no artificial luminaries or areas of potential light spill within the northern section of the Site. Due to this the northern section of the Site was not subject to detailed sampling as no sources of artificial light were present.

The baseline lighting assessment recorded generally very low artificial light levels across the Site, with the majority of the Site having lux levels of 0 – 0.1 lux. Areas subject to increased light levels were present at Chalcroft Farm and points along Burnetts Lane.

At Chalcroft Farm, light levels of >5 lux were recorded across an area of hard standing adjacent to Chalcroft Pond, these results relate to a Mercury Vapour security light located on a utility pole opposite the pond on the

driveway into the farm, see Plate 2. Lux levels between 1 - 5 lux, were frequently recorded within the main farm complex, lux levels dissipated around the edges of the farm from 0.5 lux to 0 lux see Figure 1. The light spill from the centre of the farm complex was observed not to spill into the surrounding improved grassland fields. Artificial luminaries around the farm included security flood lighting and internal light spill from an office building.

Luminance from two streetlights assumed to be low pressure sodium maps (SOX) were adjacent to the Site boundary on Burnetts Lane, see Plate 1. these lamps had a small range of artificial light spill into the Site boundary which can be seen in Figure 1, where the extent of the light spill was plotted from the source. From the hedgerow nearest the streetlights the lux level was recorded at 0.5 - 1 lux this dropped back down to 0 - 0.1 lux at a distance of 20-25m.

Overall the current artificial lighting impact on the Site is very minimal and is limited to small localized areas which had a small range of light spill. The majority of the Site has a lux level of 0 - 0.1 lux providing a large extent of dark habitats and corridors for nocturnal species throughout the Site.

The existing artificial lighting adjacent to the great crested newt population located within Chalcroft Farm pond (where the highest lux level of >5 lux was recorded for the Site) is considered likely to influence the dispersal of this species across the lit trackway. The artificial luminance onto the pond and the terrestrial habitats directly surrounding the southern section of the pond may adversely affect the movement of this species within the landscape. Great crested newt may avoid using areas with higher lux levels and instead favouring habitat with lower lux levels which may affect the dispersal of this species into the surrounding habitat causing the population to become isolated.

The brown long eared maternity colony located within a building in the Chalcroft Farm complex had a reading of 0.1 - 0.2 lux outside of the building, this level of luminance is considered very low .

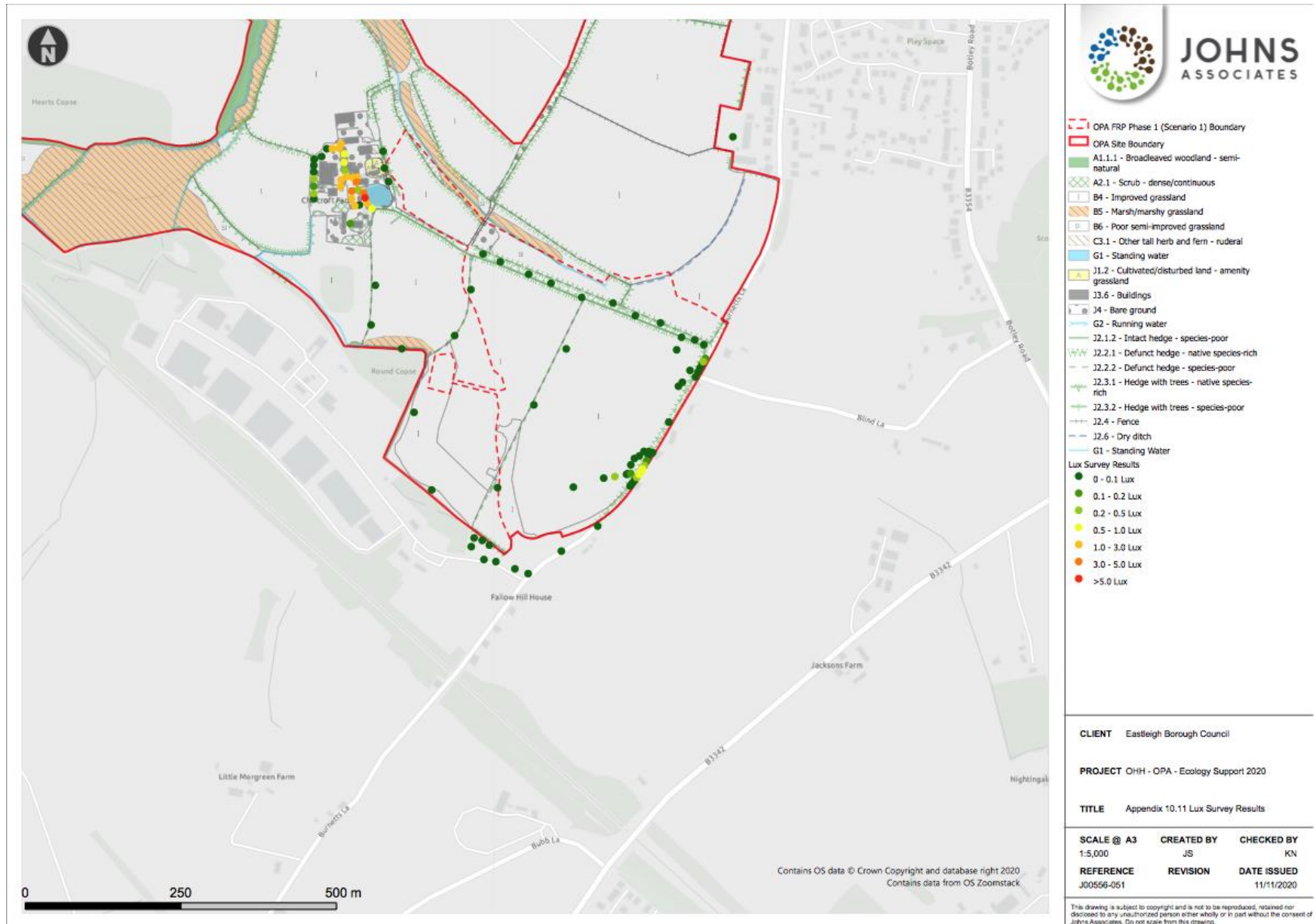
Plate 1: Low pressure sodium lamp on Burnetts Lane



Plate 2: Security light on utility pole adjacent to a great crested newt breeding pond.



Figure 1: Lux Survey Results



5 CONCLUSIONS

The survey results highlight that the Site has a very low overall baseline lux level. Only two specific areas subject to artificial lighting were identified around the operational Chalcroft Farm food processing facility and at the junction of the access track and Burnetts Lane.

Lighting designs for the development should aim to maintain low lux levels across the Site to maintain dark corridors and unlit habitats that are important for the nocturnal and crepuscular species present.

Bats are considered to be the species most likely to be negatively affected by an increase in artificial lighting from the development, in particular the species that are known to be light adverse, such as brown long-eared bats. Otter, barn owl, dormice and great crested newts could also potentially be affected by any artificial lighting of high value habitats given the current absence of artificial lighting on these habitats. This is particularly relevant to the lighting of any road severance locations.

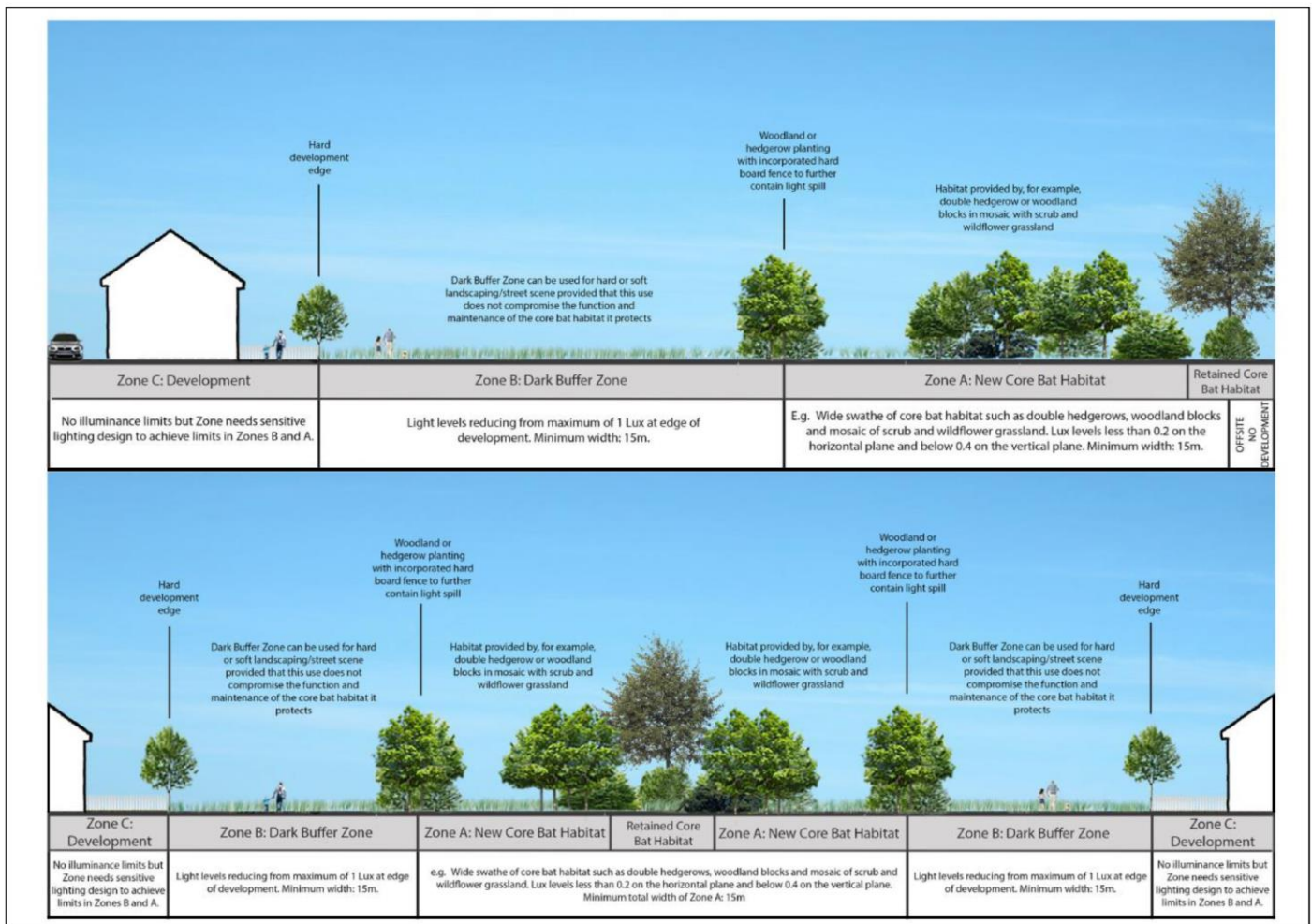
The lighting approach for new development should be in accordance with current best practice guidance on designing lighting with reference to bats (Bat Conservation Trust and Institution of Lighting Professionals, 2018).

As an overarching principle, dark corridors must be maintained around roosts, foraging areas and commuting corridors with no net increase in light levels as a result of the development in areas used by bats. It should be noted that enhancements over the existing baseline must also be built into scheme design wherever possible; i.e. development schemes that actively reduce any existing elevated lux levels associated with bat habitat features.

Important bat habitat zones and sensitive habitats should be maintained in 'completely dark' conditions, defined as < 0.2 lux on the horizontal plane and less than 0.4 lux on the vertical plane (measured at 1.5m and 4m) (Bat Conservation Trust and Institution of Lighting Professionals, 2018).

A discrete buffer-zone oriented parallel to each retained ecological feature of importance to the nocturnal/crepuscular species, present on Site, should be created. Example cross sections of suitable boundary treatments and design are shown in Figure 2.

Figure 2: Core Habitat Features and associated Buffer-Zones for Boundary Features (Above) and Within Development (Below).



Author: Katherine Newbert BSC (Hons) MSC

Johns Associates Ltd
 Suites 1 & 2,
 The Old Brewery,
 Newtown,
 Bradford on Avon,
 Wiltshire, BA15 1NF
 T: 01225 723652
 W: johnsassociates.co.uk

Third party disclaimer

Any disclosure of this report to a third party is subject to this disclaimer. The report was prepared by Johns Associates at the instruction of, and for use by, our client named on the front of the report. It does not in any way constitute advice to any third party who is able to access it by any means. Johns Associates excludes to the fullest extent lawfully permitted all liability whatsoever for any loss or damage howsoever arising from reliance on the contents of this report. We do not however exclude our liability (if any) for personal injury or death resulting from our negligence, for fraud or any other matter in relation to which we cannot legally exclude liability.

6 BIBLIOGRAPHY

Andrews, H. (2013). *Bat Tree Habitat Key*. Andrews Ecology.

- Barataud, M. (2016). *Acoustic Ecology of European Bats: Species Identification, Study of their Habits and Foraging Behaviour*. Inventaires Et Biodiversite.
- Bat Conservation Trust (BCT). (2015, 01 01). *BCT National Bat Monitoring Programme (NBMP) - Results and Reports*. Retrieved 08 10, 2016, from http://www.bats.org.uk/pages/results_and_reports.html
- Bat Conservation Trust. (2009). *BATS AND LIGHTING IN THE UK*. London: Bat Conservation Trust.
- Bat Conservation Trust. (2016). *Bat Survey Guidelines for Professional Ecologists: Good Practice Guidelines* (3rd ed.).
- Bat Conservation Trust and Institution of Lighting Professionals. (2018). *Guidance Note 08/18. Bats and Artificial Lighting in the UK. Bats and the Built Environment Series*.
- Bates, F. (2010). *The impact of hedgerow management on organic and conventional farms on small mammals, bats and their insect prey*. . PhD Thesis , University of Bristol .
- Bontadina, F. e. (2002). Radio-tracking reveals that lesser horseshoe bats (*Rhinolophus hipposideros*) forage in woodlands. *Journal of Zoology*, 258(3), 281-290.
- Boughey, K. e. (2011). Effects of landscape-scale broadleaved woodland configuration and extent on roost location for six bat species across the UK. *Biological Conservation* , 144, 2300-2310.
- Boughey, K. e. (2011). Improving the biodiversity benefits of hedgerows: How physical characteristics and the proximity of foraging habitat affect the use of linear features by bats. *Biological Conservation* (144), 1790-1798.
- British Standards Institute. (2013). *BS 42020:2013 Biodiversity - Code of practice for planning and development* (First ed.). London: BSI.
- British Standards Institute. (2015). *BS 8596:2015 Surveying for bats in trees and woodland. Guide*. British Standards Institute.
- Bruce-Whiete, C. S. (2011). *A review of the impact of artificial light on invertebrates* . Retrieved from Buglife: https://www.buglife.org.uk/sites/default/files/A%20Review%20of%20the%20Impact%20of%20Artificial%20Light%20on%20Invertebrates%20docx_0.pdf
- Dananay, K. L. and Benard, M. F (2018) Artificial light at night decreases metamorphic duration and juvenile growth in a widespread amphibian. *Proceedings. Biological sciences*, 285(1882), 20180367.
- Department for Communities and Local Government. (2012, 03 27). *NATIONAL PLANNING POLICY FRAMEWORK 2012*. Retrieved from www.gov.uk: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf
- Downs, N. e. (2006). The use by bats of habitat features in mixed farmland in Scotland . *Acta Chiropterologica* , 8, 169-85.
- Downs, N. e. (2006). The use by bats of habitat features in mixed farmland in Scotland . *Acta Chiropterologica*, 8(1), 169-185.
- Duverge, P. e. (2003). *Use of farmland habitats by greater horseshoe bats*. (F. e. Tattersall, Ed.) London: The Linnean Society London.
- Emery, M. (2008). *Effect of street lighting on bats*. Bristol: Urbis Street Lighting.
- Emery, M. (2008). *Effect of street-lighting on bats*. Project Report, Urbis Lighting Ltd.
- Entwistle, A. e. (n.d.). *Habitat management for bats* . 2001, Joint Nature Conservation Committee.
- Fure, A. (2006). *Bats and lighting* . The London Naturalist .
- Fure, A. (2012). Bats and lighting - six years on. *The London Naturalist*, 69-88.
- Gunnell, K., Murphy, B., & Williams, C. (2013). *Designing for Biodiversity: A technical guide for new and existing buildings* (Second ed.). London: RIBA Publishing.
- Hölker, F., Wolter, C., Perkin, E. K., Tockner, K. (2011) Light pollution as a biodiversity threat. *Trends in Ecology & Evolution*. 25:681–682. [PubMed: 21035893]
- Institute of Lighting Professionals and the Bat Conservation Trust. (2018, August). *Bats and Artificial Lighting in the UK - Bats in the Built Environment*.
- Jones, G. e. (2015). *Greater horseshoe bats and their insect prey: the impact and importance of climate change and agri-environment schemes* . University of Bristol , School of Biological Sciences .
- Jones, J. (n.d.). *Impact of lighting on bats* . London Biodiversity Partnership .
- Falchi, F., Cinzano, P., Elvidge, C. D., Keith, D. M., Haim, A. (2011) Limiting the impact of light pollution on human

- health, environment and stellar visibility. *Journal of Environmental Economics and Management*. 92:2714–2722.
- Limpens, e. a. (1991). Bats, their behaviour and linear landscape elements. *Energy Procedia*.
- Limpens, H. e. (1991). Bats, their behaviour and linear landscape elements . *Mytosis*(29), 39-48.
- Macdonald, D. e. (2015). *Wildlife Conservation on Farmland*.
- Middleton, N., Froud, A., & French, K. (2014). *Social Calls of the Bats of Britain and Ireland*. Pelagic Publishing.
- Mitchell-Jones, A. J. (2004). *Bat Mitigation Guidelines*. English Nature.
- Natural England and the Commission for Rural Communities. (2006). *Natural Environment and Rural Communities (NERC) Act 2006 c.16*. London: The Stationary Office.
- Rich, C. e. (Ed.). (2006). *Ecological Consequences of Artificial Night Lighting*.
- Robert, K. A., Lesku, J. A., Partecke, J., Chambers, B. (2015) Artificial light at night desynchronizes strictly seasonal reproduction in a wild mammal. *Proceedings of the Royal Society*. B 282: 20151745. Available at: <http://dx.doi.org/10.1098/rspb.2015.1745> (Accessed June 2020).
- Rotics, S., Dayan, T., Kronfeld-Schor, N. (2011) Effect of artificial night lighting on temporally partitioned spiny mice. *Journal of Mammalogy*. 2011; 92:159–168.
- Russ, J. (2012). *British Bat Calls: A Guide to Species Identification*. Pelagic Publishing.
- Russ, J. e. (2002). Habitat associations of bats in Northern Ireland: implications of conservation. . *Biological Conservation* , 108, 49-58.
- Russart KLG, Nelson RJ. Artificial light at night alters behavior in laboratory and wild animals. *Journal of Exploratory Zoology Part A: Ecological and Integrative Physiology*. 2018;329(8-9):401-408. doi:10.1002/jez.2173
- Rydel, J. e. (1996). *Bats and Streetlamps*. Bats Magazine.
- Stone, E. (2013). *Bats and lighting: Overview of current evidence and mitigation*. University of Bristol.
- Stone, E. (2013). *Bats and lighting: Overview of current evidence and mitigation*. University of Bristol.
- Stone, E. L. (2009). Street lighting disturbs commuting bats. *Curr. Biol.*, 1123-1127.
- Stone, E. L. (2015). The impacts of new street light technologies: experimentally testing the effects on bats of changing from low-pressure sodium to white metal halide. *Philos. T. R. Soc. B*.
- Stone, E. L. (n.d.). Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. *Glob. Change Biol.*, 2458-2465.
- Spoelstra, K., van Grunsven, R. H. A., Donners, M., Gienapp, P., Huigens, M. E., Slaterus, R., Veenendaal, E. (2015) Experimental Illumination of Natural Habitat—An Experimental Set-up to Assess the Direct and Indirect Ecological Consequences of Artificial Light of Different Spectral Composition. *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences*. 2015; 370:20140129. [PubMed: 25780241]
- Touzot, M., Teulier, L., Langagne, T., Secondi, J., Théry, M., Libourel, P., Guillard, L. & Mondy, N. (2019) Artificial light at night disturbs the activity and energy allocation of the common toad during the breeding period. *Conservation Physiology*, 7 (1): co2002; doi:10.1093/conphys/coz002
- UK Government. (1981). *The Wildlife and Countryside Act 1981(WCA 1981) as in force today (including any amendments) within the United Kingdom*, from. Retrieved from www.legislation.gov.uk: <http://www.legislation.gov.uk/ukpga/1981/69>
- UK Government. (1992, 01 01). *Legislation.gov.uk - Protection of Badgers Act 1992*. Retrieved from [Legislation.gov.uk](http://www.legislation.gov.uk): <http://www.legislation.gov.uk/ukpga/1992/51/contents>
- UK Government. (2006, 05 02). *Legislation - Natural Environment and Rural Communities Act 2006*. Retrieved from [Legislation.gov.uk](http://www.legislation.gov.uk): <http://www.legislation.gov.uk/ukpga/2006/16/contents>
- UK Government. (2010, 04 01). *Conservation of Habitats and Species Regulations 2010 (as amended)*. Retrieved 08 10, 2016, from www.legislation.gov.uk: <http://www.legislation.gov.uk/uksi/2010/490/regulation/1/made>
- UK Government. (2012, 03 27). *Gov.uk - Publications - National Planning Policy Framework*. Retrieved from www.gov.uk: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>
- Use IP (2008) *Lux Light Level Chart* [online] Available at: https://www.use-ip.co.uk/datasheets/lux_light_level_chart.pdf
- Zeale, M. R., Davidson-Watts, I., & Jones, G. (2012). Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy*, 93(4), 1110-1118.

