

Martin Harris, Manchester

ECOLOGICAL APPRAISAL

784-B033892 Rev 1



University of Manchester

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CONTENTS

1.0 INTRODUCTION	1
1.1 Background	1
1.2 Site Location	1
1.3 Development Proposals	1
1.4 Purpose of the Report	1
2.0 METHODOLOGY	2
2.1 Desk Study	2
2.2 Field Surveys	2
2.3 Limitations	4
3.0 BASELINE CONDITIONS.....	6
3.1 Designated Sites	6
3.2 Habitats	6
3.3 Protected & Notable Species	6
3.4 Importance of Ecological Features	7
4.0 RELEVANT PLANNING POLICY & LEGISLATION.....	9
4.1 Revised National Planning Policy Framework	9
4.2 Biodiversity 2020: A strategy for England's Wildlife & Ecosystem Services	10
4.3 Local Biodiversity Action Plan	10
4.4 Local Plan	11
4.5 Legislation	12
5.0 DISCUSSION	13
5.1 Designated Sites	13
5.2 Habitats	13
5.3 Protected & Notable Species	13
5.4 Enhancements	14
6.0 REFERENCES	15
FIGURES.....	16
APPENDIX A – REPORT CONDITIONS.....	17
APPENDIX B – KEY LEGISLATION.....	18
APPENDIX C – RELEVANT DESK STUDY DATA.....	27
APPENDIX D – TARGET NOTES	28
APPENDIX E – ARTIFICIAL LIGHTING	30

EXECUTIVE SUMMARY

Contents	Summary
Site Location	The site is located within the University of Manchester campus in the Chorlton-on-Medlock area of central Manchester and is centred at Ordnance Survey National Grid Reference SJ 84424 96602.
Proposals	The construction of a new two-storey music practice building is proposed within the site boundary.
Existing Site Information	No previous reports or surveys have been completed by or been made available to Tetra Tech.
Scope of this Survey(s)	An extended Phase 1 habitat survey, detailing the habitat types and dominant vegetation, as well as the presence of any invasive species, and the potential for the proposed site to support protected / notable fauna.
Results	The site was dominated by hardstanding currently used as carparking and was immediately surrounded by buildings forming the University of Manchester campus. No vegetation was present within the site and the site had no suitability for species such as GCN, badger, reptile, bat roosting and nesting birds. No invasive species were recorded within the site. The buildings adjacent to the site were noted to have suitability for roosting bats and nesting birds. The site was also in the impact risk zone of Rochdale Canal SAC SSSI located 6.3km northeast of the site however the proposals are not of a type that require further consultation with Natural England on the likely impacts of the proposals on this designated site.
Recommendations	No further surveys are recommended in relation to invasive species, badger, reptile and GCN. Due to the close proximity of the proposed construction zone to buildings with bird nesting potential, it is recommended that works either avoid the nesting bird season which runs from March to September inclusive or the works are preceded by a nesting bird check undertaken by a suitably qualified ecologist in the 48-hour period prior to the commencement of construction. The adjacent buildings were also noted to have suitability for bat roosting as such it is recommended that a sensitive lighting scheme is included within the proposals.

GLOSSARY

BCT	Bat Conservation Trust
BoCC	Birds of Conservation Concern
CIEEM	Chartered Institute of Ecology & Environmental Management
DEFRA	Department for the Environment, Food and Rural Affairs
EcIA	Ecological Impact Assessment
EPS	European Protected Species
EPSL	European Protected Species Licence
GCN	Great Crested Newt
GMLRC	Greater Manchester Local Records Centre
HPI	Habitat(s) of Principal Importance
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plan
LNR	Local Nature Reserve
Natura 2000 site	A European site designated for its nature conservation value
NE	Natural England
NERC Act	Natural Environment and Rural Communities Act 2006
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
PEA	Preliminary Ecological Appraisal
SAC	Special Area of Conservation
SAP	Species Action Plan
SBI	Site of Biological Importance
SPA	Special Protection Area
SPI	Species of Principal Importance
SSSI	Site(s) of Special Scientific Interest
W&CA	Wildlife & Countryside Act 1981 (as amended)

1.0 INTRODUCTION

1.1 BACKGROUND

Tetra Tech was commissioned by the University of Manchester on 23rd March 2022 to undertake an Ecological Appraisal and Habitat Condition Assessment to inform a Biodiversity Net Gain assessment of the site known as Martin Harris, Manchester.

This Ecological Appraisal report has been prepared by Consultant Ecologist Jade Armstrong BSc (Hons) MSc, qualifying CIEEM member and the conditions pertinent to it are provided in Appendix A. The Biodiversity Net Gain Assessment will be reported separately.

1.2 SITE LOCATION

The 'site' was located within the University of Manchester campus in the Chorlton-on-Medlock area of central Manchester and is centred at Ordnance Survey National Grid Reference SJ 84424 96602, off Bridgeford Street, M13 9PL – see Figure 1. The site comprises hardstanding and is immediately surrounded by buildings (not included within the site boundary).

1.3 DEVELOPMENT PROPOSALS

It is proposed that a new two storey building will be constructed within the site to form a new music practice building as part of the University of Manchester campus. No other construction or landscaping is currently proposed.

1.4 PURPOSE OF THE REPORT

The purpose of this report is to complete:

- A desk study to obtain existing information on statutory and non-statutory sites of nature conservation interest and relevant records of protected/notable species within the site and its zone of influence;
- An extended Phase 1 habitat survey, involving a walkover of the site to record habitat types and dominant vegetation, including any invasive species, and a reconnaissance survey for evidence of protected fauna or habitats capable of supporting such species; and
- An assessment of the potential ecological receptors present on site, identify any constraints they pose to future development and (if possible) any recommendations for any further surveys, avoidance, mitigation or enhancement measures that are needed (as appropriate).

Note that scientific names are provided at the first mention of each species and common names (where appropriate) are then used throughout the rest of the report for ease of reading.

A summary of the key legislation is also provided in Appendix B.

2.0 METHODOLOGY

2.1 DESK STUDY

2.1.1 Previous Reports

No previous reports or surveys of the site have been completed by or made available to Tetra Tech.

2.1.2 Local Ecological Records Centre

Information was requested from the Greater Manchester Local Record Centre for information on any nature conservation designations and protected or notable species records within 2 km of the site.

The data search covered:

- Statutory designated sites for nature conservation, namely SACs, SPAs, Ramsar sites, SSSIs, NNRs and LNRs;
- Non-statutory designated sites for nature conservation, namely SBIs;
- Legally protected species, such as great crested newts *Triturus cristatus*, badger *Meles meles* and bats;
- Notable habitats and species, such as those listed as Habitats or Species of Principal Importance (HPIs or SPIs); and
- Priority habitats or species within the Manchester City Council LBAP.

The data search did not cover:

- Tree Preservation Orders (TPOs); or
- Conservation Areas designated for their special architectural and historic interest.

2.1.3 Online Resources

A search for relevant information was also made on MAGIC www.magic.gov.uk - DEFRA's interactive, web-based database for statutory designations and information on any EPSL applications that have been granted within 2km of the site.

2.2 FIELD SURVEYS

The following methodologies have been used to identify the ecological receptors present on or near the site, which are relevant to the proposed development.

2.2.1 Habitats

An extended Phase 1 habitat survey was undertaken on the site on 31st March 2022 by Tetra Tech Consultant Ecologist Jade Armstrong BSc (Hons), MSc. Jade holds a Natural England Class 1 licence for bats (2018-37885-CLS-CLS), GCN (2021-54029-CLS-CLS) and a barn owl disturbance licence (CL29/00531). The weather conditions were 7°C, dry with a light breeze.

The vegetation and broad habitat types within the site were noted during the survey in accordance with the categories specified for a Phase 1 Habitat Survey (JNCC, 2010). Dominant plant species were recorded for each habitat present using nomenclature according to Stace (Stace, 2019). The site was also appraised for its suitability to support notable flora, with regard to the *Guidelines for Preliminary Ecological Appraisal* (CIEEM, 2017).

2.2.2 Protected & Notable Species

The site was inspected for evidence of, and its potential to support, protected or notable species, especially those listed under the Schedule 2 of the Habitat Regulations, Schedule 5 of the W&CA, the

CRoW Act, those given extra protection under the NERC Act, and species included in the Manchester City Council LBAP.

Great Crested Newt

The site was appraised for its suitability to support GCN. The assessment was based on Guidance outlined in the *Herpetofauna Workers' Manual* (Gent & Gibson, 2003) and the *Great Crested Newt Conservation Handbook* (Langton, Becket & Foster, 2001).

Bats

Roosting Bats – Buildings / Structures / Trees

Any suitable buildings, structures or trees on site were assessed from the ground for their suitability to support breeding, resting and hibernating bats using survey methods based on the *BCT Bat Surveys for Professional Ecologists: Good Practice Guidelines* (Collins, 2016) – hereafter referred to as the 'BCT Guidelines'. The categories used to classify the bat roost suitability of any features found, are explained in Table 1 below.

Table 1: Categories of Bat Roost Suitability (BCT Guidelines)

Suitability	Typical Roosting Features
Negligible	Negligible habitat feature on site likely to be used by roosting bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions and/or suitable surrounding habitat to be used on a regular basis or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation). A tree of sufficient size and age to contain potential roost features but with none seen from the ground or features seen with only very limited roosting potential.
Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis & potentially for longer periods of time due to their size, shelter, protection, conditions and surrounding habitat.

Foraging/commuting Bats

The BCT Guidelines use the criteria in Table 2 below to categorise the potential value of habitats and features for use by foraging and commuting bats and these have been used to characterise the value of this site.

Table 2: Categories of Habitat Suitability (BCT Guidelines)

Suitability	Typical Foraging & Commuting Features
Negligible	Negligible habitat features on site likely to be used by commuting or foraging bats.
Low	Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or unvegetated stream, but isolated, i.e. not very well connected to the surrounding landscape by other habitat. Suitable, but isolated habitat that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch of scrub.

Suitability	Typical Foraging & Commuting Features
Moderate	Continuous habitat connected to the wider landscape that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	Continuous high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, tree-lined watercourses and grazed parkland. Site is close to and connected to known roosts.

Reptiles

The site was appraised for its suitability to support reptiles. The assessment was based on guidance outlined in the Herpetofauna Workers' Manual (Gent & Gibson, 2003).

Badger

The site was surveyed for evidence of badger setts or other badger activity such as paths, latrines or signs of foraging. Methodologies used and any setts recorded were classified according to published criteria (Harris, Cresswell & Jefferies, 1989).

Other Species

The site was also appraised for its suitability to support other protected or notable fauna including mammals, amphibians, birds and invertebrates with regard to the Guidelines for Preliminary Ecological Appraisal (CIEEM, 2017) and *BS42020:2013 Biodiversity – Code of Practice for Planning and Development* (BSI, 2013). Evidence of any current or historical presence of such species was recorded.

Invasive Species

The site was searched for evidence of invasive plant species, such as Japanese knotweed *Reynoutria japonica* (formerly *Fallopia japonica*), Indian (Himalayan) balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, wall cotoneaster *Cotoneaster horizontalis* and rhododendron *Rhododendron ponticum*. A full list of all invasive plant species is provided in Appendix B.

2.3 LIMITATIONS

The optimal period to undertake an extended Phase 1 habitat survey is April-September. The survey was completed at the end of March which is just outside the optimal survey window. However, given the character of the site (hardstanding with no semi natural habitats) this is not considered to significantly affect conclusions drawn in this report and is therefore not considered to form a limitation.

To determine presence or likely absence of protected species usually requires multiple visits at suitable times of the year. As a result, this survey focuses on assessing the potential of the site to support species of note, which are considered to be of principal importance for the conservation of biodiversity with reference to those given protection under UK or European wildlife legislation. This report cannot therefore be considered a comprehensive assessment of the ecological interest of the site. However, it does provide an assessment of the ecological interest present on the day the site was visited and highlights areas where further survey work may be recommended.

The details of this report will remain valid for a period of two years from the date of the survey, after which the validity of this assessment should be reviewed to determine whether further updates are necessary. Note that the recommendations within this report should be reviewed (and reassessed if necessary) should there be any changes to the red line boundary or development proposals which this report was based on.

3.0 BASELINE CONDITIONS

3.1 DESIGNATED SITES

There were no statutory designated sites of ecological importance identified within 2 km of the site. The nearest statutory designated site Clayton Vale LNR that was located 3.9 km northeast of the site. The site also lies within the impact risk zone of Rochdale Canal SAC & SSSI located 6.3 km northeast of the site. However, the project is not of a type that require further consultation with Natural England on the likely impacts of the proposals on this designated site and should not cause a likely significant impact to this designated site.

There were two SBIs identified within 2 km of the site by the GMLRC search; Rochdale Canal Sott's Lane to Ducie Street Basin located approximately 1.7 km northeast and Ashton Canal (West) located approximately 1.6 km northeast. Both of these sites had no direct habitat or hydrological connectivity to the site.

3.2 HABITATS

The following habitat has been identified through our assessment, with detailed Target Notes included in Appendix D, as appropriate, and mapped on Figure 2.

3.2.1 Hardstanding

The site was approximately 10m x 10m and was entirely dominated by tarmac hardstanding currently used as car parking spaces (TN1). No flora, buildings or structures were identified within the site.

3.3 PROTECTED & NOTABLE SPECIES

The following species have been considered through our assessment, with desk study results given in Appendix C and detailed Target Notes included in Appendix D and mapped on Figure 2.

3.3.1 Great Crested Newt

During the desk study no ponds or waterbodies were identified within 500m of the site. Furthermore, no previous GCN licences were identified within 2 km of the site and no records returned from GMLRC. The site was considered unsuitable for GCN due to the absence of waterbodies and vegetation and as such GCN will not be discussed further within this report.

3.3.2 Bats

A total of 15 previous EPSLs for bats were identified within 2 km of the site. The most recent licence was granted in 2021 for a project destroying a common pipistrelle *Pipistrellus pipistrellus* resting place, this licence was located approximately 1.1 km northeast of the site. The closest licence to the site was granted in 2016 for a project also destroying a common pipistrelle resting place at a location approximately 700m east of the site.

A total of 56 records for bats were returned from GMLRC within the previous 10 years. The species included common pipistrelle, unidentified pipistrelle species *Pipistrellus* sp., unidentified bat species *Chiroptera* sp., unidentified *Myotis* species *Myotis* sp. and brown long eared bat *Plecotus auritus*. The closest record was located approximately 150m southeast of the site and was for an injured pipistrelle species. The records ranged from injured bats to small bat roosts and bat commuting.

There were no buildings, structures or trees within the site and therefore no suitable roosting locations. It was noted that the buildings immediately adjacent to the site had crevices suitable for roosting (TN2,TN3,TN4).

There was no vegetation within the site or linear features of value to bat commuting or foraging.

3.3.3 Reptiles

No records for reptile within the previous 10 years were returned from GMLRC. The hardstanding within the site was considered unsuitable for reptiles due to the absence of suitable cover and opportunities for foraging. Furthermore the site had no direct connectivity to habitats suitable for reptiles. As such reptiles will not be discussed further within this report.

3.3.4 Badger

Two records for badger were returned within 2 km of the site, the records were for sightings only. The habitats within the site were considered unsuitable for both badger foraging and sett creation. There were no banks that could present opportunity for digging and sett creation. Furthermore, the site was dominated by hardstanding that would prevent construction of a sett. As such badger will not be discussed further within this report.

3.3.5 Otter & Water Vole

There were no water bodies present within the site or immediately adjacent and no records were returned by GMLRC within the previous 10 years. The site is considered to be unsuitable for otter *Lutra lutra* and water vole *Arvicola amphibius* and as such these species will not be discussed further within this report.

3.3.6 Birds

A total of 246 bird records were returned from GMLRC in the previous 10 years. A number of the species returned were listed as red or amber BoCC such as house sparrow *Passer domesticus*, bullfinch *Pyrrhula pyrrhula* and dunnock *Prunella modularis*. In addition, records for kingfisher *Alcedo atthis* and peregrine *Falco peregrinus* (Schedule 1 species of the WCA) were also returned. The site had very little value for birds due to the lack of vegetation that could provide foraging and nesting opportunities. Furthermore, no buildings or waterbodies were present that could be used for peregrine nesting or kingfisher foraging. It was however noted that the buildings immediately adjacent to the site, had suitability for common nesting birds.

3.3.7 Other Notable Species

Records of hedgehog *Erinaceus europaeus* were returned from GMLRC in the previous 10 years. However, the site was considered unsuitable for hedgehog due to the absence of vegetation suitable for foraging and resting.

3.3.8 Invasive species

No invasive plant species were present within the site.

3.4 IMPORTANCE OF ECOLOGICAL FEATURES

In line with the CIEEM PEA Guidelines, and based on the above baseline information, the importance of each ecological feature recorded within the study area is given in Table 3 below. The categories used are those which are defined in Section 4 of the CIEEM EcIA Guidelines (2018 v1.1):

Table 3 Importance of Ecological Features

Feature	Importance	Rationale
Hardstanding	Negligible	No ecological value
Bats	Local	Adjacent buildings may support roosts.
Birds	Local	Adjacent buildings may support nesting birds
Either: International (incl. European) / National / Regional / County / Local / Negligible Or: Unknown (i.e. further surveys/information needed)		

The potential for the proposals to have adverse or beneficial impacts on these features, along with the need for any mitigation or enhancement measures are discussed in detail below.

4.0 RELEVANT PLANNING POLICY & LEGISLATION

4.1 REVISED NATIONAL PLANNING POLICY FRAMEWORK

A revised NPPF was issued on 19th February 2019 (Ministry of Housing Communities and Local Government, 2019) and currently supplements government Circular 06/2005, *Biodiversity and Geological Conservation: Statutory Obligations and their Impact within the Planning System* (Office of the Deputy Prime Minister, 2005).

Circular 06/2005 states that the presence of protected species is a material consideration in the planning process. Paragraph 170 of the NPPF also states that:

'Planning policies and decisions should contribute to and enhance the natural environment by:

- a) protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan)*
- b) recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland*
- c) maintaining the character of the undeveloped coast, while improving public access to it where appropriate*
- d) minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures*
- e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and*
- f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*

The conservation and enhancement of wildlife is also specifically reference re: development within the National Parks or the Broads.

Paragraph 175 then goes on to confirm that:

When determining planning applications, local planning authorities should apply the following principles:

- a) if significant harm to biodiversity resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused;*
- b) development on land within or outside a Site of Special Scientific Interest, and which is likely to have an adverse effect on it (either individually or in combination with other developments), should not normally be permitted. The only exception is where the benefits of the development in the location proposed clearly outweigh both its likely impact on the features of the site that make it of special scientific interest, and any broader impacts on the national network of Sites of Special Scientific Interest;*

- c) *development resulting in the loss or deterioration of irreplaceable habitats (such as ancient woodland and ancient or veteran trees) should be refused, unless there are wholly exceptional reasons and a suitable compensation strategy exists; and*
- d) *development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to incorporate biodiversity improvements in and around developments should be encouraged, especially where this can secure measurable net gains for biodiversity.*

Regarding EclA's and HRA's – any sites identified, or required, as compensatory measures for adverse effects on any Natura 2000/habitats site should also be given the same level as protection as the pSPA's and cSAC's themselves. In addition, when an application is being determined, Paragraph 177 clarifies that:

“The presumption in favour of sustainable development does not apply where the plan or project is likely to have a significant effect on a habitats site (either alone or in combination with other plans or projects), unless an appropriate assessment has concluded that the plan or project will not adversely affect the integrity of the habitats site.”

Paragraph 180 is also relevant as;

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

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

4.2 BIODIVERSITY 2020: A STRATEGY FOR ENGLAND'S WILDLIFE & ECOSYSTEM SERVICES

Biodiversity 2020 (DEFRA, 2011) replaces the previous UK Biodiversity Action Plan and sets national targets to be achieved. The intent of Biodiversity 2020, however, is much broader than the protection and enhancement of less common species and is meant to embrace the wider countryside as a whole.

The priority species and habitats considered under Biodiversity 2020 are the SPI & HPI detailed under NERC Act (see Appendix B for further details).

4.3 LOCAL BIODIVERSITY ACTION PLAN

Local Biodiversity Action Plans (LBAPs) identify habitat and species conservation priorities at a local level (typically County by County) and are usually drawn up by a consortium of local Government organisations and conservation charities. Although they are no-longer managed at a national level many are still reviewed and updated at a local level.

The Manchester City Council LBAP (Manchester City Council, 2005) is the relevant document for this site and it contains the following relevant Habitat & Species Action Plans:

Table 4 LBAP SAPs

Species Action Plans	
Great crested newt	Pipistrelle bat
Water vole	Skylark <i>Alauda arvensis</i>
Brown hare <i>Lepus europaes</i>	Linnet <i>Linaria cannabina</i>
Reed bunting <i>Emberiza schoeniclus</i>	Spotted flycatcher <i>Muscicapa striata</i>

Species Action Plans	
Tree sparrow <i>Passer montanus</i>	Grey partridge <i>Perdix perdix</i>
Bullfinch	Song thrush <i>Turdus philomelos</i>
Floating water plantain <i>Luronium natans</i>	Grass-wrack pondweed <i>Potamogeton compressus</i>
Manchester Poplar <i>Populus nigra</i> subsp <i>betulifolia</i>	

Table 5 LBAP HAPs

Habitats Action Plans	
Acid Grassland	Ancient and/or species rich hedgerows
Wet Woodlands	Lowland Broadleaved Woodland
Lowland Heathland	Lowland Meadows
Unimproved Neutral Grassland	Marshy Grassland
Managed Greenspace	Reedbed
Rivers	Canals
Ponds & Lodges	

It should be noted that the existence of a SAP or HAP does not always infer an elevated level importance for those features. These plans may be designed to encourage an increase in these habitats/species, rather than to protect a county-scarce feature (for example).

4.4 LOCAL PLAN

The Manchester City Council Biodiversity Action plan (Manchester City Council, 2005) sets out a number of objectives which aim to increase biodiversity and protect existing species and biodiversity in particular Objective 3 and Objective 5:

“To promote biodiversity in Manchester

Promotion will lead to a greater sense of ownership as regards the City’s natural resource. The Strategy provides a significant opportunity to show the importance of biodiversity across all sectors of society:

Priority Actions

- To promote biodiversity through all partner organisations in the public private and voluntary sector.*
- To raise the profile of Manchester’s major natural attractions by increased publicity.*
- To increase the involvement of local people in biodiversity.*
- To promote wildlife-friendly gardening.*
- To fully utilise media opportunities*
- To promote the benefits of eco tourism across the city”*

“To ensure that Biodiversity is integrated into the wider sustainable development agenda

As well as incorporating biodiversity into new build, opportunities will arise to secure funding for biodiversity related projects.

Priority Actions

- *To encourage elements of biodiversity good practice and sustainability into all new developments.*
- *To encourage developers to identify ecological impacts of proposals.*
- *To ensure that sites and species of special biodiversity interest (as listed in this strategy) do not suffer any overall negative impact from development.*
- *To seek protection against inappropriate development through the planning process.*
- *To maximise the opportunities for improving biodiversity by the introduction of new funding.”*

4.5 LEGISLATION

Full details of the UK legislation and offences which are relevant to the ecological receptors identified are included in Appendix B. However, based on the findings of our assessment, it is considered that the proposals will need to consider the following legal provisions:

- Disturbance of a European protected species (bats); and
- Disturbance of nesting wild birds.

5.0 DISCUSSION

5.1 DESIGNATED SITES

5.1.1 Natura 2000 Sites and Sites of Special Scientific Interest

The site lies within the impact risk zone of Rochdale Canal SAC SSSI located 6.3 km northeast of the site however the proposals are not of a type that require further consultation with Natural England on the likely impacts of the proposals on this designated site and should not cause a likely significant impact to this site. The site has no habitat or hydrological connectivity to this site and is located a suitable distance to avoid indirect effects such as noise, lighting, shading and air pollution (including construction related dust). The development is small scale and, based on its proposed use, unlikely to increase visitor pressures to this designated site.

5.1.2 Sites of Biological Importance

There were two SBIs identified within 2 km of the site by the GMLRC search: Rochdale Canal Sott's Lane to Ducie Street Basin and Ashton Canal (West). Both of these sites had no direct habitat or hydrological connectivity to the site and were considered to be a suitable distance away as to not be impacted by dust from construction works.

5.2 HABITATS

5.2.1 Hardstanding

The site was dominated by hardstanding forming car parking spaces. Hardstanding is considered to have no ecological value. Loss of this habitat is not considered to impact ecological interest of the site.

5.3 PROTECTED & NOTABLE SPECIES

5.3.1 Bats

There were no buildings, structures or trees located within the site and as such no areas suitable for bat roosting. There was also no vegetation or linear features within the site that would form commuting routes for bats.

During the site visit the buildings immediately adjacent to the site were noted to have suitable access points that could be utilised as bat roosts. The access points would be suitable for common crevice dwelling species such as common pipistrelle and soprano pipistrelle. No works are proposed to the adjacent buildings however due to the close proximity of the proposed new building it is recommended that a lighting strategy is adopted for any new lighting included within the site to reduce impacts on any potential roosts within the adjacent buildings. It must be noted that species likely to be present (common pipistrelle and soprano pipistrelle) are light tolerant species and not *Myotis* species which are more light averse.

Lighting Strategy

Artificial lighting can have an adverse effect on bats and other nocturnal wildlife, and measures are recommended to avoid or reduce this impact. A wildlife sensitive lighting scheme should be designed in consultation with a suitably experienced ecologist to limit the level of artificial light specially on potential roosting features in the adjacent buildings. Where artificial lighting is necessary, the following measures should be considered to reduce adverse effects:

- Lighting should be directed groundward to avoid upward light spillage, with of hood design, lamp height, and angle, to reduce light spill particularly avoiding illuminating retained foraging and commuting habitat on the site such as the woodland

- Use of LED lamps or less ultraviolet (UV) light emitting bulbs, such as metal halide or high-pressure sodium; and, with a low colour correlated temperature – preferably below 3500K (warm white) hoods / shields as necessary. Light spill on potential roosting features should be a maximum of 1 lux (ILP, 2018).
- Minimising hours of lighting to those absolutely necessary for security and safety purposes, where possible lighting should avoid key periods of bat activity (i.e. sunset and sunrise). Consider how new technologies can be used to control lighting levels (e.g. dimming lights at certain times). It is recommended that construction works are only undertaken during day light hours in order to prevent disturbance of foraging and commuting bats

Further technical details are given in the BCT and the institute of Lighting Engineers' Bats and lighting in the UK (2018) (Appendix E).

5.3.2 Birds

A number of bird records were returned during the desk study however, the site was considered unsuitable for bird nesting due to the absence of buildings, structures and vegetation. The adjacent buildings had some suitability for nesting birds, these buildings will not be directly impacted during the proposed works however, due to the close proximity (<5m distance) there remains the residual chance of disturbance to nesting birds. It is advised that a check for nesting birds is undertaken by a suitably qualified ecologist before construction works commence if works are to be undertaken within the bird nesting season (March – September inclusive). Should an active nest be identified in the adjacent buildings an appropriate buffer (as advised by a suitably experienced ecologist) should be implemented until the chicks have fledged. Where possible, it is advised that construction works are undertaken over the autumn/winter period to avoid potentially impacting nesting birds.

5.4 ENHANCEMENTS

5.4.1 Biodiversity Net Gain

A Biodiversity Net Gain assessment using the Defra Small Sites Metric (JP040) will be completed within a separate report however, bat and bird boxes integrated into the new building would make a valuable enhancement to the site. The boxes should be placed at 4m and lighting should be directed away from these new roost features.

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Please note that the legislation which is relevant to this report is not included in the list above, but details are included in Appendix B below.

FIGURES

Figure 1 – Site Location Plan

Figure 2 – Phase 1 Habitat Plan



Site Location Plan

Martin Harris

University of Manchester



Legend

Site boundary

Notes:

Drawn by: SB
Checked by: JA
Office: Southampton

Figure No. 1
Revision No. A

0 10 20 30 Meters
Scale 1:1,000 @A3

11 April 2022
NGR: 384422E 396602N

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The Pavilion, 1st Floor
Botleigh Grange
Office Campus
Hedge End
Southampton
Hampshire, SO30 2AF



Phase 1 Habitat Plan

Martin Harris

University of Manchester



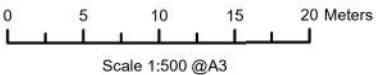
Legend

-  Site boundary
-  Hardstanding
-  Potential bat roost locations

Notes:

Drawn by: SB
Checked by: JA
Office: Southampton

Figure No. 2
Revision No. A



27 April 2022
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The whole of the report must be read as other sections of the report may contain information which puts into context the findings in any executive summary.

The performance of environmental protection measures and of buildings and other structures in relation to acoustics, vibration, noise mitigation and other environmental issues is influenced to a large extent by the degree to which the relevant environmental considerations are incorporated into the final design and specifications and the quality of workmanship and compliance with the specifications on site during construction. Tetra Tech accept no liability for issues with performance arising from such factors.

APPENDIX B – KEY LEGISLATION

Bern Convention

The *Convention on the Conservation of European Wildlife and Natural Habitats* (the *Bern Convention*) was adopted in Bern, Switzerland in 1979, and was ratified in 1982. Its aims are to protect wild plants and animals and their habitats listed in Appendices 1 and 2 of the Convention, and regulate the exploitation of species listed in Appendix 3. The regulation imposes legal obligations on participating countries to protect over 500 plant species and more than 1000 animals. To meet its obligations imposed by the Convention, the European Community adopted the *EC Birds Directive* (1979) and the *EC Habitats Directive* (1992 – see below). Since the Lisbon Treaty, in force since 1st December 2009, European legislation has been adopted by the European Union.

Bonn Convention

The Convention on the Conservation of Migratory Species of Wild Animals or 'Bonn Convention' was adopted in Bonn, Germany in 1979 and came into force in 1985. Participating states agree to work together to preserve migratory species and their habitats by providing strict protection to species listed in Appendix I of the Convention. It also establishes agreements for the conservation and management of migratory species listed in Appendix II.

In the UK, the requirements of the convention are implemented via the Wildlife & Countryside Act 1981 (as amended), Wildlife (Northern Ireland) Order 1985 (as amended), Nature Conservation and Amenity Lands (Northern Ireland) Order 1985 and the Countryside and Rights of Way Act 2000 (CROW).

Habitats Directive

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, or the 'Habitats Directive', is a European Union directive adopted in 1992 in response to the Bern Convention. Its aims are to protect approximately 220 habitats and 1,000 species listed in its several Annexes.

In the UK, the Habitats Directive is transposed into national law via the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales, and via the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland.

Birds Directive

The EC Directive on the Conservation of Wild Birds (79/409/EEC) or 'Birds Directive' was introduced to achieve favourable conservation status of all wild bird species across their distribution range. In this context, the most important provision is the identification and classification of Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex 1 of the Directive, as well as for all regularly occurring migratory species, paying particular attention to the protection of wetlands of international importance.

Conservation of Habitats and Species Regulations 2017 (as amended)

Regulations place a duty on the Secretary of State to propose a list of sites which are important for either habitats or species (listed in Annexes I or II of the Habitats Directive respectively) to the European Commission. These sites, if ratified by Ministers, are then designated as Special Protection Areas (SPAs) within six years. Public bodies must also help preserve, maintain and re-establish habitats for wild birds.

The 2018 amendments mainly related to the impact of the *People Over Wind* decision and some implications arising for neighbourhood plan development and a range of other planning tools including Local Development Orders and Permission in Principle – see here for full details:

<https://www.legislation.gov.uk/uksi/2018/1307/note/made>

The Regulations make it an offence to deliberately capture, kill, disturb or trade in the animals listed in Schedule 2, or pick, uproot, destroy, or trade in the plants listed in Schedule 5 - see below:

Schedule 2 – European Protected Species of Animals	Schedule 5 – European Protected Species of Plants
Horseshoe bats <i>Rhinolophidae</i> - all species	Shore dock <i>Rumex rupestris</i>
Common bats <i>Vespertilionidae</i> - all species	Killarney fern <i>Trichomanes speciosum</i>
Large Blue Butterfly <i>Maculinea arion</i>	Early gentian <i>Gentianella anglica</i>
Wild cat <i>Felis sylvestris</i>	Lady's-slipper <i>Cypripedium calceolus</i>
Dolphins, porpoises and whales <i>Cetacea</i> – all sp.	Creeping marsh-wort <i>Apium repens</i>
Dormouse <i>Muscardinus avellanarius</i>	Slender naiad <i>Najas flexilis</i>
Pool frog <i>Rana lessonae</i>	Fen orchid <i>Liparis loeselii</i>
Sand lizard <i>Lacerta agilis</i>	Floating-leaved water plantain <i>Luronium natans</i>
Fisher's estuarine moth <i>Gortyna borelii lunata</i>	Yellow marsh saxifrage <i>Saxifraga hirculus</i>
Great crested newt <i>Triturus cristatus</i>	
Otter <i>Lutra lutra</i>	
Lesser whirlpool ram's-horn snail <i>Anisus vorticulus</i>	
Smooth snake <i>Coronella austriaca</i>	
Sturgeon <i>Acipenser sturio</i>	
Natterjack toad <i>Epidalea calamita</i>	
Marine turtles <i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Lepidochelys kempii</i> , <i>Eretmochelys imbricata</i> , <i>Dermochelys coriacea</i>	
Wildlife & Countryside Act 1981 (as amended)	
This is the principal mechanism for the legislative protection of wildlife in the UK. This legislation is the chief means by which the 'Bern Convention' and the Birds Directive are implemented in the UK. Since it was first introduced, the Act has been amended several times. The Act makes it an offence to (with exception to species listed in Schedule 2) intentionally: - kill, injure, or take any wild bird; - take, damage or destroy the nest of any wild bird while that nest is in use; or - take or destroy an egg of any wild bird. Or to intentionally do the following to a wild bird listed in Schedule 1: - disturbs any wild bird while it is building a nest or is in, on or near a nest containing eggs or young; or - disturbs dependent young of such a bird. In addition, the Act makes it an offence (subject to exceptions) to: - intentionally or recklessly kill, injure or take any wild animal listed on Schedule 5; - interfere with places used for shelter or protection, or intentionally disturbing animals occupying such places; and - The Act also prohibits certain methods of killing, injuring, or taking wild animals. Finally, the Act also makes it an offence (subject to exceptions) to: intentionally pick, uproot or destroy any wild plant listed in Schedule 8, or any seed or spore attached to any such wild plant; unless an authorised person, intentionally uproot any wild plant not included in Schedule 8; or sell, offer or expose for sale, or possess (for the purposes of trade), any live or dead wild plant included in Schedule 8, or any part of, or anything derived from, such a plant. Following all amendments to the Act, Schedule 5 'Animals which are Protected' contains a total of 154 species of animal, including several mammals, reptiles, amphibians, fish and invertebrates. Schedule 8 'Plants which are Protected' of the Act, contains 185 species, including higher plants, bryophytes and fungi and lichens. A comprehensive and up-to-date list of these species can be obtained from the JNCC website. Part 14 of the Act makes unlawful to plant or otherwise cause to grow in the wild any plant which is listed in Part II of Schedule 9. It is recommended that plant material of these species is disposed of as bio-hazardous waste, and these plants should not be used in planting schemes.	

Schedule 1 - Birds which are protected by special penalties			
Avocet	<i>Recurvirostra avosetta</i>	Osprey	<i>Pandion haliaetus</i>
Bee-eater	<i>Merops apiaster</i>	Owl, Barn	<i>Tyto alba</i>
Bittern	<i>Botaurus stellaris</i>	Owl, Snowy	<i>Nyctea scandiaca</i>
Bittern, Little	<i>Ixobrychus minutus</i>	Peregrine	<i>Falco peregrinus</i>
Bluethroat	<i>Luscinia svecica</i>	Petrel, Leach's	<i>Oceanodroma leucorhoa</i>
Brambling	<i>Fringilla montifringilla</i>	Phalarope, Red-necked	<i>Phalaropus lobatus</i>
Bunting, Cirl	<i>Emberiza cirlus</i>	Plover, Kentish	<i>Charadrius alexandrinus</i>
Bunting, Lapland	<i>Calcarius lapponicus</i>	Plover, Little Ringed	<i>Charadrius dubius</i>
Bunting, Snow	<i>Plectrophenax nivalis</i>	Quail, Common	<i>Coturnix coturnix</i>
Buzzard, Honey	<i>Pernis apivorus</i>	Redstart, Black	<i>Phoenicurus ochruros</i>
Capercaillie	<i>Tetrao urogallus</i>	Redwing	<i>Turdus iliacus</i>
Chough	<i>Pyrrhocorax pyrrhocorax</i>	Rosefinch, Scarlet	<i>Carpodacus erythrinus</i>
Corncrake	<i>Crex crex</i>	Ruff	<i>Philomachus pugnax</i>
Crake, Spotted	<i>Porzana porzana</i>	Sandpiper, Green	<i>Tringa ochropus</i>
Crossbills (all species)	<i>Loxia</i>	Sandpiper, Purple	<i>Calidris temminckii</i>
Curlew, Stone	<i>Burhinus oedichnemus</i>	Sandpiper, Wood	<i>Tringa glareola</i>
Divers (all species)	<i>Gavia</i>	Scaup	<i>Aythya marila</i>
Dotterel	<i>Charadrius morinellus</i>	Scoter, Common	<i>Melanitta nigra</i>
Duck, Long-tailed	<i>Clangula hyemalis</i>	Scoter, Velvet	<i>Melanitta fusca</i>
Eagle, Golden	<i>Aquila chrysaetos</i>	Serin	<i>Serinus serinus</i>
Eagle, White-tailed	<i>Haliaetus albicilla</i>	Shorelark	<i>Eremophila alpestris</i>
Falcon, Gyr	<i>Falco rusticolus</i>	Shrike, Red-backed	<i>Lanius collurio</i>
Fieldfare	<i>Turdus pilaris</i>	Spoonbill	<i>Platalea leucorodia</i>
Firecrest	<i>Regulus ignicapillus</i>	Stilt, Black-winged	<i>Himantopus himantopus</i>
Garganey	<i>Anas querquedula</i>	Stint, Temminck's	<i>Calidris temminckii</i>
Godwit, Black-tailed	<i>Limosa limosa</i>	Swan, Bewick's	<i>Cygnus bewickii</i>
Goshawk	<i>Accipiter gentilis</i>	Swan, Whooper	<i>Cygnus cygnus</i>
Grebe, Black-necked	<i>Podiceps nigricollis</i>	Tern, Black	<i>Chlidonias niger</i>
Grebe, Slavonian	<i>Podiceps auritus</i>	Tern, Little	<i>Sterna albifrons</i>
Greenshank	<i>Tringa nebularia</i>	Tern, Roseate	<i>Sterna dougallii</i>
Gull, Little	<i>Larus minutus</i>	Tit, Bearded	<i>Panurus biarmicus</i>
Gull, Mediterranean	<i>Larus melanocephalus</i>	Tit, Crested	<i>Parus cristatus</i>
Harriers (all species)	<i>Circus</i>	Tree-creeper, Short-toed	<i>Certhia brachydactyla</i>
Heron, Purple	<i>Ardea purpurea</i>	Warbler, Cetti's	<i>Cettia cetti</i>
Hobby	<i>Falco subbuteo</i>	Warbler, Dartford	<i>Sylvia undata</i>
Hoopoe	<i>Upupa epops</i>	Warbler, Marsh	<i>Acrocephalus palustris</i>
Kingfisher	<i>Alcedo atthis</i>	Warbler, Savi's	<i>Locustella luscinioides</i>
Kite, Red	<i>Milvus milvus</i>	Whimbrel	<i>Numenius phaeopus</i>
Merlin	<i>Falco columbarius</i>	Woodlark	<i>Lullula arborea</i>
Oriole, Golden	<i>Oriolus oriolus</i>	Wryneck	<i>Jynx torquilla</i>
Animal (Vertebrate) Species Listed in Schedule 5 (full legal protection at all times)			
Horseshoe Bats (all species)	<i>Rhinolophidae</i>	Newt – Great Crested	<i>Triturus cristatus</i>
Typical Bats (all species)	<i>Vespertilionidae</i>	Snake – Smooth	<i>Coronella austriaca</i>
Dolphin – Bottle-nosed	<i>Tursiops truncatus (tursio)</i>	Toad, Natterjack	<i>Epidalea calamita</i>
Dolphin – Common	<i>Delphinus delphis</i>	Turtles – All Species	<i>Cheloniidae & Dermochelyidae</i>
Dormouse – Hazel	<i>Muscardinus avellanarius</i>	Basking Shark	<i>Cetorhinus maximus</i>
Pine Marten	<i>Martes martes</i>	Burbot	<i>Lota lota</i>
Porpoise – Harbour	<i>Phocaena phocaena</i>	Goby – Giant	<i>Gobius cobitis</i>
Otter – Eurasian	<i>Lutra lutra</i>	Goby – Couch's	<i>Gobius couchii</i>
Squirrel – Red	<i>Sciurus vulgaris</i>	Seahorse – Short-snouted ¹	<i>Hippocampus hippocampus</i>
Walrus	<i>Odobenus rosmarus</i>	Seahorse – Spiny	<i>Hippocampus guttulatus</i>
Water Vole	<i>Arvicola amphibius</i>	Sturgeon	<i>Acipenser sturio</i>
Whales – All Species	<i>Cetacea</i>	Vendace	<i>Coregonus albula</i>

¹ Both sea horse species are protected in England only.

Wildcat	<i>Felis sylvestris</i>	Whitefish	<i>Coregonus lavaretus</i>
Lizard – Sand	<i>Lacerta agilis</i>		
Animal (Vertebrate) Species Protected under Section 9 (1) part: Killing and Injuring & Section 9 (5) Sale			
Adder	<i>Vipera berus</i>	Slow-worm	<i>Anguis fragilis</i>
Lizard – Viviparous	<i>Zootoca vivipara</i>	Snake – Grass	<i>Natrix helvetica (natrix)</i>
Animals (Vertebrate) Species Protected under Section 9 (5) Sale only			
Frog – common	<i>Rana temporaria</i>	Newt – Smooth	<i>Lissotriton vulgaris</i>
Newt – Palmate	<i>Lissotriton helvetica</i>	Toad – Common	<i>Bufo bufo</i>
Animals (Vertebrate) Species Protected under Section 9 (1) (4)(a): Killing, Injuring & Taking and Damage / Destruction of place of shelter / protection only			
Allis Shad	<i>Alosa alosa</i>	Shark – Angel	<i>Squatina squatina</i>
Twaite Shad	<i>Alosa fallax</i>		
Butterflies & Moths – Full Protection under Schedule 5² at all times			
High brown fritillary	<i>Argynnis adippe</i>	Fisher's Estuarine Moth	<i>Gortyna borelii</i>
Large Blue	<i>Maculinea arion</i>	Barberry Carpet	<i>Pareulype berberata</i>
Heath Fritillary	<i>Mellicta athalea</i>	Black-veined Moth	<i>Siona lineata</i>
Marsh Fritillary	<i>Eurodryas aurinia</i>	Sussex Emerald	<i>Thalera fimbrialis</i>
Swallowtail	<i>Papilio machaon britannicus</i>	Essex Emerald	<i>Thetidia smaragdalis</i>
Large Copper	<i>Lycaena dispar</i>	Fiery Clearwing	<i>Bembecia chrysidiformis</i>
Reddish-buff Moth	<i>Acosmetia caliginosa</i>	New-Forest Burnet	<i>Zygaena viciae</i>
Butterflies – Protected under Section 9 (5) Sale Only			
Purple Emperor	<i>Apatura iris</i>	Adonis Blue	<i>Lysandra bellargus</i>
Northern Brown Argus	<i>Aricia artaxerxes</i>	Chalkhill Blue	<i>Lysandra coridon</i>
Pearl-bordered Fritillary	<i>Boloria euphrosyne</i>	Glanville Fritillary	<i>Melitaea cinxia</i>
Chequered Skipper	<i>Carterocephalus palaemon</i>	Large Tortoiseshell	<i>Nymphalis polychloros</i>
Large Heath	<i>Coenonympha tullia</i>	Silver-studded Blue	<i>Plebejus argus</i>
Small Blue	<i>Cupido minimus</i>	Black Hairstreak	<i>Strymonidia pruni</i>
Mountain Ringlet	<i>Erebia epiphron</i>	White-letter Hairstreak	<i>Strymonidia w-album</i>
Duke of Burgundy	<i>Hamearis lucina</i>	Brown Hairstreak	<i>Thecla betulae</i>
Silver-spotted Skipper	<i>Hesperia comma</i>	Lulworth Skipper	<i>Thymelicus acteon</i>
Wood White	<i>Leptidea sinapis</i>		
Other Invertebrates – Full Protection under Schedule 5 at all times			
Rainbow Leaf-beetle	<i>Chrysolina cerealidis</i>	Tadpole Shrimp	<i>Triops cancriformis</i>
Spangled Diving-beetle	<i>Graphopterus zonatus</i>	Trembling Sea-mat	<i>Victorella pavida</i>
Lesser Silver Water-beetle	<i>Hydrochara caraboides</i>	De Folin's Lagoon Snail	<i>Caecum armoricum</i>
Moccas Beetle	<i>Hypebaeus flavipes</i>	Sandbowl Snail	<i>Catinella arenaria</i>
Violet Click-beetle	<i>Limoniscus violaceus</i>	Freshwater Pearl Mussel	<i>Margaritifera margaritifera</i>
Bembridge Beetle	<i>Parcymus aeneus</i>	Glutinous Snail	<i>Myxas glutinosa</i>
New Forest Cicada	<i>Cicadetta montana</i>	Lagoon Snail	<i>Paludinella littorina</i>
Wart-Biter	<i>Decticus verrucivorus</i>	Lagoon Sea Slug	<i>Tenellia adspersa</i>
Mole-Cricket	<i>Gryllotalpa gryllotalpa</i>	Northern Hatchet-shell	<i>Thyasira gouldi</i>
Field-Cricket	<i>Gryllus campestris</i>	Tentacled Lagoon-worm	<i>Alkmaria romijni</i>
Norfolk Hawker Dragonfly	<i>Aeshna isosceles</i>	Lagoon Sand-worm	<i>Armandia cirrhosa</i>
Southern Damselfly	<i>Coenagrion mercuriale</i>	Medicinal Leech	<i>Hirudo medicinalis</i>
Fen Raft Spider	<i>Dolomedes fimbriatus</i>	Marine Hydroid	<i>Clavopsella navis</i>
Ladybird Spider	<i>Eresus niger (cinaberinus)</i>	Ivell's Sea Anemone	<i>Edwardsia ivelli</i>
Fairy Shrimp	<i>Chirocephalus diaphanus</i>	Starlet Sea Anemone	<i>Nematosella vectensis</i>
Lagoon Sand Shrimp	<i>Gammarus insensibilis</i>	Atlantic Stream (White-clawed) Crayfish	<i>Austropotamobius pallipes</i>
Other Invertebrates Protected under Section 9 (1) Possession & 9 (2) (5) Sale only			
Stag Beetle	<i>Lucanus cervus</i>	Roman Snail ³	<i>Helix pomatia</i>

² Viper's Bugloss Moth *Hadena irregularis* was removed from Schedule 5 in 1996 as it is believed to be extinct.

³ England only

Fan Mussel	<i>Atrina fragilis</i>	Pink Sea-fan	<i>Eunicella verrucosa</i>
Other Invertebrates Protected under Section 9 (4) (a) Damage / Destruction of Place of Shelter / Protection only			
Mire Pill Beetle	<i>Curimopsis nigrita</i>		
Vascular Plant Species - Full Protection under Schedule 8 at all times (previous Scientific name in brackets)			
Adder's-tongue Least	<i>Ophioglossum lusitanicum</i>	Lily – Snowdon	<i>Gagea serotina</i> (<i>Lloydia serotina</i>)
Alison- Small	<i>Alyssum alyssoides</i>	Marsh-mallow – Rough	<i>Malva setigera</i> (<i>Althaea hirsuta</i>)
Broomrape – Bedstraw	<i>Orobancha caryophyllacea</i>	Milk-parsley – Cambridge	<i>Selinum carvifolia</i>
Broomrape – Oxtongue	<i>Orobancha picridis</i>	Mudwort – Welsh	<i>Limosella aquatica</i>
Broomrape – Thistle	<i>Orobancha reticulata</i> ⁴	Naiad – Holly-leaved	<i>Najas marina</i>
Cabbage – Lundy	<i>Coincya wrightii</i> (<i>Rhynchosinapis wrightii</i>)	Orache – Stalked	<i>Atriplex pedunculata</i> (<i>Halimione pedunculata</i>)
Calamint – Wood	<i>Clinopodium menthifolium</i> (<i>Calamintha sylvatica</i>)	Orchid – Early Spider	<i>Ophrys sphegodes</i>
Catchfly – Alpine	<i>Silene suecica</i> (<i>Lychnis alpina</i>)	Orchid – Ghost	<i>Epipogium aphyllum</i>
Centaury – Slender	<i>Centaureum tenuiflorum</i>	Orchid – Lapland Marsh	<i>Dactylorhiza lapponica</i>
Cinquefoil – Rock	<i>Potentilla rupestris</i>	Orchid – Late Spider	<i>Ophrys fuciflora</i>
Clary – Meadow	<i>Salvia pratensis</i>	Orchid – Lizard	<i>Himantoglossum hircinum</i>
Club-rush – Triangular	<i>Schoenoplectus triqueter</i> (<i>Scirpus triqueter</i>)	Orchid – Military	<i>Orchis militaris</i>
Colt's-foot – Purple	<i>Homogyne alpina</i>	Orchid – Monkey	<i>Orchis simia</i>
Cotoneaster – Wild	<i>Cotoneaster cambricus</i> (<i>C. integerrimus</i>)	Pear – Plymouth	<i>Pyrus cordata</i>
Cotton-grass – Slender	<i>Eriophorum gracile</i>	Pennycress – Perfoliate	<i>Microthlaspi perfoliatum</i> (<i>Thlaspi perfoliatum</i>)
Cow-wheat – Field	<i>Melampyrum arvense</i>	Pennyroyal	<i>Mentha pulegium</i>
Crocus – Sand	<i>Romulus columnae</i>	Pigmyweed	<i>Crassula aquatica</i>
Cudweed – Broad-leaved	<i>Filago pyramidata</i>	Pine - Ground	<i>Ajuga chamaepitys</i>
Cudweed – Jersey	<i>Gnaphalium luteoalbum</i>	Pink – Cheddar	<i>Dianthus gratianopolitanus</i>
Cudweed – Red-tipped	<i>Filago lutescens</i>	Pink – Childing	<i>Petrorhagia nanteuilii</i>
Cut-grass	<i>Leersia oryzoides</i>	Ragwort – Fen	<i>Jacobaea paludosa</i> (<i>Senecio paludosa</i>)
Deptford Pink	<i>Dianthus armeria</i>	Ramping-fumitory – Martin's	<i>Fumaria reuteri</i> (<i>F. martinii</i>)
Diapensia	<i>Diapensia lapponica</i>	Rampion – Spiked	<i>Phyteuma spicata</i>
Eryngo – Field	<i>Eryngium campestre</i>	Restharrow – Small	<i>Ononis reclinata</i>
Fern – Dickie's-bladder	<i>Cystopteris dickieana</i>	Rock-cress – Alpine	<i>Arabis alpina</i>
Fleabane – Alpine	<i>Erigeron borealis</i>	Rock-cress – Bristol	<i>Arabis scabra</i>
Fleabane – Small	<i>Pulicaria vulgaris</i>	Sandwort – Norwegian	<i>Arenaria norvegica</i> ⁵
Galingale – Brown	<i>Cyperus fuscus</i>	Sandwort – Teesdale	<i>Minuartia stricta</i>
Gentian – Alpine	<i>Gentiana nivalis</i>	Saxifrage – Drooping	<i>Saxifraga cernua</i>
Gentian - Dune	<i>Gentianella amarella</i> subsp. <i>occidentalis</i> (<i>Gentianella uliginosa</i>)	Saxifrage – Tufted	<i>Saxifraga cespitosa</i>
Gentian – Fringed	<i>Gentianopsis ciliata</i> (<i>Gentianella ciliata</i>)	Solomon's-seal – Whorled	<i>Polygonatum verticillatum</i>
Gentian - Spring	<i>Gentiana verna</i>	Sow-thistle – Alpine	<i>Cicerbita alpina</i>
Germander – Cut-leaved	<i>Teucrium botrys</i>	Spearwort – Adder's-tongue	<i>Ranunculus ophioglossifolius</i>
Germander – Water	<i>Teucrium scordium</i>	Speedwell – Fingered	<i>Veronica triphyllos</i>

⁴ The Weeds Act 1959 does not apply to thistles *Cirsium* & *Carduus* species supporting this broomrape.

⁵ All subspecies occurring in the UK

Gladiolus – Wild	<i>Gladiolus illyricus</i>	Speedwell – Spiked	<i>Veronica spicata</i> ⁶
Goosefoot – Stinking	<i>Chenopodium vulvaria</i>	Spike-rush – Dwarf	<i>Eleocharis parvula</i>
Grass-poly	<i>Lythrum hyssopifolia</i>	South-stack Fleawort	<i>Tephrosia integrifolia</i> <i>ssp. maritima</i>
Hare's-ear – Sick- leaved	<i>Bupleurum falcatum</i>	Star-of-Bethlehem – Early	<i>Gagea bohemica</i>
Hare's-ear – Small	<i>Bupleurum baldense</i>	Starfruit	<i>Damasonium alisma</i>
Hawk's-beard – Stinking	<i>Crepis foetida</i>	Strapwort	<i>Corrigiola littoralis</i>
Hawkweed – Northroe	<i>Hieracium northroense</i>	Violet – Fen	<i>Viola persicifolia</i>
Hawkweed – Shetland	<i>Hieracium zetlandicum</i>	Viper's-grass	<i>Scorzonera humilis</i>
Hawkweed – Weak- leaved	<i>Hieracium attenuatifolium</i>	Water-plantain – Ribbon- leaved	<i>Alisma gramineum</i>
Heath – Blue	<i>Phyllodoce caerulea</i>	Wood-sedge – Starved	<i>Carex depauperata</i>
Helleborine – Red	<i>Cephalanthera rubra</i>	Woodsia – Alpine	<i>Woodsia alpina</i>
Horsetail – Branched	<i>Equisetum ramosissimum</i>	Woodsia – Oblong	<i>Woodsia ilvensis</i>
Hound's-tongue – Green	<i>Cynoglossum germanicum</i>	Wormwood – Field	<i>Artemisia campestris</i>
Knawel – Perennial	<i>Scleranthus perennis</i> ⁷	Woundwort - Downy	<i>Stachys germanica</i>
Knot-grass – Sea	<i>Polygonum maritimum</i>	Woundwort – Limestone	<i>Stachys alpina</i>
Leek – Round-headed	<i>Allium sphaerocephalon</i>	Yellow-rattle – Greater	<i>Rhinanthus angustifolius</i>
Lettuce – Least	<i>Lactuca saligna</i>		
Vascular Plant Species – Partial Protection under Section 13 (2) Protection from commercial exploitation and sale			
Bluebell	<i>Hyacinthoides non-scripta</i>		
Bryophytes – Full Protection under Schedule 8 at all times			
Anamodon – Long- leaved	<i>Anomodon langifolius</i>	Flamingo Moss	<i>Desmatodon cernuus</i>
Blackwort	<i>Southbya nigrella</i>	Frostwort	<i>Gymnomitrium</i> <i>apiculatum</i>
Crystalwort – Lizard	<i>Riccia bifurca</i>	Glaucous Beard Moss	<i>Barbula glauca</i>
Earwort – Marsh	<i>Jamesoniella undulifolia</i>	Green Shield Moss	<i>Buxbaumia viridis</i>
Feathermoss – Polar	<i>Hygrohypnum polare</i>	Hair Silk Moss	<i>Plagiothecium piliferum</i>
Flapwort – Norfolk	<i>Leiocolea rutheana</i>	Knothole Moss	<i>Zygodon forsteri</i>
Grimmia – Blunt- leaved	<i>Grimmia unicolor</i>	Large Yellow Feather Moss	<i>Scorpidium turgescens</i>
Petalwort	<i>Petalophyllum ralfsii</i>	Millimetre Moss	<i>Micromitrium tenerum</i>
Lindenberg's Leafy- Liverwort	<i>Adelanthus lindenbergianus</i>	Multi-fruited River Moss	<i>Cryphaea lamyana</i>
Feather-moss Slender Green	<i>Drepanocladus vernicosus</i>	Nowell's Limestone Moss	<i>Zygodon gracilis</i>
Alpine Copper-Moss	<i>Mielichhoferia melicoferia</i>	Rigid Apple Moss	<i>Bartramia stricta</i>
Baltic Bog-Moss	<i>Sphagnum balticum</i>	Round-leaved feather Moss	<i>Rhynchostegium</i> <i>rotundifolium</i>
Blue Dew-Moss	<i>Saelania glaucescens</i>	Schleicher's Thread Moss	<i>Bryum schleicheri</i>
Blunt-leaved bristle- Moss	<i>Orthotrichum obtusifolium</i>	Triangular Pygmy Moss	<i>Acaulon triquetrum</i>
Bright-Green Cave- Moss	<i>Cyclodictyon laetevirens</i>	Turpswort	<i>Geocalyx graveolens</i>
Cordate Beard Moss	<i>Barbula cordata</i>	Vaucher's Feather Moss	<i>Hypnum vaucheri</i>
Cornish Path Moss	<i>Ditrichum cornubicum</i>	Western Rustwort	<i>Marsupella profunda</i>
Derbyshire Feather Moss	<i>Thamnobryum angustifolium</i>		
Stoneworts – Full Protection under Schedule 8 at all times			
Bearded Stonewort	<i>Chara canescens</i>	Foxtail Stonewort	<i>Lamprothamnium</i> <i>papulosum</i>

⁶ Both subspecies: *spicata* & *hybrida*

⁷ Includes both subspecies: *perennis* & *prostratus*

Lichens – Full Protection under Schedule 8 at all times			
New Forest Beech Lichen	<i>Enterographa elaborata</i>	Forked Hair Lichen	<i>Bryoria furcellata</i>
Snow Caloplaca	<i>Caloplaca nivalis</i>	Golden Hair Lichen	<i>Teloschistes flavicans</i>
Tree Catapyrenium	<i>Catapyrenium psoromoides</i>	Orange-fruited Elm Lichen	<i>Caloplaca luteoalba</i>
Laurer's Catillaria	<i>Catillaria laurei</i>	River Jelly Lichen	<i>Collema dichotomum</i>
Convolut Cladonia	<i>Cladonia convoluta</i>	Starry Breck Lichen	<i>Buellia asterella</i>
Upright Mountain Cladonia	<i>Cladonia stricta</i>	Caledonia Pannaria	<i>Pannaria ignobilis</i>
Goblin Lights	<i>Catolechia wahlenbergii</i>	New Forest Parmelia	<i>Parmelia minarum</i>
Elm Gyalecta	<i>Gyalecta ulmi</i>	Oil Stain Parmentaria	<i>Parmentaria chilensis</i>
Tarn Lecanora	<i>Lecanora archariana</i>	Southern Grey Physcia	<i>Physcia tribacioides</i>
Copper Lecidea	<i>Lecidea inops</i>	Ragged Pseudo-cyphellaria	<i>Pseudocyphellaria lacerata</i>
Arctic Kidney Lichen	<i>Nephroma arcticum</i>	Rusty Alpine Psora	<i>Psora rubiformis</i>
Ciliate Strap Lichen	<i>Heterodermia leucomelos</i>	Rock Nail	<i>Calicium corynellum</i>
Coralloid Rosette Lichen	<i>Heterodermia propagulifera</i>	Serpentine Selanopsora	<i>Selanopsora liparina</i>
Ear-lobed Dog Lichen	<i>Peltigera lepidophora</i>	Sulphur Tresses	<i>Alectoria ochroleuca</i>
Lichens – Partial Protection under Section 13 (2) Commercial Exploitation and Sale Only			
Tree Lungwort	<i>Lobaria pulmonaria</i>		
Fungi – Full Protection under Schedule 8 at all times			
Royal Boletus	<i>Boletus regius</i>	Oak Polypore	<i>Buglossosporus pulvinus</i>
Hedgehog Fungus	<i>Hericium erinaceum</i>	Sandy Stilt Ball	<i>Battaria phalloides</i>
Invasive plant species listed in Schedule 9			
Alexanders, Perfoliate	<i>Smyrniun perfoliatum</i>	Kelp, Japanese	<i>Laminaria japonica</i>
Algae, Red	<i>Grateloupia luxurians</i>	Knotweed, Giant	<i>Reynoutria (Fallopia) sachalinensis</i>
Archangel, Variegated Yellow	<i>Lamiastrum galeobdolon subsp. argentatum</i>	Knotweed, Hybrid	<i>Reynoutria (Fallopia) japonica x sachalinensis</i>
Azalea, Yellow	<i>Rhododendron luteum</i>	Knotweed, Japanese	<i>Reynoutria (Fallopia) japonica</i>
Balsam, Himalayan	<i>Impatiens glandulifera</i>	Leek, Few-flowered	<i>Allium paradoxum</i>
Cotoneaster, Wall	<i>Cotoneaster horizontalis</i>	Lettuce, water	<i>Pistia stratiotes</i>
Cotoneaster, Entire-leaved	<i>Cotoneaster integrifolius</i>	Montbretia	<i>Crocasmia x crocosmiiflora</i>
Cotoneaster, Himalayan	<i>Cotoneaster simonsii</i>	Parrot's Feather	<i>Myriophyllum aquaticum</i>
Cotoneaster, Hollyberry	<i>Cotoneaster bullatus</i>	Pennywort, Floating	<i>Hydrocotyle ranunculoides</i>
Cotoneaster, Small-leaved	<i>Cotoneaster microphyllus</i>	Potato, Duck	<i>Sagittaria latifolia</i>
Creeper, False Virginia	<i>Parthenocissus inserta</i>	Primrose, Floating Water	<i>Ludwigia peploides</i>
Creeper, Virginia	<i>Parthenocissus quinquefolia</i>	Primrose, Water	<i>Ludwigia grandiflora</i>
Dewplant, Purple	<i>Disphyma crassifolium</i>	Primrose, Water	<i>Ludwigia uruguayensis</i>
False-acacia	<i>Robinia pseudoacacia</i>	Rhododendron	<i>Rhododendron ponticum</i> and hybrid <i>R. ponticum x R. maximum</i>
Fanwort/Carolina Water-Shield	<i>Cabomba caroliniana</i>	Rhubarb, Giant	<i>Gunnera tinctoria</i>
Fern, Water	<i>Azolla filiculoides</i>	Rose, Japanese	<i>Rosa rugosa</i>
Fig, Hottentot	<i>Carpobrotus edulis</i>	Salvinia, Giant	<i>Salvinia molesta</i>
Garlic, Three-cornered	<i>Allium triquetrum</i>	Seafingers, Green	<i>Codium fragile</i>
Hogweed, Giant	<i>Heracleum mantegazzianum</i>	Seaweed, Californian Red	<i>Pikea californica</i>

Hyacinth, Water	<i>Eichhornia crassipes</i>	Seaweed, Hooked Asparagus	<i>Asparagopsis armata</i>
Kelp, Giant species	<i>Macrocystis angustifolia</i> , <i>M. integrifolia</i> , <i>M. laevis</i> , <i>M. pyrifera</i>	Seaweed, Japanese	<i>Sargassum muticum</i>
Seaweeds, Laver	<i>Porphyra</i> spp except except native species, <i>P. amethystea</i> , <i>P. leucosticta</i> , <i>P. linearis</i> , <i>P. miniate</i> , <i>P. purpurea</i> , <i>P. umbilicalis</i>	Wakame	<i>Undaria pinnatifida</i>
Shallon	<i>Gaultheria shallon</i>	Waterweed, Curly	<i>Lagarosiphon major</i>
Stonecrop, Australian Swamp/New Zealand Pygmyweed	<i>Crassula helmsii</i>	Waterweeds	All species of the genus <i>Elodea</i>

Protection of Badgers Act 1992

The main legislation protecting badgers in England and Wales is the Protection of Badgers Act 1992 (the 1992 Act). Under the 1992 Act it is an offence to: wilfully kill, injure, take or attempt to kill, injure or take a badger; dig for a badger; interfere with a badger sett by, damaging a sett or any part thereof, destroying a sett, obstructing access to a sett, causing a dog to enter a sett or disturbing a badger while occupying a sett.

The 1992 Act defines a badger sett as: “any structure or place which displays signs indicating current use by a badger”

Natural Environment and Rural Communities Act 2006

Section 41 (S41) of this Act requires the Secretary of State to publish a list (in consultation with Natural England) of Habitats and Species which are of Principal Importance for the conservation of biodiversity in England. The S41 list is used to guide decision-makers such as public bodies including local and regional authorities, in implementing their duty under Section 40 of the Natural Environment and Rural Communities (NERC) Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal (e.g. planning) functions. The S41 list includes 65 Habitats of Principal Importance and 1,150 Species of Principal Importance.

Hedgerow Regulations 1997

The Hedgerow Regulations were made under Section 97 of the Environment Act 1995 and came into force in 1997. They introduced new arrangements for local planning authorities in England and Wales to protect important hedgerows in the countryside, by controlling their removal through a system of notification. Important hedgerows are defined by complex assessment criteria, which draw on biodiversity features, historical context and the landscape value of the hedgerow.

Birds of Conservation Concern

This is a review of the status of all birds occurring regularly in the United Kingdom. It is regularly updated and is prepared by leading bird conservation organisations, including the British Trust for Ornithology (BTO), Joint Nature Conservation Committee (JNCC) and The Royal Society for the Protection of Birds (RSPB).

The latest report was produced in 2015 (Eaton *et al*, 2015) and identified 67 red list species, 96 amber species, and 81 green species. The criteria are complex, but generally:

- **Red list** species are those that have shown a decline of the breeding population, non-breeding population or breeding range of more than 50% in the last 25 years.
- **Amber list** species are those that have shown a decline of the breeding population, non-breeding population or breeding range of between 25% and 50% in the last 25 years. Species that have a UK breeding population of less than 300 or a non-breeding population of less than 900 individuals are also included, together with those whose 50% of the population is localised in 10 sites or fewer and those whose 20% of the European population is found in the UK.

- **Green list** species are all regularly occurring species that do not qualify under any of the red or amber criteria are green listed

Global IUCN Red List

The International Union for Conservation of Nature (IUCN) Threatened Species was devised to provide a list of those species that are most at risk of becoming extinct globally. It provides taxonomic, conservation status and distribution information about threatened taxa around the globe. The system catalogues threatened species into groups of varying levels of threat, which are: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), Not Evaluated (NE). Criteria for designation into each of the categories is complex, and consider several principles.

Local Biodiversity Action Plan (LBAP)

Local Biodiversity Action Plans (LBAP) identify habitat and species conservation priorities at a local level (typically at the County level), and are usually drawn up by a consortium of local Government organisations and conservation charities.

Some LBAP's may also include Habitat Action Plans (HAP) and/or Species Action Plans (SAP), which are used to guide and inform the local decision making process.

Wild Mammals (Protection) Act 1996

This Act offers protects a form of protection to all wild species of mammals, irrespective of other legislation, and focussed on animal welfare, rather than conservation.

Unless covered by one of the exceptions, a person is guilty of an offence if he mutilates, kicks, beats, nails or otherwise impales, stabs, burns, stones, crushes, drowns, drags or asphyxiates any wild mammal with intent to inflict unnecessary suffering.

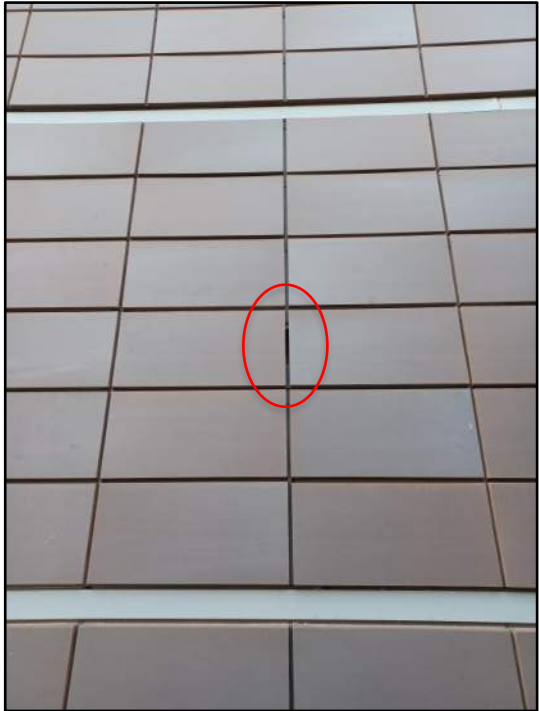
It's application is typically restricted to preventing deliberate harm to wildlife (in general) during construction works etc.

APPENDIX C – RELEVANT DESK STUDY DATA

Species Common Name	Species Latin Name	Number of records in previous 10 years	Protection / Legislation
Birds			
Black Redstart	<i>Phoenicurus ochruros</i>	6	Amber list of BoCC
Grey Heron	<i>Ardea cinerea</i>	4	WCA 1981
Kingfisher	<i>Alcedo atthis</i>	6	Schedule 1 of WCA 1981
Peregrine	<i>Falco peregrinus</i>	10	Schedule 1 of WCA 1981
Bullfinch	<i>Pyrrhula pyrrhula</i>	16	Amber list of BoCC
Curlew	<i>Numenius arquata</i>	1	Red list of BoCC
Dunnock	<i>Prunella modularis</i>	89	Amber list of BoCC
Herring Gull	<i>Larus argentatus</i>	3	Red list of BoCC
House Sparrow	<i>Passer domesticus</i>	33	Red list of BoCC
Lesser Redpoll	<i>Acanthis cabaret</i>	2	Red list of BoCC
Linnet	<i>Linaria cannabina</i>	1	Red list of BoCC
Song Thrush	<i>Turdus philomelos</i>	34	Amber list of BoCC
Starling	<i>Sturnus vulgaris</i>	39	Red list of BoCC
Tree Sparrow	<i>Passer montanus</i>	1	Red list of BoCC
Yellow Wagtail	<i>Motacilla flava</i>	1	Red list of BoCC
Bats			
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	45	EPS, WCA
Myotis species	<i>Myotis sp.</i>	1	EPS, WCA
Pipistrelle species	<i>Pipistrellus sp.</i>	3	EPS, WCA
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	2	EPS, WCA
Bat species	<i>Chiroptera sp.</i>	4	EPS, WCA
Other			
Bee Orchid	<i>Epithet apifera</i>	1	Section 13 of WCA 1981
Cinnabar	<i>Tyria jacobaeae</i>	11	Priority Species under the UK Post-2010 Biodiversity Framework
Hedgehog	<i>Erinaceus europaeus</i>	40	NERC

APPENDIX D – TARGET NOTES

Target Note	Description	Photograph
1	Hardstanding. No vegetation present. Currently in use for car parking.	
2	Small crevice under roof end identified through binoculars on the southeast façade of the adjacent building. Droppings identified through binoculars that were bird droppings. The feature did not look to extend inwards through binoculars. Given the city centre location, absence of habitat connectivity and type of feature, this feature was categorised as low potential for roosting bats.	

3	Gaps identified between the cladding on the northwest façade of an adjacent building. Some crevices were large enough for small passerine bird species access and bat access. The crevices were small and likely to form summer roosting opportunities for bats. Given the city centre location, absence of habitat connectivity and type of feature, this feature was categorised as low potential for roosting bats.	
4	Wood cladding was identified on the southeast façade of the adjacent building. The crevices were small and likely to form summer roosting opportunities for bats. Given the city centre location, absence of habitat connectivity and type of feature, this feature was categorised as low potential for roosting bats.	

APPENDIX E – ARTIFICIAL LIGHTING



Guidance Note 08/18

Bats and artificial lighting in the UK

Bats and the Built Environment series



Common pipistrelle bat © Hugh Clark / www.bats.org.uk

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Contents

Acknowledgements	4
Glossary of technical terms	5
Chart of example lux levels for reference	6
1. Bats	7
General ecology	7
Legal protection of bats	7
Impacts from artificial lighting	8
Summary	10
2. Artificial lighting	11
Types of lights used in exterior lighting applications	11
Light source spectral ranges	11
Legal requirements for lighting	12
Lighting and the planning system	12
3. Mitigation of artificial lighting impacts on bats	14
Step 1: Determine whether bats could be present on site	14
Step 2: Determine the presence of – or potential for – roosts, commuting habitat and foraging habitat and evaluate their importance	16
Step 3: Avoid lighting on key habitats and features altogether	16
Step 4: Apply mitigation methods to reduce lighting to agreed limits in other sensitive locations – lighting design considerations	17
Step 5: Demonstrate compliance with lux limits and buffers	21
4. References	24

This document is aimed at lighting professionals, lighting designers, planning officers, developers, bat workers/ecologists and anyone specifying lighting. It is intended to raise awareness of the impacts of artificial lighting on bats, and mitigation is suggested for various scenarios. However it is not meant to replace site-specific ecological and lighting assessments.

This is a working document and as such the information contained has been updated in line with advances in our knowledge both into the impact on bats and also to reflect the advances in technology available in the lighting industry at the time of publication.

The information provided here is believed to be correct. However, no responsibility can be accepted by the Bat Conservation Trust, the Institution of Lighting Professionals or any of their partners or officers for any consequences of errors or omissions, nor responsibility for loss occasioned to any person acting or refraining from action as a result of information and no claims for compensation for damage or negligence will be accepted.

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Glossary of technical terms

Terms used in this document or that may be used by the lighting industry

Arc tube	A tube, normally ceramic or quartz, enclosed by the outer glass envelope of a high-intensity discharge lamp (HID) that contains the arc stream.
Asymmetric beams	Lamp is off-centre in a reflector more steeply curved at one end.
Calculation Plane	An even grid of points denoting the anticipated or modelled intensity (candelas) or illuminance (lux) levels at a given point.
Candela	The intensity of a light source in a specific direction. Unit of luminous intensity.
CMS – Central Management System	Is a specially developed software and service package that can efficiently handle all tasks of data collection and facility management. It allows users to remotely monitor and control lighting and apply dimming and/or switching controls.
Colour Rendering Index (CRI)	A scale from 0 to 100 percent indicating how accurate a given light source is at rendering colour when compared to a reference light source. The higher the number, the better a light source is at revealing the actual colours present at a surface or object.
Contrast	The relationship between the luminance of an object and its background. The higher the contrast the more likely it is an object can be seen.
Cowl	Physical light spill control accessory.
Diffuse	Term describing dispersed light distribution referring to the scattering of light.
Efficacy	A measure of light output against energy consumption measured in lumens per watt.
Glare	The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility.
Hood	Physical light spill control accessory.
Illuminance	Illuminance is the quantity of light, or luminous flux, falling on a unit area of a surface. It is sometimes designated by the symbol E. The unit is the lux (lx). Luminance refers to the light given off from a source while illuminance refers to the amount of light hitting a surface.
Lamp	Light source.
Light cone	The angle at which the beam falls off to 50% of peak intensity.
Light pollution	The spillage of light into areas where it is not required. Also known as obtrusive light.
Light spill	The light that falls outside the light cone.
Light trespass (nuisance)	Light that impacts on a surface outside of the area designed to be lit by a lighting installation. The correct legal term is nuisance.
Louvres	Physical light spill control accessory.

Lumen	The unit of light power emitted from a light source
Luminaire	Lighting enclosure, lantern, or unit designed to distribute light from a lamp or lamps.
Luminance	The physical measurement of the stimulus that produces the sensation of brightness measured by the luminous intensity reflected in a given direction. The unit is the candela per square metre (cd/m ²). Luminance refers to the light given off from a source while illuminance refers to the amount of light hitting a surface.
Lux (LX)	This is 'illuminance' or the quantity of light (luminous flux), falling on a unit area of a surface in the environment. It is sometimes designated by the symbol E.
Maintenance factor	A correction applied to a lighting calculation to allow for the build-up of dirt on a luminaire and the depreciation of the lumen output of a lamp over time. 1=100% output, 0.9=90% etc.
Optic	The components of a luminaire such as reflectors, refractors, and protectors which make up the directional light control section.
Photocell	A unit which senses light to control luminaires.
Reflector	A device used to reflect light in a given direction.
Refractor	A device used to redirect the light output from a lamp when the light passes through it. It is usually made from prismatic glass or plastic.
Shield	Physical light spill control accessory.
Sky glow	The brightening of the night sky caused by artificial lighting.
Symmetric beams	Lamp mounted in the centre of the reflector.
Voltage	The difference in electrical potential between two points of an electrical circuit.
Watt (W)	The unit for measuring electrical power.
Upward Light Output Ratio ULOR (%)	The proportion of direct light transmitted from the luminaire above 90° in the vertical plane

Chart of example lux levels for reference

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

Source: IPCCTV specialists use-IP Ltd

1. Bats

General ecology

Bats are the only true flying mammals. Like us, they are warm-blooded, give birth to live young and produce milk for suckling. In Britain there are 18 species, all of which are small (most weigh less than a £1 coin) and eat insects.

Bats have developed a highly sophisticated echolocation system that allows them to avoid obstacles and catch these insects. When they're flying, bats produce a stream of high-pitched calls and listen to the echoes to produce a sound picture of their surroundings.

Some bats specialise in catching large insects such as beetles or moths but others eat large numbers of very small insects, such as gnats, midges and mosquitoes. Bats gather to feed wherever there are lots of insects, so the best places for them include traditional pasture, woodland, hedgerows, marshes, ponds and slow moving rivers.

During the winter there are relatively few insects available, so bats hibernate. They seek out appropriate sheltered roosts, let their body temperature drop to close to that of their surroundings and slow their heart rate to only a few beats per minute. This greatly reduces their energy requirements so that their food reserves last as long as possible.

During the spring and summer period female bats gather together into maternity colonies for a few weeks to give birth and rear their young (called pups). Usually only one pup is born each year. Bats may gather together from a large area to form these maternity roosts in warm and dry environments, so impacts at the summer breeding site can affect the whole colony of bats from a wide surrounding area.

Both winter and summer roosts have specific conditions that bats require at those times of the year and that is why bats are so faithful to their roosts. They are also an unusually long-lived mammal

with a slow reproductive rate for their size, meaning that they return year after year to roosts. If roosts are damaged or disturbed it takes a very long time for a population to recover.

For information on populations see <http://www.bats.org.uk>

Legal protection of bats

Due to the decline in bat numbers over the last century and the importance of specific roost requirements in their life cycle, all species of bat and their roost sites (whether bats are present at the time or not) are fully protected under international and domestic legislation. The international protection (the EC Habitats Directive) has been transposed into national laws by means of the Conservation of Habitats and Species Regulations 2017 (England and Wales), the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (Scotland) and the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended). Commonly the regulations are referred to as the Habitats Regulations. This makes it illegal to kill, injure, capture, or cause disturbance that affects populations of bats, obstruct access to bat roosts, or damage or destroy bat roosts. Individual bats are protected from 'intentional' or 'reckless' disturbance under the Wildlife and Countryside Act 1981 (as amended).

Lighting in the vicinity of a bat roost causing disturbance and potential abandonment of the roost could constitute an offence both to a population and to individuals (Garland and Markham, 2007). It is therefore important that the use of an area by bats is thoroughly assessed before artificial lighting is changed or added in the vicinity of a roost or where bats may commute or forage.

Natural England, Natural Resources Wales, Scottish Natural Heritage or Northern Ireland Environment Agency will need to

see that any impacts have been fully assessed and appropriate mitigation considered within any mitigation licence applications in relation to bats. Similarly these bodies will be statutory consultees in planning applications where impacts on Special Areas of Conservation (SACs), including those designated for bat conservation, are considered possible.

Local authorities also have a duty to ensure impacts upon legally protected species are avoided, and impacts upon bats are a material consideration in any planning permission. Furthermore, local authorities typically have specific planning policies ensuring that impacts upon wildlife, including bats, are avoided within development.

Impacts from artificial lighting

Studies have estimated that in 2016 more than 80% of the world population and more than 99% of the U.S. and European population live under light-polluted skies. Worldwide this is up from 66% in 2001, or an increase of more than 14% (Cinzano et al 2001); 'light-polluted skies' are defined as being about 10% higher than normal night sky brightness levels (Fabio et al 2016).

This means that only about a fifth of England now has 'pristine night skies' – that is skies 'completely free from light pollution' (CPRE 2016). Concerns about the impacts of this have been expressed for a long time, both in reference to human and ecosystem health (Gaston et al 2015).

For bats, artificial lighting is thought to increase the chances of predation, and therefore bats may modify their behaviour to respond to this threat (Speakman et al 1991, Jones et al 1994). Many avian predators will hunt bats which may be one reason why bats avoid flying in the day.

When we refer to artificial lighting we are referring to a number of different characteristics and types (see 'Artificial lighting' section below), all of which have varying impacts. For example, different

types of luminaire emit a different spectrum of light. The spectrum of light runs from short wave (ultraviolet) to long wave (infrared), and can vary in intensity (potentially causing glare) and illuminance (measured in lux). Definitions of technical terms can be found in the glossary.

Roosting and commuting

Illuminating a bat roost can cause disturbance (Downs et al 2003) and this may result in the bats deserting the roost or even becoming entombed within it (Packman et al 2015). Light falling on a roost access point will at least delay bats from emerging and this shortens the amount of time available to them for foraging (Boldogh et al 2007). As the main peak of nocturnal insect abundance occurs at and soon after dusk, a delay in emergence means this vital time for feeding is missed. This has been shown to have direct impacts on bats' reproductive ecology, such as slower growth rates and starvation of young (Duverge et al 2000).

In addition, the associated flightpath to and from the access point is just as valuable and vulnerable as the roost itself. Severing a key flightpath some distance from the roost could cause desertion in its own right.

Foraging

In addition to causing disturbance to bats at the roost, artificial lighting can also affect the feeding behaviour of bats. There are two aspects to this. One is the attraction that light from certain types of light sources has to a range of insects; the other is the presence of lit conditions posing a barrier to movement.

Many night-flying species of insect are attracted to light, especially those light sources that emit an ultraviolet component or have a high blue spectral content. This is particularly a problem if it is a single light source in a dark area. As well as moths (Wakefield et al 2015), a range of other insects can be attracted to light such as crane flies, midges and lacewings (Bruce-White et al 2011).

Studies have shown that noctule, Leisler's bat, serotine and pipistrelle bats can congregate around white mercury street lights (Rydell J et al 1993, Blake et al 1994) and white metal halide lamps (Stone et al 2015b) feeding on the insects attracted to the light, but this behaviour is not true for all bat species. The slower-flying broad winged species such as long-eared bats, *Myotis* species (which include Brandt's bat, whiskered, Daubenton's bat, Natterer's bat and Bechstein's bat), barbastelle, and greater and lesser horseshoe bats generally avoid all street lights (Stone et al 2009, 2012, 2015a). 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.

The spectral impacts of light break down further still; when presented with lights with a range of colour types, it has been shown that *Plecotus* and *Myotis* species (slow flying) avoided white and green light lit areas, but *Pipistrellus* species (fast flying) were significantly more abundant feeding at these lights (Spoelstra et al 2015, 2017). However, both groups were equally abundant in the red light areas compared to the dark control, which may provide options for lighting when considering mitigation (see 'Mitigation' section below).

In addition it is thought that insects are attracted to lit areas from beyond the immediately illuminated habitat. This is thought to result in adjacent habitats supporting reduced numbers of insects, a 'vacuum effect'; population declines have been shown further afield, suggesting both direct and indirect impacts at play (Langevelde et al 2018). This is a further impact on the ability of the light-avoiding bats to be able to feed. It is noticeable that most of Britain's rarest bats are among those species listed as avoiding artificial light, so artificial lighting has potentially devastating conservation consequences for these species (Rowse et al 2016).

Drinking

The effects of artificial lighting on drinking resources for bats has been recorded to be stronger than on foraging. White light has been shown to stop slower-flying species drinking at cattle troughs, and even for faster-flying species drinking behaviour was reduced, however foraging behaviour increased as above (Russo et al 2017).

Commuting

When considering how bats move through the landscape, artificial lighting has been shown to be particularly harmful if used along river corridors, near woodland edges and near hedgerows. In mainland Europe, in areas where there are foraging or 'commuting' bats, stretches of road are left unlit or lighting is designed in such a way as to avoid bat colonies being cut off from their foraging grounds.

Studies have shown that continuous lighting in the landscape, such as along roads or waterways, creates barriers which many bat species cannot cross, especially the slower-flying species (Fure, A. 2012), even at very low light levels. Lesser horseshoe bats have been shown to move their flight paths which link their roosts and foraging grounds to avoid artificial light installed on their usual commuting route. Significant impacts have been recorded from as low as 3.6 lux (Stone et al 2012). Furthermore, the average light level on hedgerows most regularly used by this species has been recorded at 0.45 lux (Stone et al 2009).

Even bat species that have been shown to opportunistically forage in lit conditions (see above) have subsequently been recorded being impacted by artificial lighting. In our cities, for example, common pipistrelles – the UK's most numerous species – have been recorded avoiding gaps that are well lit, thereby creating a barrier effect (Hale et al 2015).

Migrating

Green light has been shown to not only impact upon foraging bats (see above) but also bats migrating through Europe.

Nathusius' and soprano pipistrelles have been shown to be attracted to green light from a distance further than their echolocation calls reach, indicating they are attracted to the light rather than insects (Voigt et al 2017). This demonstrates positive light attraction for this species meaning limiting UV is only part of the solution and indicates impacts from artificial light at night that aren't yet fully understood for migrating bats. This is especially true given that the most recent studies in this area suggest that red light also causes positive light responses for both of these bat species when they are migrating over and above warm-white light (Voigt et al 2018).

Summary

In summary, these impacts both alone and in combination are likely to have significant impacts for slower-flying, rarer species, and even for fast-flying species, potentially affecting reproductive, foraging and roosting opportunities. On a population and ecosystem level, impacts may affect the overall genetic pool of bat species and their prey species.

Consequently, if bats are suspected as being present on site ecological advice should be sought – and potentially survey data collected – in advance of any lighting design or fixing of scheme layout.

2. Artificial lighting

Types of lights used in exterior lighting applications

- 1. Low-pressure sodium lamps (SOX)** (orange lamps seen along roadsides). Light is emitted predominantly at one wavelength, contains no ultraviolet (UV) light, and has a low attraction to insects. The lamps tend to be large which makes it more difficult to focus the light from these lamps. These are in the gradual process of being removed or replaced, in part due to their poor colour rendition, and will not be available past 2019.
- 2. High-pressure sodium lamps (SON)** (brighter pinkish-yellow lamps). Commonly used as road lighting. Light is emitted over a moderate band of long wavelengths giving little, if any, UV component, except for the version of the lamp used in horticulture. Insects are attracted to the brighter light. The lamp is of medium size and the light can be more easily directed than low pressure sodium. This lamp is still used for some main road lighting but this is being reduced; these lamps are expected to be phased out in the future.
- 3. Mercury lamps (MBF)** (bluish-white lamps). These emit light over a moderate spectrum, including a larger component of UV light to which insects are particularly sensitive. Insects are attracted in large numbers along with high densities of certain tolerant bat species (Rydell & Racey 1993). They ceased to be available in the EU in 2015 and are rare now.
- 4. White SON.** This is a reddish white light source. It is based on high-pressure sodium technology and has the same UV component as SON. This source is no longer used and is not available now.
- 5. Metal halide.** A small lamp and therefore more easy to focus light and make directional. Emits a small UV content. The light source is available in three forms a) quartz arc tube (HQI); b) ceramic arc tube (CDM-T) and c) CosmoPolis which is the newest of the ceramic forms. Still used by some for some exterior lighting applications.
- 6. Light emitting diodes (LEDs).** This is the light source of choice for most local authorities. The light emitted is more directional and normally controlled by lenses or sometimes reflectors. The light is produced in a narrow beam. It is an instant light source. LED is available in a number of colour temperatures. Older installations tend to use 'cool white' (blueish colour) at $>5700^{\circ}$ Kelvin. More recently, 4000° K has become more commonly used. 'Warm white' (more yellow/orange colour) at around 3000° K and as low as 2700° K can now be used with little reduction in lumen output. LED typically features no UV component and research indicates that while lower UV components attract fewer invertebrates, warmer colour temperatures with peak wavelengths greater than 550nm ($\sim 3000^{\circ}$ K) cause less impacts on bats (Stone, 2012, 2015a, 2015b).
- 7. Tungsten halogen.** Is not used in new lighting schemes but may be encountered as security light on a private household.
- 8. Compact fluorescent.** Mostly in use in residential street lighting. It produces a white light; variants are available with

Light source spectral ranges

High pressure sodium	~ 390 to 800 nanometres (nm)
Tungsten Halogen	~ 400 to 800 nm
Metal Halide	~ 400 to 800 nm
LEDs	~ 410 to 750 nm
Compact fluorescent	~ 410 to 820 nm

UV spectral ranges

UVA	315 to 400 nanometres (nm)
UVb	280 to 315 nm
UVc	100 to 280 nm

minimal UV output. It can be used at a low wattage and therefore on a low output to achieve low levels of illuminance (measured in lux).

Legal requirements for lighting

It is important to remember that there is no legislation requiring an area or road to be lit.

The building regulations for domestic buildings specify that 150 watts is the maximum for exterior lighting of buildings but this does not apply to private individuals who install their own lighting.

There are a number of British Standards that relate to various components of lighting – BS5489 for road lighting, BS12164 for outdoor workplaces, BS12193 for sports lighting – and there are also guidelines that relate to crime prevention, prevention of vehicular accidents and amenity use.

BS5266-1:2011 relates to the design of emergency lighting and specifies that the minimum lighting level within an escape route from a building is 1 lux. While this represents an increase in lighting, because of the nature and infrequent use of emergency lighting (as most systems are non-maintained – off unless an emergency occurs) this should not pose an issue to bats.

Lighting and the planning system

Many county councils and less often district and borough councils set out standards in local guidance policy documents.

When a developer is assessing the need for lighting it would be beneficial to ask the local authority for their lighting policy document as this should incorporate all of the above. It is likely that local planning authorities will have policies outlining lighting standards for new roads or in public areas. However, local authorities also have a duty to ensure impacts upon legally protected species are avoided.

Roads, cycleways and footpaths to be adopted by a council highway authority may require some form of lighting. Some local authorities may only use columns and may not permit bollard lighting along footpaths or cycleways, or have certain illuminance standards to meet, therefore it is advisable to seek further specific information for your location. In addition to lighting on the application site the ecologist may also need to assess the effects of proposed illumination on habitat beyond the site boundary; for example, along roads and paths where proposed lighting connects to existing street lighting to cover access to the development and beyond. Surveys for lighting and bat activity to cover these areas may be required outside the proposed development's red line boundary.

Consequently, a judgement on the sensitivity of the particular bat feature or habitat on site and the perceived public need for lighting in proximity to it would need to be made. This would be done through collaborative discussion between the project ecologist, lighting professional and local authority (potentially involving one or more of the planning officer, ecology officer, highways officer or council lighting professional). This team can decide whether, where bat features or habitats are particularly important or sensitive, it may be appropriate to avoid, redesign or limit lighting accordingly. Such reasoned compromise decisions between protected species and public lighting, where it is justified to deviate from policy standards, are becoming increasingly accepted by local authorities. In addition, any unavoidable residual lighting may require further mitigation (alternative habitat creation, artificial barriers to lighting etc) over and above that for direct habitat loss. See 'Mitigation' section below for further information.

Domestic lighting needs no planning permission and depends on direct advice on the effects of lighting on bats being given to the householder. Lighting associated with new development or a

listed building does require planning permission.

When dealing with applications for the addition of artificial lighting planning officers or developers should ensure a lighting assessment is done alongside an ecological assessment. Full details on this process can be found in Mitigation section below.

Planning conditions requiring the detail of any domestic amenity and security lighting are regularly applied, as are those relating to the post-development monitoring of light levels against any modelled or baseline levels. This usually includes light trespass through windows in proximity to important bat habitat or roost features.

3. Mitigation of artificial lighting impacts on bats

This section provides a simple process which should be followed where the impact on bats is being considered as part of a proposed lighting scheme. It contains techniques which can be used on all sites, whether a small domestic project or larger mixed-use, commercial or infrastructure development. It also provides best-practice advice for the design of the lighting scheme for both lighting professionals and other users who may be less familiar with the terminology and theory.

The stepwise process and key follow-up actions are outlined in the flowchart overleaf, and are followed throughout the chapter.

The questions within this flow chart should be asked as early as possible, so that necessary bat survey information can be gathered in advance of any lighting design or fixing of overall scheme design.

Effective mitigation of lighting impacts on bats depends on close collaboration from the outset between multiple disciplines within a project. Depending on the specific challenges this will almost certainly involve ecologists working alongside architects and/or engineers; however, lighting professionals and landscape architects should be approached when recommended by your ecologist. This should be done as early in your project as possible in order to ensure mitigation is as effective as it can be and to minimise delays and unforeseen costs.

Step 1: Determine whether bats could be present on site

If your site has the potential to support bats or you are at all unsure, it is highly recommended that an ecologist is appointed to advise further and conduct surveys, if necessary. This information should be collected as early as possible in the design process, and certainly before lighting is designed, so as to avoid the need for costly revisions.

If any of the following habitats occur on site, and are adjacent to or connected with any of these habitats on or off site, it is possible that newly proposed lighting may impact local bat populations:

- Woodland or mature trees
- Hedgerows and scrub
- Ponds and lakes
- Ditches, streams, canals and rivers
- Infrequently managed grassland
- Buildings – pre 1970s or in disrepair

If you are unsure about whether bats may be impacted by your project, and an ecologist has not yet been consulted, sources of information on the presence of bats within the vicinity of your site include the following.

- Local environmental records centres (LERC) – Will provide third-party records of protected and notable species for a fee. Search <http://www.alerc.org.uk/> for more information.
- National Biodiversity Network Atlas – Provides a resource of third-party ecological records searchable online at <https://nbnatlas.org>. Typically this is less complete than LERC data. Please note: Some datasets are only accessible on a non-commercial basis, while most can be used for any purpose, as long as the original source is credited.
- Local authority planning portals – Most local planning authorities have a searchable online facility detailing recent planning applications. These may have been accompanied by ecological survey reports containing information on bat roosts and habitats.
- Defra's MAGIC map – Provides an online searchable GIS database including details of recent European protected species licences and details of any protected sites designated for bat conservation.

The professional directory at the website of the Chartered Institute of Ecology and Environmental Management (www.cieem.net) will provide details of ecologists in your area with the relevant

Step 1

Could bats be present on site?

Consult local sources of ecological information or seek advice from an ecologist

Step 2

Determine the presence of – or potential for – roosts, commuting habitat and foraging habitat and evaluate their importance.

Appoint ecologist to carry out daytime and, if necessary, night-time bat surveys and to evaluate the importance of the site's features and habitats to bats.

Step 3

Avoid lighting on key habitats and features altogether.

No illumination of any roost entrances and associated flightpaths, nor on habitats and features used by large numbers of bats, by rare species or by highly light-averse species.

Step 4

In other locations of value for bats on site, apply mitigation methods to reduce lighting to a minimum.

Spatial design

Building design

Landscaping

Set dark habitat buffers and acceptable lux limits with ecologist guidance

Step 5

Demonstrate compliance with lux limits and buffers.

Lighting professional to prepare final lighting scheme design and/or lux calculations or undertake baseline light surveys as necessary. Post-completion bat and lighting monitoring may be required.

skills/experience. The early involvement of a professional ecologist can minimise the likelihood of delays at the planning stage (if applicable) and ensure your project is compliant with conservation and planning legislation and policy.

It should be noted that the measures discussed in this document relate only to the specific impacts of lighting upon bat habitat features on or adjacent to the site. If loss or damage to roosting, foraging or commuting habitat is likely to be caused by other aspects of the development, separate ecological advice will be necessary in order to avoid, mitigate or compensate for this legally and according to the ecologist's evaluation.

Step 2: Determine the presence of – or potential for – roosts, commuting habitat and foraging habitat and evaluate their importance

Your ecologist will visit the site in order to record the habitats and features present and evaluate their potential importance to bats, and the likelihood that bats could be affected by lighting both on and immediately off site. This may also include daytime building and tree inspections. On the basis of these inspections further evening surveys may be recommended, either to determine the presence of roosts within buildings and/or trees or to assess the use of the habitats by bats by means of a walked survey. Such surveys may be undertaken at different times during the active season (ideally May to September) and should also involve the use of automated bat detectors left on site for a period of several days. The surveys should be carried out observing the recommendations within the Bat Conservation Trust's Bat Surveys for Professional Ecologists: Good Practice Guidelines (Collins, 2016).

The resulting report will detail the relative conservation importance of each habitat feature to bats (including built structures, if suitable). The ecologist's evaluation of the individual features will depend on the

specific combination of contributing factors about the site, including:

- The conservation status of species recorded or likely to be present
- Geographic location
- Type of bat activity likely (breeding, hibernating, night roosting, foraging etc)
- Habitat quality
- Habitat connectivity off-site
- The presence of nearby bat populations or protected sites for bats (usually identified in a desk study)

The evaluation of ecological importance for each feature is most commonly expressed on a geographic scale from Site level to International level, or alternatively in terms of that feature's role in maintaining the 'favourable conservation status' of the population of bats using it.

The ecologist should set out where any key bat roost features and/or habitat areas (ie flightpath habitat and broader areas of foraging habitat) lie on a plan of the site or as an ecological constraints and opportunities plan (ECOP) together with their relative importance. The ECOP and report can then be used to help guide the design of the lighting strategy as well as the wider project.

Step 3: Avoid lighting on key habitats and features altogether

As has been described in 'Artificial lighting', above, there is no legal duty requiring any place to be lit. British Standards and other policy documents allow for deviation from their own guidance where there are significant ecological/environmental reasons for doing so. It is acknowledged that in certain situations lighting is critical in maintaining safety, such as some industrial sites with 24-hour operation. However in the public realm, while lighting can increase the perception of safety and security, measureable benefits can be subjective. Consequently, lighting design should be flexible and be able to fully take into account the presence of protected species

and the obligation to avoid impacts on them.

Sources of lighting which can disturb bats are not limited to roadside or external security lighting, but can also include light spill via windows, permanent but sporadically operated lighting such as sports floodlighting, and in some cases car headlights. Additionally, glare (extremely high contrast between a source of light and the surrounding darkness – linked to the intensity of a luminaire) may affect bats over a greater distance than the target area directly illuminated by a luminaire and must also be considered on your site.

It is important that a competent lighting professional is involved in the design of proposals as soon as potential impacts (including from glare) are identified by the ecologist in order to avoid planning difficulties or late-stage design revision. Your lighting professional will be able to make recommendations about placement of luminaires tailored to your specific project.

Where highways lighting schemes are to be designed by the local planning authority (LPA) post-planning, an ecology officer should be consulted on the presence of important bat constraints which may impact the design and illuminance in order for the scheme to remain legally compliant with wildlife legislation.

Where adverse impacts upon the 'favourable conservation status' of the bat population using the feature or habitat would be significant, an absence of artificial illumination and glare, acting upon both the feature and an appropriately-sized buffer zone is likely to be the only acceptable solution. Your ecologist will be best placed to set the size of such a buffer zone but it should be sufficient to ensure that illumination and glare is avoided and so the input of a lighting professional may be required. Further information on demonstrating an absence of illumination via lux/illuminance contour plans is provided in Step 5.

Because different species vary in their response to light disturbance (as discussed in section 1 'Bats'), your ecologist will be able to provide advice tailored to the specific conditions on your project, however examples of where the no-lighting approach should be taken in particular include:

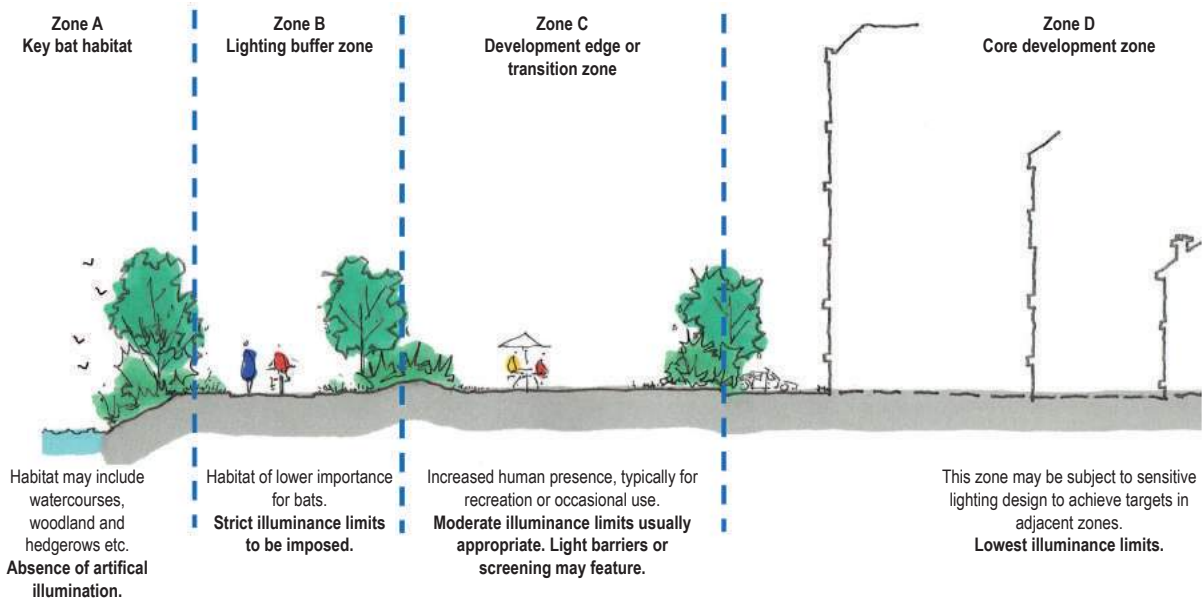
- Roosting and swarming sites for all species and their associated flightpath/commuting habitat.
- Foraging or commuting habitat for highly light-averse species (greater and lesser horseshoe bats, some *Myotis* bats, barbastelle bats and all long-eared bats).
- Foraging or commuting habitat used by large numbers of bats as assessed through survey.
- Foraging or commuting habitat for particularly rare species (grey long-eared bat, barbastelle, small *Myotis*, Bechstein's bat and horseshoe bats).
- Any habitat otherwise assessed by your ecologist as being of importance to maintaining the 'favourable conservation status' of the bat population using it.

Completely avoiding any lighting conflicts in the first place is advantageous because not only would proposals be automatically compliant with the relevant wildlife legislation and planning policy, but they could avoid costly and time-consuming additional surveys, mitigation and post-development monitoring. Furthermore, local planning authorities are likely to favour applications where steps have been taken to avoid such conflicts.

Step 4: Apply mitigation methods to reduce lighting to agreed limits in other sensitive locations – lighting design considerations

Where bat habitats and features are considered to be of lower importance or sensitivity to illumination, the need to provide lighting may outweigh the needs of bats. Consequently, a balance between a reduced lighting level appropriate to the

Example of illuminance limit zonation



ecological importance of each feature and species, and the lighting objectives for that area will need to be achieved.

It is important to reiterate the legal protection from disturbance that bats receive under the Wildlife and Countryside Act 1981, as amended. Where the risk of offences originating from lighting is sufficiently high, it may be best to apply the avoidance approach in Step 3.

Advice from an ecologist and lighting professional will be essential in finding the right approach for your site according to their evaluation. The following are techniques which have been successfully used on projects and are often used in combination for best results.

Dark buffers, illuminance limits and zonation

Dark buffer zones can be used as a good way to separate habitats or features from lighting by forming a dark perimeter around them. Buffer zones rely on ensuring light levels (levels of illuminance measured in lux) within a certain distance of a feature do not exceed certain defined limits. The buffer zone can be further subdivided into zones of increasing illuminance limit radiating away from the feature. Examples of this application are given in the figure above.

Your ecologist (in collaboration with a lighting professional) can help determine the most appropriate buffer widths and illuminance limits according to the value of that habitat to bats (as informed by species and numbers of bats, as well as the type of use).

Appropriate luminaire specifications

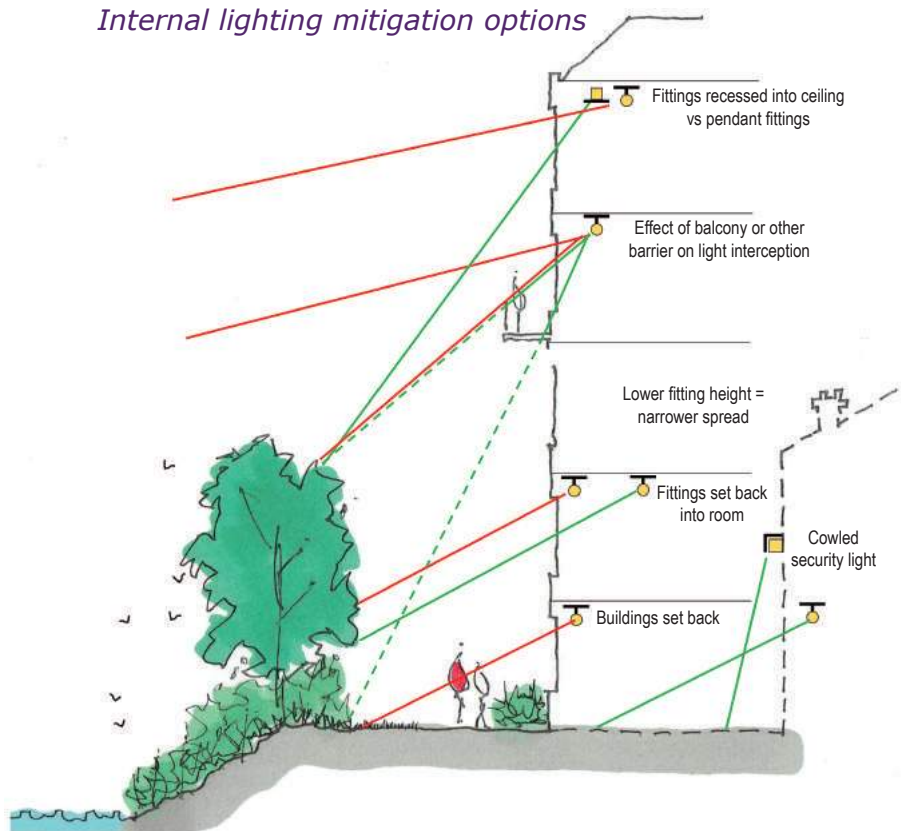
Luminaires come in a myriad of different styles, applications and specifications which a lighting professional can help to select. The following should be considered when choosing luminaires.

- All luminaires should lack UV elements when manufactured. Metal halide, fluorescent sources should not be used.
- LED luminaires should be used where possible due to their sharp cut-off, lower intensity, good colour rendition and dimming capability.
- A warm white spectrum (ideally <2700Kelvin) should be adopted to reduce blue light component.
- Luminaires should feature peak wavelengths higher than 550nm to avoid the component of light most disturbing to bats (Stone, 2012).
- Internal luminaires can be recessed where installed in proximity to windows to reduce glare and light spill. (See figure overleaf.)
- The use of specialist bollard or low-level downward directional luminaires to

retain darkness above can be considered. However, this often comes at a cost of unacceptable glare, poor illumination efficiency, a high upward light component and poor facial recognition, and their use should only be as directed by the lighting professional.

- Column heights should be carefully considered to minimise light spill.
- Only luminaires with an upward light ratio of 0% and with good optical control should be used – See ILP Guidance for the Reduction of Obtrusive Light.
- Luminaires should always be mounted on the horizontal, ie no upward tilt.
- Any external security lighting should be set on motion-sensors and short (1min) timers.
- As a last resort, accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed.

Internal lighting mitigation options



- Taller buildings may be best located toward the centre of the site or sufficiently set back from key habitats to minimise light spill.
- Street lights can be located so that the rear shields are adjacent to habitats or optics selected that stop back light thereby directing light into the task area where needed.

Sensitive site configuration

The location, orientation and height of newly built structures and hard standing can have a considerable impact on light spill (see figure above for examples of good internal lighting design). Small changes in terms of the placement of footpaths, open space and the number and size of windows can all achieve a good outcome in terms of minimising light spill on to key habitats and features.

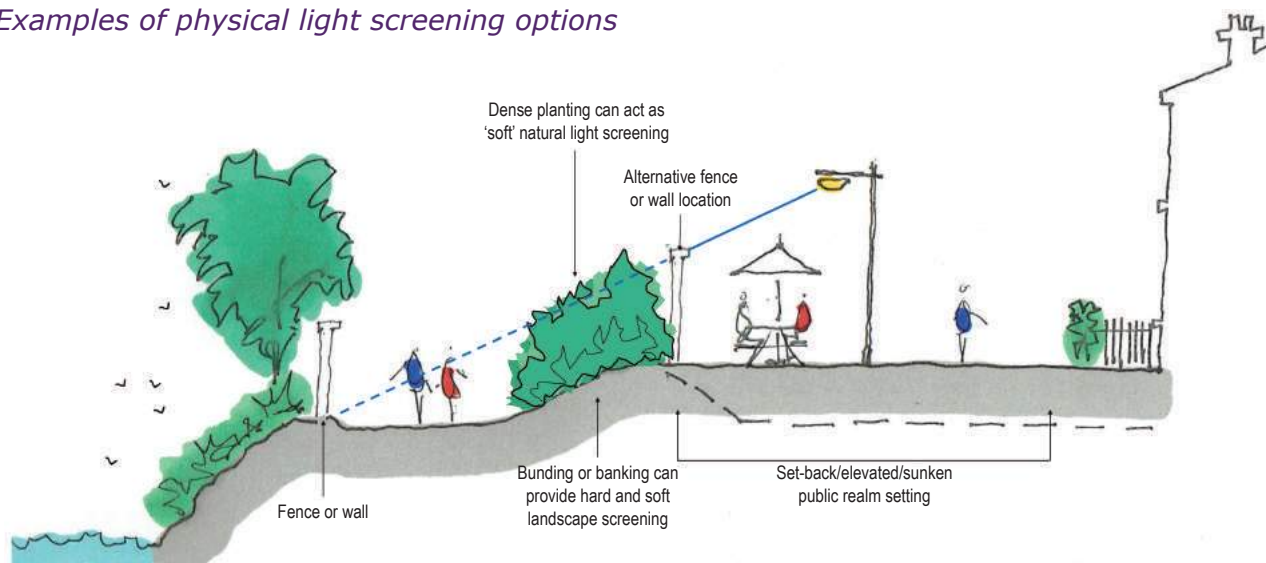
- It may be possible to include key habitats and features into unlit public open space such as parks and gardens.
- Buildings, walls and hard landscaping may be sited and designed so as to block light spill from reaching habitats and features.

Screening

Light spill can be successfully screened through soft landscaping and the installation of walls, fences and bunding (see figure overleaf for example of physical light-screening options). In order to ensure that fencing makes a long-term contribution, it is recommended that it is supported on concrete or metal posts. Fencing can also be over planted with hedgerow species or climbing plants to soften its appearance and provide a vegetated feature which bats can use for navigation or foraging.

The planting of substantial landscape features integrated to the wider network of green corridors such as hedgerows, woodland and scrub is encouraged by

Examples of physical light screening options



planning policy and would make a long-term positive contribution to the overall bat habitat connectivity and light attenuation. A landscape architect can be appointed to collaborate with your ecologist on maximising these natural light screening opportunities.

It should be noted that newly planted vegetation (trees, shrubs and scrub) is unlikely to adequately contribute to light attenuation on key habitats for a number of years until it is well established. Sufficient maintenance to achieve this is also likely to be required. Consequently, this approach is best suited to the planting of 'instant hedgerows' or other similarly dense or mature planting, including translocated vegetation. In some cases, it is appropriate to install temporary fencing or other barrier to provide the desired physical screening effects until the vegetation is determined to be sufficiently established.

Given the fact that planting may be removed, die back, or be inadequately replaced over time it should never be relied on as the sole means of attenuating light spill.

Glazing treatments

Glazing should be restricted or redesigned wherever the ecologist and lighting professional determine there is a likely significant effect upon key bat habitat and features. Where windows and glass

facades etc cannot be avoided, low transmission glazing treatments may be a suitable option in achieving reduced illuminance targets.

Products available include retrofit window films and factory-tinted glazing. 'Smart glass', which can be set to automatically obscure on a timer during the hours of darkness, and automatic blinds can also be used but their longevity depends on regular maintenance and successful routine operation by the occupant, and should not be solely relied upon.

Depending on the height of the building and windows, and therefore predicted light spill, such glazing treatments may not be required on all storeys. This effect can be more accurately determined by a lighting professional.

Creation of alternative valuable bat habitat on site

The provision of new, additional or alternative bat flightpaths, commuting habitat or foraging habitat could result in appropriate compensation for any such habitat being lost to the development. Your ecologist will be able to suggest and design such alternative habitats although particular consideration as to its connectivity to other features, the species to be used, the lag time required for a habitat to sufficiently establish, and the provision for its ongoing protection and maintenance should be given.

Dimming and part-night lighting

Depending on the pattern of bat activity across the key features identified on site by your ecologist, it may be appropriate for an element of on-site lighting to be controlled either diurnally, seasonally or according to human activity. A control management system can be used to dim (typically to 25% or less) or turn off groups of lights when not in use.

It should be noted that these systems depend on regular maintenance and a long-term commitment for them to be successful. Additionally, part-night lighting should be designed with input from an ecologist as they may still produce unacceptably high light levels when active or dimmed. Part-night lighting is not usually appropriate where lights are undimmed during key bat activity times as derived from bat survey data. Research has indicated that impacts upon commuting bats are still prevalent where lighting is dimmed during the middle of the night at a time when illumination for human use is less necessary (Azam et al, 2015). Thus this approach should not always be seen as a solution unless backed up by robust ecological survey and assessment of nightly bat activity.

Step 5: Demonstrate compliance with illuminance limits and buffers

Design and pre-planning phase

It may be necessary to demonstrate that the proposed lighting will comply with any agreed light-limitation or screening measures set as a result of your ecologist's recommendations and evaluation. This is especially likely to be requested if planning permission is required.

A horizontal illuminance contour plan can be prepared by a suitably experienced and competent lighting professional (member of the Chartered Institution of Building Services Engineers (CIBSE), Society of Light and Lighting (SLL), Institution of

Lighting Professionals (ILP) or similar to ensure competency) using an appropriate software package to model the extent of light spill from the proposed and, possibly, existing luminaires. The various buffer zone widths and illuminance limits which may have been agreed can then be overlaid to determine if any further mitigation is necessary. In some circumstances, a vertical illuminance contour plot may be necessary to demonstrate the light in sensitive areas such as entrances to roosts.

Such calculations and documentation would need to be prepared in advance of submission for planning permission to enable the LPA ecologist to fully assess impacts and compliance.

Because illuminance contour plots and plans may need to be understood and examined by non-lighting professionals such as architects and local planning authority ecologists, the following should be observed when producing or assessing illuminance contour plans to ensure the correct information is displayed.

- A horizontal calculation plane representing ground level should always be used.
- Vertical calculation planes should be used wherever appropriate, for example along the site-facing aspects of a hedgerow or façade of buildings containing roosts to show the illumination directly upon the vertical faces of the feature. Vertical planes can also show a cross-sectional view within open space. Vertical planes will enable a visualisation of the effects of illumination at the various heights at which different bat species fly.
- Models should include light from all luminaires and each should be set to the maximum output anticipated to be used in normal operation on site (ie no dimming where dimming is not anticipated during normal operation).
- A calculation showing output of luminaires to be expected at 'day 1' of operation should be included, where the luminaire and/or scheme Maintenance Factor is set to zero.

- Where dimming, PIR or variable illuminance states are to be used, an individual set of calculation results should accompany each of these states.
- The contours (and/or coloured numbers) for 0.2, 0.5, 1, 5, and 10 lux must be clearly shown as well as appropriate contours for values above these.
- Each contour plan should be accompanied by a table showing their minimum and maximum lux values.
- Where buildings are proposed in proximity to key features or habitats, plots should also model the contribution of light spill through nearby windows, making assumptions as to internal luminaire specification and transmissivity of windows. It should be assumed that blinds or curtains are absent or fully open although low-transmittance glazing treatments may be appropriate. Assumptions will need to be made as to the internal luminaire specification and levels of illuminance likely to occur on 'day 1' of operation. These assumptions should be clearly stated and guided by the building/room type and discussions between architect, client and lighting professional. It is acknowledged that in many circumstances, only a 'best effort' can be made in terms of accuracy of these calculations.
- Modelled plots should not include any light attenuation factor from new or existing planting due to the lag time between planting and establishment and the risk of damage, removal or failure of vegetation. This may result in difficulties in the long term achievement of the screening effect and hamper any post-construction compliance surveys.
- The illuminance contour plots should be accompanied by an explanatory note from the lighting professional to list where, in their opinion, sources of glare acting upon the key habitats and features may occur and what has been done/can be done to reduce their impacts.

N.B. It is acknowledged that, especially for vertical calculation planes, very low

levels of light (<0.5 lux) may occur even at considerable distances from the source if there is little intervening attenuation. It is therefore very difficult to demonstrate 'complete darkness' or a 'complete absence of illumination' on vertical planes where some form of lighting is proposed on site despite efforts to reduce them as far as possible and where horizontal plane illuminance levels are zero. Consequently, where 'complete darkness' on a feature or buffer is required, it may be appropriate to consider this to be where illuminance is below 0.2 lux on the horizontal plane and below 0.4 lux on the vertical plane. These figures are still lower than what may be expected on a moonlit night and are in line with research findings for the illuminance found at hedgerows used by lesser horseshoe bats, a species well known for its light averse behaviour (Stone, 2012).

Baseline and post-completion light monitoring surveys

Baseline, pre-development lighting surveys may be useful where existing on- or off-site lighting is suspected to be acting on key habitats and features and so may prevent the agreed or modelled illuminance limits being achieved. This data can then be used to help isolate which luminaires might need to be removed, where screening should be implemented or establish a new illuminance limit reduced below existing levels. For example, where baseline surveys establish that on- and off-site lighting illuminates potential key habitat, improvements could be made by installing a tall perimeter fence adjacent to the habitat and alterations to the siting and specification of new lighting to avoid further illumination. Further information and techniques to deal with modeling pre-development lighting can be found in ILP publication PLG04 *Lighting Impact Assessments* due to be published late 2018.

Baseline lighting surveys must be carried out by a suitably qualified competent person. As a minimum, readings should be

taken at ground level on the horizontal plane (to give illuminance hitting the ground), and in at least one direction on the vertical plane at, for example, 1.5m or 2m above ground (to replicate the likely location of bats using the feature or site). The orientation should be perpendicular to the dominant light sources or perpendicular to the surface/edge of the feature in question (such as a wall or hedgerow) in order to produce a 'worst case' reading. Further measurements at other orientations may prove beneficial in capturing influence of all luminaires in proximity to the feature or principal directions of flight used by bats. This should be discussed with the ecologist.

Baseline measurements should be taken systematically across the site or features in question. That is, they will need to be repeated at intervals to sample across the site or feature, either in a grid or linear transect as appropriate. The lighting professional will be able to recommend the most appropriate grid spacing.

Measurements should always be taken in the absence of moonlight, either on nights of a new moon or heavy cloud to avoid artificially raising the baseline. As an alternative, moonlight can be measured at a place where no artificial light is likely to affect the reading.

As all proposed illuminance level contours will be produced from modelled luminaires at 100% output, baseline measurements need to be taken with all lights on and undimmed, with blinds or screens over windows removed. Cowls and other fittings on luminaires can remain in place.

Where possible, measurements should be taken during the spring and summer when vegetation is mostly in leaf, in order to accurately represent the baseline during

the principal active season for bats and to avoid artificially raising the baseline.

The topography of the immediate surrounding landscape should be considered in order to determine the potential for increased or decreased light spill beyond the site.

Post-construction/operational phase compliance-checking

Post-completion lighting surveys are often required where planning permission has been obtained on the condition that the proposed lighting levels are checked to confirm they are in fact achieved on site and that the lighting specification (including luminaire heights, design and presence of shielding etc) is as proposed.

All lighting surveys should be conducted by a suitably qualified competent person and should be conducted using the same measurement criteria and lighting states used in the preparation of the illuminance contour plots and/or baseline surveys as discussed above. It may be necessary to conduct multiple repeats over different illumination states or other conditions specific to the project.

Results should always be reported to the LPA as per any such planning condition. A report should be prepared in order to provide an assessment of compliance by the lighting professional and a discussion of any remedial measures which are likely to be required in order to achieve compliance. Any limitations or notable conditions such as deviation from the desired lighting state or use of blinds/barriers should be clearly reported. Ongoing monitoring schedules can also be set, especially where compliance is contingent on automated lighting and dimming systems or on physical screening solutions.

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