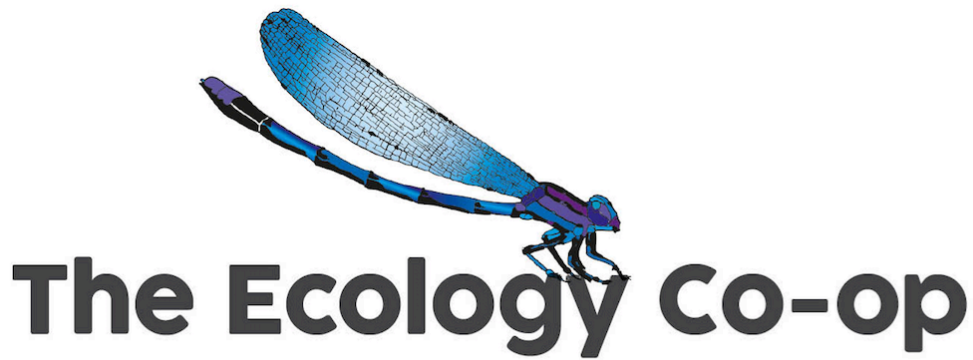




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Mitigation Statement, Habitat Creation and Ecological Enhancement

**Land at Wandleys Farm, Wandleys Lane, Fontwell,
West Sussex**

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6th November 2017

Project No: 2265

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Report Summary

1. The Ecology Co-op was commissioned by Mr and Mrs Lillywhite to outline necessary mitigation for a proposal to develop land at Wandleys Farm, Wandleys Lane, Fontwell in West Sussex where it was determined that the site supports a low population of reptiles and foraging by bats, particularly along the boundaries of the site.
2. Pre-construction work includes the installation of temporary semi-permanent reptile fencing along the western boundary of the proposed construction zone, to separate the construction site from adjacent green habitats. Prior to this installation of this fencing, the proposed site will be mown short regularly up to the point of commencement of construction. Pre-construction mitigation will also include the planting of hedgerows as early as possible prior to the commencement of construction.
3. Site staff must be briefed prior to the commencement of construction on the importance of protecting the reptile fencing and avoiding any adverse impacts upon the site boundaries.
4. Enhancement measures proposed include the installation of bat roosting features, creation of wildflower meadow habitat, installation of bird nesting features and new hedge creation.
5. Post construction management is detailed in section 4.

This report has been prepared by The Ecology Co-operation Ltd, with all reasonable skill, care and diligence within the terms of the Contract with the client. This report only becomes the property of the client once payment for it has been received in full.

We disclaim responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.



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1 INTRODUCTION

1.1 Purpose of the Report

This document has been written to demonstrate how the development will minimise its impact upon protected species, reduce the impact that this development will have upon biodiversity and provide targeted enhancement measures for Land at Wandleys Farm, Wandleys Lane, Fontwell, West Sussex. It outlines all mitigation and compensation measures that are designed to ensure that valuable habitats are either protected, replaced or enhanced on Land at Wandleys Farm further to a proposal to build 5 residential properties on this land.

All of the prescribed mitigation measures described within this document will be issued to relevant works contractors to ensure that they are carried out in full. Implementation of this will be overseen by a suitable ecological consultancy, and the works contractor will be given contact details for an ecologist so that any issues can be resolved promptly.

This report was commissioned and produced at the request of Mr and Mrs Lillywhite.

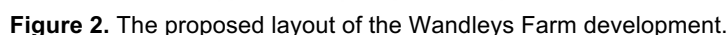
1.2 Background

The Ecology Co-op has been commissioned to outline mitigation works on Land at Wandleys Farm, Wandleys Lane in Fontwell. Following surveys at this site by The Ecology Co-op in 2017, it was determined that the western site boundary supports a 'low' population of slow worms. In addition, the site is used by foraging and commuting bats. Whilst there was no evidence of roosting bats on the site itself, some trees with low to moderate potential to support roosting bats were identified.

The site supports suitable habitat for nesting birds and therefore it is important that all vegetation clearance takes place outside of the nesting bird season (1st March to 31st August), unless a hand search by a suitably qualified ecologist is carried out first.



Figure 1. An aerial image showing the location of the site. The site boundary is outlined in red.



Reptiles

Birds

- kill, injure or take any wild bird;
- take, damage or destroy the nest of any wild bird while that nest is in use or being built; or
- take or destroy an egg of any wild bird.

- disturb any such bird when it is building its nest or while it is in or near a nest containing dependent young; or
- disturb the dependent young of any such birds



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Bats, Dormouse and Great Crested Newt

Dormouse (*Muscardinus avellanarius*), Great Crested Newt (*Triturus cristatus*), and all species of British bat (*Vespertilionidae* and *Rhinolophidae*) are listed on *Schedule 5* of the *Wildlife and Countryside Act 1981* (as amended) and receive full protection under *Section 9*. These species are also all listed as European Protected Species on *Schedule 2* of the *Conservation (Natural Habitats, etc.) Regulations 1994* which gives them full protection under *Regulation 39*. Protection was extended by the *Countryside and Rights of Way Act 2000* (the CRow Act). Under the above legislation it is an offence to:

- kill, injure or take an individual;
- possess any part of an individual either alive or dead;
- intentionally or recklessly damage, destroy or obstruct access to any place or structure used by these species for shelter, rest, protection or breeding;
- intentionally or recklessly disturb these species whilst using any place of shelter or protection; or
- sell or attempt to sell any individual.

It is also an offence to set and use articles capable of catching, injuring or killing bats (for example a trap or poison), or knowingly cause or permit such an action. In the case of dormouse and all species of British bat there is also protection under *Schedule 6* of *The Wildlife and Countryside Act 1981* (as amended) relating specifically to trapping and direct pursuit of these species.

Dormouse, Great Crested Newt and all species of British bat are included as priority species in the *UK Biodiversity Action Plan* and as species of principal importance for the conservation of biological diversity in England under *Section 74* of the *Countryside and Rights of Way (CRow) Act 2000*.

2 PRE-CONSTRUCTION MITIGATION MEASURES

All pre-construction measures are intended to take place prior to the commencement of construction to ensure the benefits of new habitat creation and enhancement are in place prior to the ecologically negative impacts of the construction phase taking place.

2.1 Reptile Fencing Installation

The western boundary of the proposed construction zone will need to be fenced with semi-permanent, amphibian and reptile-proof fencing. A semi-permanent polypropylene material that is tough and stabilised against ultraviolet light should be installed to a depth of not less than 20cm below ground and supported by stakes every 2 metres fixed with clout nails and washers (See Figure 3). The fencing should be backfilled with earth and tightly compacted to make sure that it acts as an impassable barrier. The advantage of the semi-permanent fence is that it is less susceptible to damage by dogs, deer, foxes and other animals as well as any accidental damage by construction staff and is suitable for developments where fencing may need to remain in-situ over a long period of time.



Figure 3. An example of the semi-permanent fencing material that will be used.

The fencing would be required to make a continuous fence line to separate the construction site from all adjacent green habitats along the western boundary, where reptiles might migrate onto the site and would need to remain in-situ until all construction work deemed a risk to reptiles has been completed- i.e. earthworks and associated landscaping. Figure 4 shows the proposed route for the reptile fence along the western boundary of the land at Wandleys Farm.

The installation of the fencing would need to be overseen by an ecologist, with a hand search conducted of the fencing construction line ahead of a trencher or small excavator digging the trench for the installation of the fence. The fence will be installed outside of the reptile hibernation period (generally October to late February dependent of weather conditions) to minimise the risk of killing or injury of reptiles during the fence installation.

Construction method:

1. At least 24 hours prior to construction, the fence route would be hand searched by a suitably qualified ecologist and strimmed (using brush-cutters where necessary) of vegetation to a height of no more than 5cm and a two-metre width, with all cuttings raked off and removed. This will ensure that reptiles are discouraged from the fencing construction zone. The strimming process will be completed in two passes, with the grass cut to a height of 10-15cm on the first pass, to reduce the risk of harming reptiles during the strimming process. In the unlikely event that any nesting birds are found along the fencing route, then strimming will have to wait until the nesting birds and chicks have fledged and moved on.
2. The fencing construction zone will not be allowed to grow taller than 5cm prior to construction of the fence and materials will not be stored along the fencing route, which could otherwise attract amphibians and reptiles to them as refugia.
3. The entire length of the fence must first be established by excavating a 20cm wide 20cm deep trench, overseen under watching brief by a suitably qualified ecologist. Excavated earth will be piled on the outside edge of the trench so that it is easily backfilled once the fence has been installed.



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4. Excavation work for the fencing trench will be carried out by an excavator or trencher not larger than 1.5 tons in weight to minimize ground disturbance.
5. Fence stakes will be positioned every 2 metres and will be sunk into the ground to a depth of at least 30cm to ensure they are secure.
6. The fencing material (which is supplied in 100kg rolls) will be rolled out along the outside edge of the trench and will be lifted into place when each full roll has been unravelled or cut into manageable sections.
7. The fencing sheet will be attached to the stakes using 2 clout nails and plastic washers at the top and 15cm from the bottom of each stake.
8. Once fixed the excavated earth will be backfilled along the trench and trodden in to ensure that it is lightly compacted to prevent animals from digging into it.
9. After establishment, fence checks would be undertaken every week to look for any signs of damage. Once construction has commenced, the fence checks and maintenance will become the responsibility of the works contractor.
10. Site staff must be briefed prior to the commencement of construction on the importance of protecting the reptile fencing and contacting an ecologist in the event that any reptiles or other wildlife is identified within the construction zone.

In order to prevent reptiles from migrating on to the site, the fence will have 'cut backs' on each of its ends (See Figure 5). This is where the fence loops back on itself, so that any animals travelling along the edge of the fence are guided away from the site.



Figure 4. The proposed fencing route at Land at Wandleys Farm, to separate the proposed construction zone from all adjacent green habitats along the western boundary where reptiles might migrate onto the site. The site boundary is shown in red.



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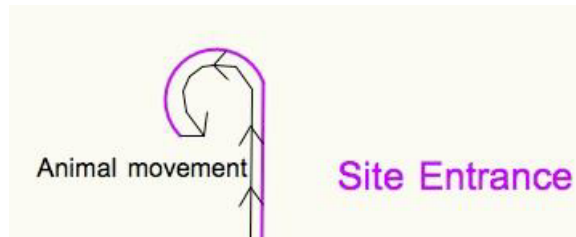


Figure 5. Cut backs' used to guide animals away from the site.

Site staff must be briefed prior to commencement of construction on the importance of protecting the reptile fencing and contacting an ecologist in the event that any reptiles or other wildlife is identified within the construction zone.

2.1.1 Reptile Mitigation Strategy

- The site will be mown short regularly prior to the construction of the reptile fencing and subsequently prior to the commencement of construction.
- Any scrub or vegetation to be removed within the site will first be subject to a fingertip search for reptiles by an ecologist and then trimmed to a height of 300mm and then to a height of 150mm under ecological supervision. All arisings should be removed from site.
- Following the installation of the fencing along the western boundary, a suitably qualified ecologist will need to oversee the topsoil strip of the entire site to ensure there are no reptiles present within construction zone during the construction phase. This will be carried out using a wide toothed bucket on a medium sized excavator (up to 10 tonnes).
- The excavated spoil will be stored as directed by the ecologist, in a suitable area within the site that reptiles will not be able to access.

2.2 Great Crested Newts

Precautionary mitigation is recommended for great crested newts in the form of 'reasonable avoidance measures'. As detailed within Section 2.1 of this report, the site will be mown regularly keeping the grass as short as possible to deter reptiles and amphibians migrating on to the site from the adjacent green habitats. The amphibian and reptile-proof fence line will deter any individuals from migrating onto the site and therefore limit the risk of harming reptiles or amphibians. As indicated within the Phase 2 survey holding document produced by the Ecology Co-op, it is considered highly unlikely that great crested newts would be found upon the site at any time.

2.3 Dormice

As dormice presence has not been identified within the hedgerows bordering the proposed site, a European Protected Species License will not be required for the work to be carried out at Wandleys Farm.

However, some precautionary mitigation is recommended in this instance due to the removal of some scrub and trees along the eastern boundary of the site to allow for two new access roads and the known presence of dormice within the wider landscape. The following measures will be implemented for enhancement to encourage future colonisation by dormice and to ensure that there is minimal risk of harm to dormice:



1. The creation of new species rich hedgerows along the north, south and western boundaries of the site will benefit wildlife both in creating new foraging habitat and creating new connectivity to the wider landscape (see Figure 6). The proposed new hedging will include planting 50% hawthorn, 10% blackthorn, 10% hazel, 10% wild privet, 10% dogwood and 10% wayfaring tree. Honeysuckle could be planted at a density of at least 1 plant per two linear metres. This could lead to future dormouse colonisation.
2. A hand search of all scrub and hedge to be removed along the eastern boundary is to be carried out by a suitably qualified ecologist to ensure there are no dormice present within the site and limit to risk in harming any active dormice.

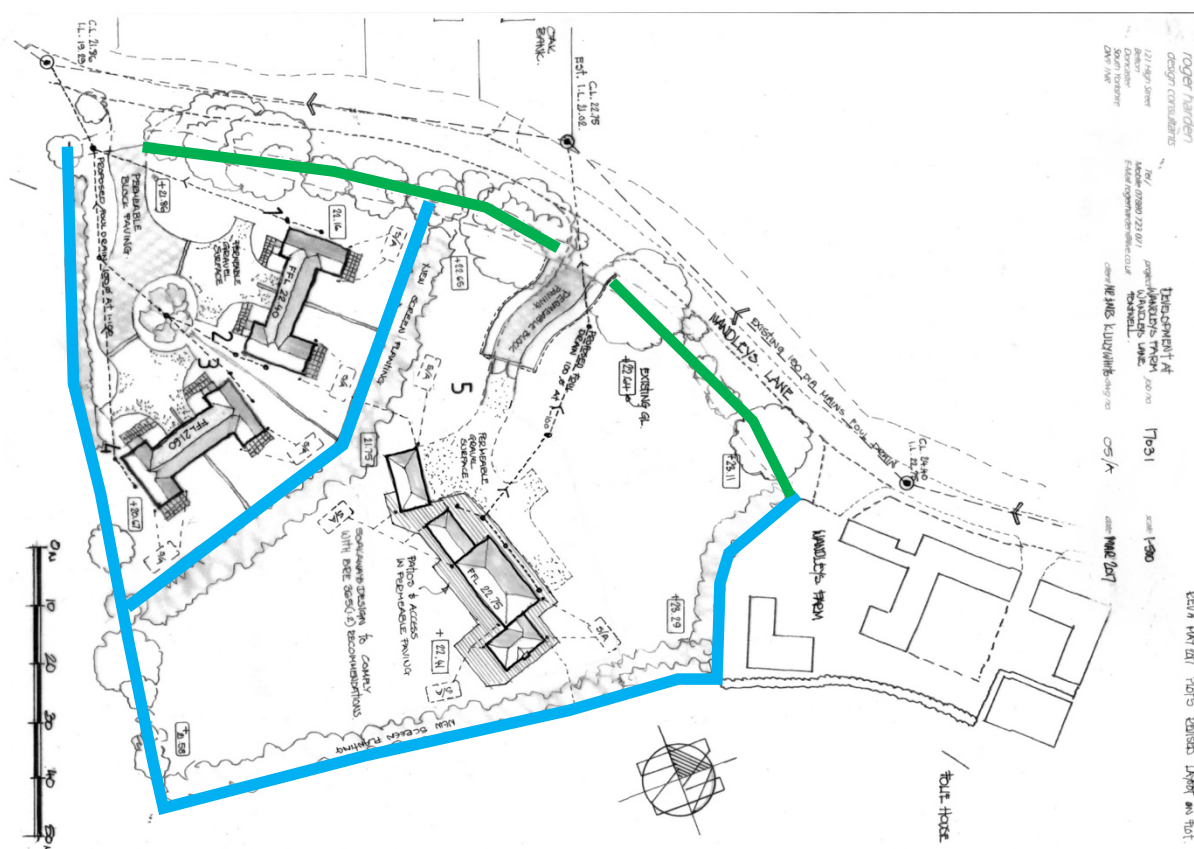


Figure 6. The blue lines indicate the proposed new hedging along the boundaries of the site and within the site. The green lines indicate the proposed additional planting to support the existing hedgerow with trees.

2.4 Nesting Birds

Any scrub, trees or hedgerows to be cleared must be removed outside of the nesting bird season (1st March to 31st August) unless features are first hand search by a suitably qualified ecologist.

3 CONSTRUCTION PHASE ENHANCEMENT MEASURES

3.1 Wildflower Meadow Creation

Wildflower meadow creation will be best undertaken through a process of 'subsoil recycling'. This will require the subsoil excavated from the foundations of the proposed dwellings to be saved for spreading



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in targeted locations where wildflower meadow habitat creation is proposed. The subsoil mixed with topsoil will lower the nutrient value of the growing base where wildflower meadow seed will be broadcast. The recycling of this subsoil will not only create a suitable growing substrate for this wildflower meadow, it will reduce the need for any removal of subsoil from the development site and thus also reduce cost, traffic and pollution impacts associated with developments.

The method for wildflower meadow creation will be as follows:

1. Topsoil samples are taken and sent for analysis to establish the nutrient content of the soil.
2. The grass is cut as short as possible with cuttings removed and turf and topsoil is then stripped from the area where the wildflower meadow is proposed, with the thin layer of turf then replaced.
3. The subsoil excavated from any building foundations is then spread across the area that will be sown with wildflower meadow mixture.
4. Topsoil is then applied over the subsoil to establish a suitable growing base, with the amount of topsoil applied measured according to the identified nutrient levels of the topsoil. If it is very nutrient rich, then only a very thin layer of topsoil will be applied. A rotavator will be used to mix the topsoil with the more nutrient poor subsoil to a depth of 10-15cm.

As part of on-going management, the sward should be cut and gathered to a height of approximately 5cm at least three times in its first year of establishment to control the flush of annual weeds which will grow during the first growing season. Thereafter, the sward should be cut (with all cuttings removed and composted) between mid-August and late September every year. Cutting in the spring (March/April) should be included if the sward grows too vigorously.

Table 2 – Composition of EM5 – Meadow Mixture for loamy soils to be sown within the gardens of the residential units.

Wildflowers		
%	Latin name	Common name
0.5	<i>Achillea millefolium</i>	Yarrow
3	<i>Centaurea nigra</i>	Common Knapweed
1	<i>Daucus carota</i>	Wild Carrot
2.5	<i>Galium verum</i>	Lady's Bedstraw
0.3	<i>Geranium pratense</i>	Meadow Cranesbill
0.5	<i>Knautia arvensis</i>	Field Scabious
0.5	<i>Lathyrus pratensis</i>	Meadow Vetchling
0.4	<i>Leontodon hispidus</i>	Rough Hawkbit
1	<i>Leucanthemum vulgare</i>	Oxeye Daisy
0.6	<i>Lotus corniculatus</i>	Birdsfoot Trefoil
0.5	<i>Malva moschata</i>	Musk Mallow
0.5	<i>Plantago lanceolata</i>	Ribwort Plantain
0.6	<i>Plantago media</i>	Hoary Plantain
0.5	<i>Primula veris</i>	Cowslip
2	<i>Prunella vulgaris</i>	Selfheal
3	<i>Ranunculus acris</i>	Meadow Buttercup
1.5	<i>Rhinanthus minor</i>	Yellow Rattle
1	<i>Rumex acetosa</i>	Common Sorrel



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0.1	<i>Trifolium pratense</i>	Wild Red Clover
Grasses		
10	<i>Agrostis capillaris</i>	Common Bent
2	<i>Briza media</i>	Quaking Grass (w)
2	<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass (w)
10	<i>Festuca ovina</i>	Sheep's Fescue
32	<i>Cynosurus cristatus</i>	Crested Dogstail
20	<i>Festuca rubra</i>	Slender-creeping Red-fescue
3	<i>Phleum bertolonii</i>	Smaller Cat's-tail
1	<i>Trisetum flavescens</i>	Yellow Oat-grass (w)



Figure 7. The green colour indicates the possible sections of the garden that could be sown with wildflower mixture.

3.2 Tree and Hedgerow Planting

New species-rich native hedgerows are to be planted along the southern, northern and eastern boundaries of the site, creating a wildlife corridor and providing increased foraging and commuting habitat for bats plus nesting areas for birds. A new species-rich native hedgerow is to be planted between residential dwellings 1 to 4 and dwelling number 5 (see Figure 6). Enhancement of the existing hedgerow along the eastern boundary is recommended.

The new species rich hedgerows must use only native species from UK stock and include at least 50% blackthorn (*Prunus spinosa*) so that it is consistent with the surrounding landscape and traditional hedge



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planting schemes. The remaining 50% should be made up of five of the following species:

- Hawthorn (*Crataegus monogyna*),
- Spindle (*Euonymus europaeus*),
- Dogwood (*Cornus sanguinea*),
- Wayfaring-tree (*Viburnum lantana*),
- Field or Dog rose (*Rosa arvensis/ Rosa canina*),
- Guelder rose (*Viburnum opulus*),
- Field maple (*Acer campestre*),
- Wild privet (*Ligustrum vulgare*),
- Beech (*Fagus sylvatica*)
- Hazel (*Corylus avellana*).
- It is also recommended that native honeysuckle (*Lonicera periclymenum*) is introduced along these lengths.

The landscaping plan will incorporate a variety of trees with only native trees sourced from UK stock to be used in all of the wider landscaping around the site boundaries (non-native trees and shrubs may still be used for landscaping the residential plots). This will create greater habitat for a variety of birds and invertebrates. The following species are recommended for this development:

- Hawthorn (*Crataegus monogyna*)
- Field maple (*Acer campestre*)
- Holly (*Ilex aquifolium*)
- Hazel (*Corylus avellana*)
- Blackthorn (*Prunus spinosa*)
- Pedunculate Oak (*Quercus robur*)

Given the arrival of ash dieback, it is not recommended that any ash saplings are planted anywhere on the site.

3.3 Enhancements for Bats

As a measure to enhance roosting opportunities for bats, features will be incorporated into two of the new residential buildings with one 1MF bat and swift nest box installed across the two buildings (see Figure 8). The 1MF contains two nesting chambers for Swifts to breed and raise their young as well as a recess in the rear panel that creates a space between the wall of the building and the box, making it ideal for crevice dwelling bats. The 1MF box is mounted on a galvanised metal mounting plate that is screwed to an external wall of the building.

Ideally the 1MF box should be at least 6 to 7m above the ground and a clear drop below the box is recommended (5m or more). The exact locations of these features can be detailed within a subsequent detailed planning application.

Finally, two Schwegler woodcrete bat boxes (one 2F and one 2FN Schwegler bat boxes) would be hung on suitable mature trees upon the eastern boundary of the site. The boxes would be hung by a suitably qualified ecologist to ensure that this positioning is most suitable, but generally locations above 3.5



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metres in the most south-easterly facing aspect of a tree is best (see Figure 8).



2F Schwegler Bat Box



2FN Schwegler bat box



1MF Bat and Swift Nest Box

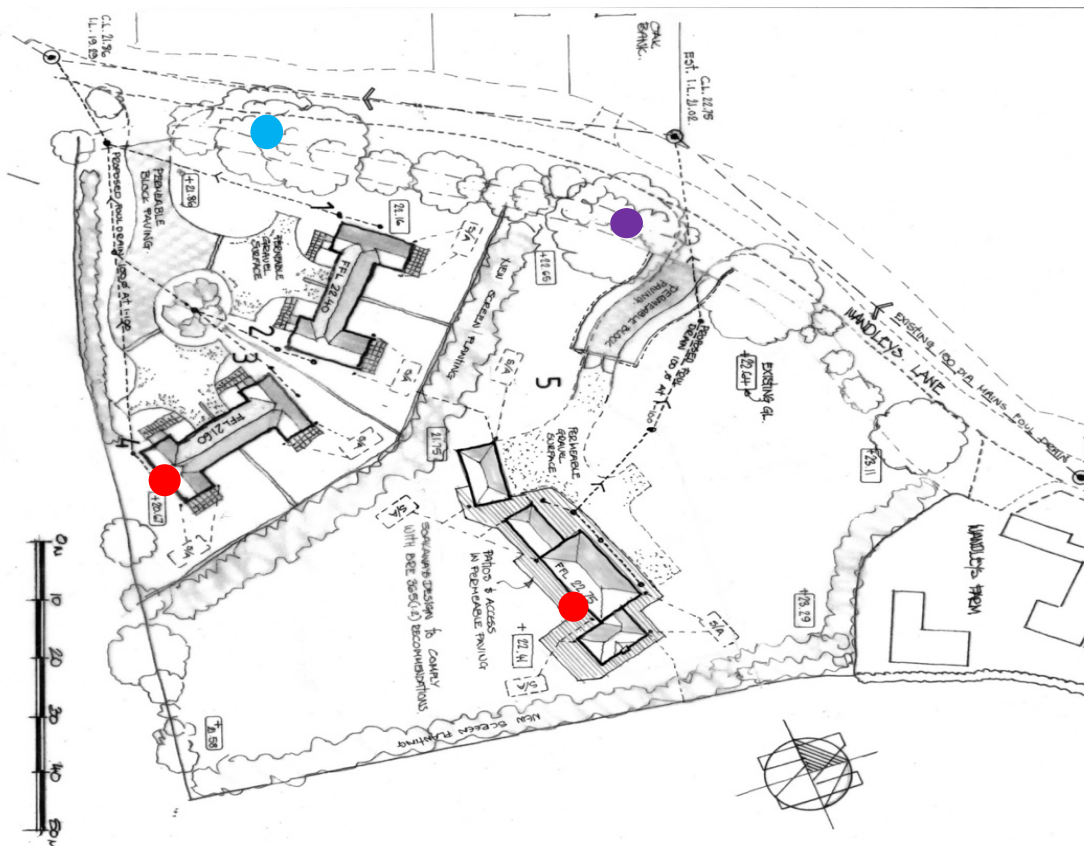


Figure 8. The indicative locations where bat and bird boxes could be installed to increase bat and bird roosting opportunities, with red dots representing 1MF Bat and Swift Nest boxes, the blue dot representing 2F Schwegler Bat Box, and the purple dot representing the 2FN Schwegler Bat Box.



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3.4 Mitigation for Bats

Bright external lighting can have a detrimental impact upon foraging and commuting bats, but importantly can also cause bats to be fooled into thinking that the light is from the sun, causing them to remain in their roosts for longer. Moderate species diversity has been recorded during the bat activity surveys undertaken with seven species including: common pipistrelle, Nathusius' pipistrelle, serotine, common noctule, brown long-eared bats, *Myotis spp.* and barbastelle bats were detected using static bat loggers.

Bat activity is concentrated along the eastern, southern and western boundaries of the site. As a result the site boundaries must be protected from artificial lighting with no street lamps or outside lights to face towards these boundaries or new species rich hedgerows proposed to be planted. In particular, a 'no light zone' should be established along all boundaries of the site, where possible, with no artificial light sources positioned within 15 metres of these boundaries. Guidelines issued by the Bat Conservation Trust should be incorporated into the lighting scheme at the Land at Sunny Corner development and the following measures must be implemented into the site design:

1. No 'upward pointing' or bare bulb lights will be installed anywhere on the development.
2. All external lights upon lamp-posts will not be more than 3.5 metres in height and will have shields installed to focus light towards footpaths and roads only (See Figure 9). No light will be allowed to emit light past horizontal (90 degrees from the ground).
3. A no-light zone to protect the eastern boundary and the proposed new species rich hedgerow along the southern, western and northern boundaries of the site from any artificial light. No lamp posts or other artificial lights should be positioned within 15 metres of these boundaries and no lights should be positioned to face towards these boundaries.
3. Any pedestrian ground lighting will not exceed 3 lux.
4. No external lights will be installed on new buildings above a height of 2 metres and all external lights will have shields to prevent light splash beyond horizontal.



Figure 9. An example of suitable downward shielded street lighting.



3.5 Reptile Mitigation

The western boundary of the site supports a low population of slow worms with a peak count of one slow worm. The western boundary of the site is linked to a field of dense, rough grassland suitable to support a population of slow worms. The site boundaries were allowed to grow over the course of the survey due to the placement of the mats, and therefore it is possible that the slow worm migrated from the field adjacent to the site as no other reptiles were identified on any of the other boundaries of the site during the survey. The site as a whole is managed regularly and is considered to be unsuitable habitat to support reptiles whilst under this management.

In the long term, the wildflower meadow creation outlined in Section 3.1 will provide an area of valuable habitat for reptiles and a wide variety of invertebrates. As this feature would be connected to suitable habitat adjacent to the site and in the wider landscape, it should be quickly inhabited by reptiles.

To further aid this colonisation it is important that at least two new reptile and amphibian hibernacula are created within the site. These can be built using logs and branches, piled on top of each other, with grass cuttings, earth and turf laid over the top to provide insulation (Figure 10). This hibernaculum would also provide benefits for other species including solitary bees, wasps and other insects.

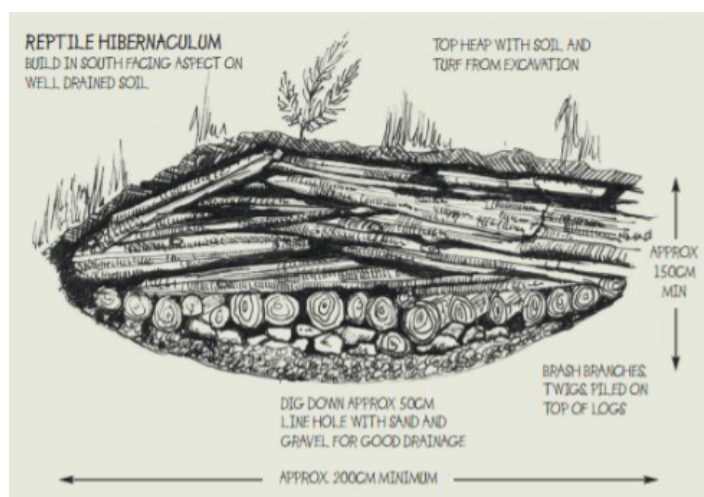


Figure 10. Illustration on how to build a reptile hibernacula. Image taken from the 'Reptile Habitat Management Guidelines' by Herefordshire Amphibian and Reptile Team and the Herefordshire Nature Trust.

3.6 Enhancements for nesting birds

In order to enhance the site for nesting birds some common nesting bird boxes will be put up across the site. Two 1MF swift and bat boxes have been recommended to be placed upon new buildings (see Section 3.3). In addition, one 1B Schwegler nest box should be installed at least 3 metres high on trees along the eastern boundary and one Small Bird nest box placed in a tree along the southern boundary. Tall roosting nest pockets could be placed within the hedgerows along the eastern/northern boundaries of the site to provide nesting space for small birds such as wrens. The roosting pockets can be placed in small trees, hedges, ivy or bushes.



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Small Bird Nest Box



1B Schwegler nest box



Tall Roosting Nest Pocket

4 POST CONSTRUCTION MANAGEMENT

4.1 Management Plan Operations

All planted hedgerows must only be cut outside the bird nesting season (1st March to 31st August) and where possible hedges shouldn't be cut until February, so that valuable winter food associated with fruiting hedge trees is retained for over-wintering birds.

Bat and bird boxes on trees should be inspected to check they had not become detached or damaged each year.

The sections of wildflower meadow should be cut and gathered each year between early August and the end of September only. This is important to ensure that species diversity of the area is maintained and grass species do not become dominant. Where necessary, a second cut could be taken in March or early April each year if the sward is growing too coarsely. Grass cuttings should be collected and composted or used to build hibernacula that will support hibernating reptiles and amphibians on a patch of ground that will remain dry throughout the year.

Should you need any further advice on the information provided above, please do not hesitate to contact The Ecology Co-op.



5 APPENDIX 2 - ARTIFICIAL LIGHTING AND WILDLIFE

Interim Guidance: Recommendations to help minimise the impact of artificial lighting - produced by The Bat Conservation Trust

Wherever human habitation spreads, so does artificial lighting. This increase in lighting has been shown to have an adverse effect on our native wildlife, particularly on those species that have evolved to be active during the hours of darkness. Consequently, development needs to carefully consider what lighting is necessary and reduce any unnecessary lighting, both temporally and spatially. When the impacts on different species groups are reviewed, the solutions proposed have commonalities that form the basis of good practice. These are outlined in the following document.

Overview of impacts

Invertebrates

Artificial light significantly disrupts natural patterns of light and dark, disturbing invertebrate feeding, breeding and movement, which may reduce and fragment populations. Some invertebrates, such as moths, are attracted to artificial lights at night. It is estimated that as many as a third of flying insects that are attracted to external lights will die as a result of their encounter.¹ Insects can become disoriented and exhausted making them more susceptible to predation. In addition, the polarisation of light by shiny surfaces attracts insects, particularly egg laying females away from water. Reflected light has the potential to attract pollinators and impact on their populations, predators and pollination rates. Many invertebrates natural rhythms depend upon day-night and seasonal and lunar changes which can be adversely affected by artificial lighting levels.

It is not always easy to disentangle the effects of lighting on moths from other impacts of urbanisation. However, it is known that UV and green and blue light, which have short wavelengths and high frequencies, are seen by most insects and are highly attractive to them. Where a light source has a UV component, male moths in particular will be drawn to it. Most light-induced changes in physiology and behaviour are likely to be detrimental. They discern it to be 'light', so they do not fly to feed or mate.²

Birds

There are several aspects of changes to bird behaviour to take into account. The phenomenon of robins and other birds singing by the light of a street light or other external lighting installations is well known, and research has shown that singing did not have a significant effect on the bird's body mass regulation. However, it was felt that the continual lack of sleep was likely to be detrimental to the birds' survival and could disrupt the long-term circadian rhythm that dictates the onset of the breeding season³. Many species of bird migrate at night and there are well-documented cases of the mass mortality of nocturnal migrating birds as they strike tall lit buildings. Other UK bird species that are particularly sensitive to artificial lighting are long-eared owls, black-tailed godwit and stone curlew.⁴

Mammals

A number of our British mammals are nocturnal and have adapted their lifestyle so that they are active in the dark in order to avoid predators. Artificial illumination of the areas in which these mammals are active and foraging is likely to be disturbing to their normal activities and their foraging areas could be

¹ Bruce-White C and Shardlow M (2011) A Review of the Impact of Artificial Light on Invertebrates - See more at: <http://www.buglife.org.uk/advice-and-publications/publications/campaigns-and-reports/review-impact-artificial-light#sthash.s7GPA1vL.dpuf>

² As above

³ Pollard A. (2009) Visual constraints on bird behaviour. University of Cardiff

⁴ Rodriguez A., Garcia A.M., Cervera F. and Palacios V. (2006) Landscape and anti-predation determinants of nest site selection, nest distribution and productivity in Mediterranean population of Long-eared Owls, *Asio otus*. *Ibis*, 148(1), pp.133-145



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lost in this way. It is thought that the most pronounced effect is likely to be on small mammals due to their need to avoid predators. However, this in itself has a knock-on effect on those predators.

The detrimental effect of artificial lighting is most clearly seen in bats. Our resident bat species have all suffered dramatic reductions in their numbers in the past century. Light falling on a bat roost exit point, regardless of species, will at least delay bats from emerging, which shortens the amount of time available to them for foraging. 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. At worst, the bats may feel compelled to abandon the roost. Bats are faithful to their roosts over many years and disturbance of this sort can have a significant effect on the future of the colony. It is likely to be deemed a breach of the national and European legislation that protects British bats and their roosts.

In addition to causing disturbance to bats at the roost, artificial lighting can also affect the feeding behaviour of bats and their use of commuting routes. There are two aspects to this: one is the attraction that short wave length light (UV and blue light) has to a range of insects; the other is the presence of lit conditions.

As mentioned, many night-flying species of insect are attracted to lamps that emit short wavelength component. Studies have shown that, although noctules, serotines, pipistrelle and Leisler's bats, take advantage of the concentration of insects around white street lights as a source of prey, this behaviour is not true for all bat species. The slower flying, broad-winged species, such as long-eared bats, barbastelle, greater and lesser horseshoe bats and the *Myotis* species (which include Brandt's, whiskered, Daubenton's, Natterer's and Bechstein's bats) generally avoid external lights.

Lighting can be particularly harmful if it illuminates important foraging habitats such as river corridors, woodland edges and hedgerows used by bats. Studies have shown that continuous lighting along roads creates barriers which some bat species cannot cross⁵. It is also known that insects are attracted to lit areas from further afield. This could result in adjacent habitats supporting reduced numbers of insects, causing a further impact on the ability of light-avoiding bats to feed.

These are just a few examples of the effects of artificial lighting on British wildlife, with migratory fish, amphibians, some flowering plants, a number of bird species, glow worms and a range of other invertebrates all exhibiting changes in their behaviour as a result of this unnatural lighting.

Recommendations

Survey and Planning

The potential impacts of obtrusive light on wildlife should be a routine consideration in the Environmental Impact Assessment (EIA) process⁶. Risks should be eliminated or minimised wherever possible. Some locations are particularly sensitive to obtrusive light and lighting schemes in these areas should be carefully planned.

In August 2013, Planning Minister Nick Boles launched the new National Online Planning Guidance Resource aimed at providing clearer protection for our natural and historic environment. The guidance looks at when lighting pollution concerns should be considered and is covered within one of the on line planning practice guides⁷. The guide provides an overview for planners with links to documents that aim to give planners an overview of the subject through the following discussion points:

⁵ Stone E. L., Jones G and Harriss (2009) Street lighting disturbs commuting bats. *Current Biology*, 19, pp 1-5

⁶ See also: Institution of Lighting Professionals – Professional Lighting Guide (PLG 04) Guidance on undertaking lighting environmental impact assessments)



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1. When is obtrusive light / light pollution relevant to planning?
2. What factors should be considered when assessing whether a development proposal might have implications for obtrusive lighting / light pollution?
3. What factors are relevant when considering where light shines?
4. What factors are relevant when considering how much the light shines?
5. What factors are relevant when considering possible ecological impact?

This can help planners reach the right design through the setting of appropriate conditions relating to performance and mitigation measures at the planning stage.

The Institution of Lighting Professionals (ILP) recommends that Local Planning Authorities specify internationally recognised environmental zones for exterior lighting control within their Development Plans⁶. In instances lacking classification, it may be necessary to request a Baseline Lighting Assessment/Survey conducted by a Lighting Professional in order to inform the classification of areas, particularly for large-scale schemes and major infrastructure projects.

When assessing or commissioning projects that include the installation of lighting schemes, particularly those subject the EIA process, the following should be considered and relayed to applicants:

- **Ecological consultants should confirm the presence of any sensitive fauna and flora**, advising the lighting designers of bat routes and roosts and other areas of importance in order to ensure that reports correspond with each other.
- **Ecological consultants should consider the need for quantitative lighting measurements**. In some instances it may be necessary for further lighting measurements to be taken. For example, outside an important bat roost. These should follow best practice guidance from the ILP and would ideally be conducted by a Lighting Professional.
- **Where appropriate, professional lighting designers should be consulted** to design and model appropriate installations that achieve the task but mitigate the impacts. This should be done at the earliest opportunity. Early decisions can play a key role in mitigating the impact from lighting.
- **Reports submitted should outline the impacts of lighting in relation to ecology**, making clear reference to the ecological findings, highlighting any sensitive areas and detail proposed mitigation. Consideration should also be given to internal lighting where appropriate.
- **Post –installation checks and sign off upon commissioning should be carried out** by the lighting designer to ensure that the lighting installation has been installed in accordance with the design, that predictions were accurate and mitigation methods have been successful.

Principles and design considerations

Do not

- **provide excessive lighting**. Use only the minimum amount of light needed for the task.
- **directly illuminate bat roosts** or important areas for nesting birds

Avoid

- **installing lighting in ecologically sensitive areas** such as: near ponds, lakes, rivers, areas of high conservation value; sites supporting particularly light-sensitive species of conservation significance (e.g. glow worms, rare moths, slow-flying bats) and habitat used by protected species.
- **using reflective surfaces under lights**.



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Do

- **consider employing a competent lighting designer** who will apply the principals of providing the right light, in the right place, at the right time and controlled by the right system.
- **minimise the spread of light** to at, or near horizontal and ensure that only the task area is lit. Flat cut-off lanterns or accessories should be used to shield or direct light to where it is required.
- **consider the height of lighting columns.** It should be noted that a lower mounting height is not always better. A lower mounting height can create more light spill or require more columns. Column height
- **consider no lighting solutions where possible** such as white lining, good signage and LED cats eyes. These options can also be effective. For example, light only high-risk stretches of roads, such as crossings and junctions, allowing headlights to provide any necessary illumination at other times.
- **use temporary close-boarded fencing until vegetation matures,** to shield sensitive areas from lighting.
- **limit the times that lights are on to provide some dark periods.** The task being lit often varies, for example roads are less used after 23.00hrs and car parks are empty. A lighting designer can vary the lighting levels as the use of the area changes reducing lighting levels or perhaps even switching installations off after certain times. This use of adaptive lighting can tailor the installation to suit human health and safety as well as wildlife needs.

Technological specifications

Research from the Netherlands has shown that spectral composition does impact biodiversity.

- **Use narrow spectrum light sources** to lower the range of species affected by lighting.
- **Use light sources that emit minimal ultra-violet light**
- **Lights should peak higher than 550 nm**
- **Avoid white and blue wavelengths of the light spectrum** to reduce insect attraction and where white light sources are required in order to manage the blue short wave length content they should be of a warm / neutral colour temperature <4,200 kelvin.

Further guidance on the spectral composition of artificial lighting will be made available following the publication of research from the Netherlands.

Further reading:

- A review of the impact of artificial light on invertebrates. Buglife. 2011
- Royal Commission on Environmental Pollution. 2009. Artificial light in the environment. London, HMSO
- The Ecological Consequences of Artificial Night Lighting" edited by Longcore and Rich
- Shedding Light: A survey of local authority approaches to lighting in England. CPRE 2014

<http://planningguidance.planningportal.gov.uk/blog/guidance/light-pollution/when-is-light-pollution-relevant-to-planning/> <http://planningguidance.planningportal.gov.uk/blog/guidance/light-pollution/when-is-light-pollution-relevant-to-planning/>

⁸ Institution of Lighting Professionals (2011) Guidance Notes for the Reduction of Obtrusive Light GN01:2011

