HIGHWAYS AGENCY

Safe roads, reliable journeys, informed travellers

A14 Cambridge to Huntingdon improvement scheme

Environmental Statement

Appendices

Appendix 11.8: Bats

Date: December 2014

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Executive summary

This is an appendix of the *A14 Cambridge to Huntingdon improvement scheme Environmental Statement (ES).* This report presents an evaluation of bats based on recent surveys. It also presents the policy and legislative context within which the environmental impact assessment has been carried out. Likely significant effects on, and mitigation for bats, are considered in *Chapter 11 of the ES.*

Bats were surveyed using guidance in *Hundt (2012)*.

Species of bat recorded within the study area from desktop and field surveys undertaken during 2013 and 2014 include barbastelle (*Barbastella barbastellus*), Brandt's (*Myotis brandtii*), brown long-eared (*Plecotus auritus*), common pipistrelle (*Pipistrellus pipistrellus*), Daubenton's (*Myotis daubentonii*), Leisler's (*Nyctalus leisleri*), Nathusius pipistrelle (*Pipistrellus nathusii*), Natterer's (*Myotis nattereri*), noctule (*Nyctalus noctula*), serotine (*Eptesicus serotinus*) and whiskered (*Myotis mystacinus*) bats. Bats within the study area have been evaluated as of district value.

1 Introduction

1.1.1 This report is an appendix of the *A14 Cambridge to Huntingdon improvement scheme Environmental Statement (ES)*. It presents an evaluation of the status of bats based on a desk-based review of records of bats and field surveys. It also presents the policy and legislative context within which the environmental impact assessment (EIA) has been carried out. Likely significant effects on, and mitigation for bats, are considered in *Chapter 11 of the ES*.

1.1.2 This report presents the findings of the surveys for the scheme during 2013 and 2014.

1.1.3 The study included a desktop survey to search for records of bats and field survey to provide more detailed information. Study or search areas are given for different elements of the study.

2 Bat ecology

2.1.1 There are currently 18 species of bat known to be present in England, 17 of which are known to be breeding. Mating occurs in autumn, but the female does not become pregnant until the following spring with one juvenile born each year. During spring and summer, female bats gather together to form maternity colonies to give birth and rear their young (*Mitchell-Jones, 2004*).

2.1.2 Bats in Britain eat insects such as beetles, moths and midges and other invertebrates such as spiders. Bats gather to feed wherever there are lots of insects, so the best foraging habitat includes pasture, woodland, marshes, ponds and slow moving rivers (*Mitchell-Jones, 2004*). Bats hibernate in winter when food is scarce.

2.1.3 Bats will use a variety of roosts for different purposes throughout the year, which range from feeding perches, transitory night and day roosts, mating roosts, hibernation sites and maternity roosts. The conservation significance of each of these roost types increases with frequency and duration of use, the number of animals involved and also on the rarity of the species/assemblage of bats present (*Mitchell-Jones, 2004*).

2.1.4 Generally, roosting habitat comprises three main types (*Natural England, undated*). These are:

- built structures: including bridges, houses, ancient monuments, churches, farms and industrial, agricultural and commercial buildings. These are often important in summer when it is warmer. Cellars, mines and tunnels can provide cool, sheltered areas suitable for hibernating;
- natural structures: include cracks and crevices in cliff faces and caves that are particularly used for hibernating; and
- hollow or damaged trees: any cracks, splits, cavities and loose bark can provide roosting habitat for bats throughout the year.

3 Policy and legislation

3.1 Legislation

3.1.1 All species of bats and their breeding sites or resting sites (roosts) are protected under *Schedule 5* of the *Wildlife and Countryside Act 1981* (*as amended*) and *Schedule 2* of the *Conservation of Habitats and Species Regulations 2010 (as amended)* which makes each a European protected species (EPS). It is an offence to intentionally kill, injure or capture a bat, to possess a bat (whether live or dead) or any part of a bat, or sell or offer for sale without a licence. It is also an offence to intentionally damage or destroy any place used by bats for shelter, whether they are present or not and to intentionally or recklessly disturb a bat in its roost or obstruct access to a bat roost.

3.1.2 Licences can be granted by Natural England (the licensing authority) to allow illegal activities, including development, to take place if carried out in accordance with the provisions of the licence.

3.1.3 *Section 40* of the *Natural Environment and Rural Communities (NERC) Act 2006* places a duty on all public bodies to have regard to the conservation of biodiversity in England, when carrying out their normal functions (the biodiversity duty).

3.2 National planning policy framework

3.2.1 The *National Planning Policy Framework (NPPF)* sets out the Government's view on how planners should balance nature conservation with development and helps ensure that Government meets its biodiversity commitments with regard to the operation of the planning system. The planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible. If significant harm resulting from a development cannot be avoided (through locating an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused.

3.2.2 The *NPPF* states that the wider benefits of an ecosystem should be recognised and the presence of a protected species is a substantial consideration for a development proposal (*Circular 06/2005 (OPDM, 2005)*). It is therefore considered essential that the presence of protected species and the extent that they may be affected by the proposed development is established in advance of a planning application in order that planning permission can be granted (*Planning Practice Guidance, 2014*).

3.2.3 The draft *National Policy Statement (NPS) for National Networks* (2013) sets out the Government's vision and policy for the future development of nationally significant infrastructure projects on the national road and rail networks. It provides guidance for promoters of nationally significant infrastructure projects, the basis for the examination by the Examining Authority and for decisions by the Secretary of State. The *NPS* includes general principles for the assessment of national networks, including for environmental impact assessment.

3.3 Priority species

3.3.1 Species of principal importance for the conservation of biodiversity in England are listed under *Section 41 (S41)* of the *NERC Act 2006*. This list is used to guide decision-makers in public bodies, in implementing their biodiversity duty. The species listed are priorities for nature conservation action and therefore for consideration in impact assessment.

3.3.2 The *UK Biodiversity Action Plan (UK BAP)* (JNCC, 2014) was the UK's response to the *Global Convention on Biological Diversity (CBD)* in 1992. It lists priority species and habitats that are identified as being the most threatened and require conservation action. In 2012, the *UK Post-2010 Biodiversity Framework (2012)* succeeded the *UK BAP* and is the UK Government's response to a new strategic plan of the *CBD* which was published in 2010.

3.3.3 Much of the work previously carried out under the *UK BAP* is now focussed at a country level. However, the *UK BAP* lists of priority species and habitats remain important and have been used to draw up the *Section 41* statutory list.

3.3.4 *The Highways Agency Biodiversity Action Plan (HABAP*) lists priority species and habitats of the soft estate of England`s trunk roads and motorways (excluding London). All bat species are a priority for conservation action as listed in the *HABAP*.

3.3.5 Local BAPs (LBAPs) integrate the conservation measures provided in the *UK BAP* to enhance biodiversity at the local and regional level. The *Cambridgeshire and Peterborough LBAP (2007)* is pertinent to the proposed scheme and Cambridgeshire and Peterborough Biodiversity Partnership (2014).

3.3.6 *Section 41* and the *UK BAP* include seven bat species (*Table 3.1*). The *Cambridgeshire and Peterborough LBAP* contains only the pipistrelle species (*Pipistrellus* sp.).

Table 3.1: Priority bat species on S41 and the UK BAP

Common name	Scientific name
Barbastelle bat	*Barbastella barbastellus*
Bechstein's bat	*Myotis bechsteinii*
Noctule	*Nyctalus noctula*
Soprano pipistrelle	*Pipistrellus pygmaeus*
Brown long-eared	*Plecotus auritus*
Greater horseshoe bat	*Rhinolophus ferrumequinum*
Lesser horseshoe bat	*Rhinolophus hipposideros*

4 Methodology

4.1 Desktop survey

4.1.1 The ES produced for the A14 Ellington to Fen Ditton scheme (*Atkins, 2009*) was reviewed to identify records for roosts from previous surveys.

4.1.2 Records were requested from the Cambridgeshire and Peterborough Environmental Records Centre (CPERC) for any sites of nature conservation importance for bats. Records of notable bat species within 1km of the scheme were also requested. The search area for the desktop survey has been dictated by professional judgement in accordance with best practice guidance (*CIEEM 2013*).

4.1.3 Records received from the CPERC were supplemented by a review of the baseline bat surveys conducted in 2013 for the scheme (*Atkins, 2013a*).

4.1.4 In addition, bat records were requested from Cambridgeshire Bat Group in July 2014 for a 5km search area around the scheme.

4.1.5 A database of incidental records of species of interest recorded by other surveyors on the scheme has been reviewed for records of relevance to this report.

4.2 Field surveys

4.2.1 Surveys for bats included ground assessment of trees and structures (buildings, culverts and bridges), climbing of trees considered suitable to support roosting bats, dusk and dawn activity surveys of trees and structures, manual transects and automated static monitoring. Each survey method is described below.

Bridge and culvert surveys

4.2.2 Bat surveys on bridges and culverts that could be impacted by the scheme were conducted on behalf of the Highways Agency. This comprised a series of daytime bat scoping surveys, followed by emergence, re-entry, activity and automated surveys. These surveys were undertaken with reference to the Bat Conservation Trust (BCT) guidelines for bat surveys (*Hundt, 2012*) and the *Design Manual for Roads and Bridges Volume 10, Section 4, Part 4, HA81/89 - Nature Conservation Advice in Relation to Bats (DMRB HA81/89)* (*Highways Agency et al., 2001*). Research to define the minimum culvert size that bats are likely to use (*Boonman, 2011*) was also considered.

4.2.3 A bat scoping survey was undertaken between 7 May and 9 June 2014 by an experienced bat ecologist and an assistant. The features that were assessed are shown on *Figure 11.9 and Figure 11.10.*

4.2.4 The surveyors assessed various parameters that could affect the potential of the features to support roosting bats and their value to bats for foraging and commuting. These parameters were recorded on a standard pro forma:

- dimensions (width, height and approximate length) (culverts only);
- shape (culverts only);
- material(s);
- potential roosting locations, such as crevices between concrete slabs (culverts) and widening and expansion joints, gaps at the corner of buttresses and crevices in brickwork (bridges);
- adjacent habitats;
- connecting habitat features;
- habitat quality; and
- lighting.

4.2.5 Habitat quality was assessed in accordance with the following criteria, which are adapted from *Hundt (2012)*:

- negligible - no features that could be used by bats for foraging or commuting;
- low – isolated habitat that could be used by foraging bats, e.g. a lone tree or patch of scrub, but not parkland, which is not connected by prominent navigable features (but if suitable foraging habitat is adjacent it may be valuable if it is all that is available);
- medium - habitat that could be used by foraging bats e.g. trees, scrub, grassland or water and the site is connected with the wider landscape by navigable features that could be used by commuting bats e.g. lines of trees and scrub or linked back gardens; and
- high – habitat of high quality for foraging bats e.g. scattered mature trees, hedgerows, broad-leaved woodland edges, tree-lined watercourses and grazed parkland and the site is connected with the wider landscape by navigable features that could be used by commuting bats e.g. river/stream valleys or hedgerows, site is close to known roost sites.

4.2.6 The results of the bat scoping survey were reviewed to assess the potential of the features to support roosting bats and whether they could provide important commuting or foraging habitat. The quality of the habitats and dimensions of the culverts were of particular relevance. Culverts less than 0.9m high or with a cross-sectional area of less than 2.2m were considered to be too small to be of value to roosting, foraging or commuting bats, in line with the results of recent research (*Boonman, 2011*). Bat roost potential was categorised as negligible; low; moderate; or high in accordance with *Hundt (2012)*.

- High potential - features of particular significance for roosting bats.
- Moderate - several potential roosting features.
- Low - a small number of potential (opportunistic) roost sites (i.e. probably not maternity roosts or hibernacula.
- Negligible - no features that could be used by bats.

4.2.7 The results informed the requirements for further survey work, specifically emergence and re-entry surveys on features considered to have a potential to support roosting bats; and activity and automated surveys on features that could provide valuable commuting and foraging habitat.

4.2.8 Emergence and return, activity and automated surveys were undertaken between 16 June and 30 July 2014.

4.2.9 Emergence and return surveys were combined with activity surveys. Two surveys were undertaken on each feature considered to have a moderate potential to support roosting bats or provide potential foraging and commuting habitat, including one dusk and dawn couplet within the same 24-hour period, in accordance with *Hundt (2012)*. Features offering only a low potential to support roosting bats were subject to a single re-entry survey. No features with high bat roost potential were recorded.

4.2.10 The dusk emergence and activity surveys commenced at least 15 minutes prior to sunset and continued for an hour and a half to two hours after sunset. The dawn re-entry and activity surveys started an hour and a half to two hours prior to sunrise and ended at sunrise. Surveyors were stationed on both sides of culverts where access permitted (as described in the limitations section).

4.2.11 The activity surveys were static; the surveyors recorded commuting and foraging activity adjacent to and within the culverts or under the bridges, as well as activity along and over the roads, including the flight height and direction of flight. The surveyors also recorded any bats emerging from or returning to these features, being verified by comparing the results obtained by the other surveyors at the opposite end of the culverts, where possible.

4.2.12 The surveyors were equipped with an AnaBat SD1 or SD2 bat detector and a Batbox Duet. Static SM2 BAT+ bat detectors were employed to record bat activity for at least five nights at three locations assessed as having a potential to provide important foraging and commuting habitat (features 14, 15 and 37). Detectors were set to record between 20:45 and 06:00. Two static detectors were employed at each location, as shown in *Figure 11.9* in *Volume 2 of the ES*. This approach ensured complete coverage of key locations, in conjunction with other activity surveys across the site.

Sound analysis

4.2.13 Sonograms were analysed using AnaLook (version 3.9c), with reference to current guidelines (*Russ, 2012*). Where possible, *Myotis* calls were identified to species level based on slope analysis.

Data interpretation

4.2.14 Bat activity indices were calculated for each static bat detector, as the number of passes per species for each survey period, divided by the number of nights within that survey period.

4.2.15 The value of the foraging and commuting habitat either side of the culverts for bats was assessed as high, moderate or low based on the following criteria. The presence of rare species was not taken into account as none were recorded.

- High – activity index of 1000 or more and eight or more species recorded.
- Moderate - activity index of 100 - 999 and six to seven species recorded.
- Low - activity index of 99 or less and five or less species recorded.

4.2.16 In the absence of guidance on criteria for allocating relative activity levels, this method was developed to enable a robust comparison between the activity at the culverts and bridges surveyed and will enable mitigation to be targeted at the most important areas if applicable. The method was developed in parallel with interpretation methods used for transect, static and woodland backtracking data to help the consistency of approach between allocating activity values across a range of different survey techniques.

Building surveys

Daytime roost assessments

4.2.17 All buildings within 100m of the route alignment were scoped for their potential to support roosting bats. Buildings were identified via aerial photography and Ordnance Survey maps. Where access was permitted, scoping of the potential for the buildings was undertaken in the daytime. This was based on an external ground-based assessment of a building's potential to support roosting bats based on the structure of the building and the quality of surrounding habitats including foraging habitat and commuting routes.

4.2.18 The scoping categorised the buildings as follows:

- Buildings which were not in need of ground based assessment owing to the lack of potential effect from the scheme.
- Buildings which required ground based assessment due to the potential for effects from the scheme that were then assessed as having negligible potential to support roosting bats (or where access was not provided).
- Buildings which required ground based assessment due to the potential for effects from the scheme and were then assessed as having potential to support roosting bats following which emergence/re-entry surveys were undertaken. The number of surveys undertaken was dictated by their roost potential assessment value and the potential effect of the works.

4.2.19 During the external inspection, the exterior walls and roofs of the buildings were viewed from ground level and features offering potential roosting opportunities for bats were noted, such as pointing cavities, window ledges, soffit boards, barge boards, cracks in brick and stonework, broken and loose hanging tiles, raised lead flashing, and/or gaps leading to cavity walls. Signs of bats using the building as a bat roost were looked for and any evidence of bat activity, potential access points and roosting sites were noted. Any suitable, foraging and commuting habitats were also recorded during the survey.

4.2.20 Equipment used and available to use included hi-powered torches, binoculars and cameras.

4.2.21 Evidence of bat activity or features with roosting potential included:

- bat droppings (these may accumulate under an established roost entrance/exit);
- accumulations of insect remains, especially wings (from feeding);
- oil (from fur) and urine staining;
- scratch marks;
- holes, apertures and other opportunities for bats to roost; and
- actual sightings (including corpses).

4.2.22 The buildings were then categorised in terms of their potential to support roosting bats as:

- negligible;
- negligible/low;
- low;
- low/moderate;
- moderate;
- high; and
- confirmed roost.

4.2.23 Emergence surveys were carried out on those buildings considered to have potential to support bats, where access was available following the guidance set out *by Hundt (2012)* amended by considerations of proximity to the main route alignment and the potential for effects on bats.

4.2.24 The number of dawn/dusk surveys undertaken for each building was based on the criteria in *Table 4.1*.

Table 4.1: Number of dawn/dusk surveys undertaken for buildings

Roost status	Offline		Online	
	Up to 50m	50-100m	Up to 25m	25-100m
Confirmed roost	3	2	3	2
High potential	3	2	3	2
Moderate potential	2	1	2	0
Low potential	1	1	1	0
Negligible potential	0	0	1	0

Dusk emergence and pre-dawn re-entry surveys

4.2.25 Surveys were carried out between 5 May 2014 and 16 July 2014 during optimal weather conditions as set out by *Hundt (2012).*

4.2.26 Dusk and pre-dawn bat emergence/re-entry surveys were undertaken at buildings with potential to support roosting bats with the appropriate number of personnel situated at key locations around the building to provide coverage of all potential roost features. At dusk, surveys began at least 15 minutes before sunset and continued for an hour and a half to two hours after sunset. Dawn surveys began an hour and a half to two hours before sunrise and ended at sunrise.

4.2.27 The position of each surveyor surrounding the building was noted, the location and direction and height of each bat pass, the species and behaviour of the bat (when known) were recorded on standardised survey sheets and their location mapped. Recordings were made of bat sounds to aid identification of species. Any lighting surrounding the building was also documented. Details of the weather conditions were recorded.

4.2.28 Indicators for potential roost sites being present in the survey area, or close by, were also sought. Such indicators include early emerging bats in relation to the sunset time (or late returning bats in relation to sunrise), as well as "streams of bats" leaving a roost site. At the dawn surveys, evidence of bat 'swarming' prior to re-entry of structures was recorded. The time the first and last bats were heard was taken as an indication of proximity to the bat roost, proximity can be estimated using knowledge of the varying species emergence behaviours.

4.2.29 Equipment used included:

- bat Box Duet and Pettersson bat detectors;
- echometer Touch (for Apple) bat detectors;
- edirol, Sony Record and Handy Zoom H2 digital recorders; and
- head torches.

Sound analysis

4.2.30 Sound recordings were made by surveyors during the surveys. Where surveyors were uncertain as to the species of bat heard, recordings made during the surveys were analysed in the office. Analysis was conducted using 'WaveSurfer 1.8.8' sound analysis software. Sonograms of bat calls were analysed according to the methodology and information contained in *Russ (2012)*.

4.2.31 Recordings were only analysed:

- where field surveyors were not sure of a bat species detected and analysis may have confirmed an additional species utilising the area;
- when rare or unusual species were recorded; and
- to confirm the species of a bat observed emerging or returning to a roost.

4.2.32 A degree of consideration of the experience of the field surveyors and the importance of the activity recorded was utilised when determining which recordings to analyse.

4.2.33 Where both soprano and common pipistrelle species were confirmed to be active during a given survey and surveyors were uncertain on some calls, analysis was not always utilised to differentiate between these two species, unless to confirm the species of a roosting bat(s).

Tree surveys

4.2.34 The tree survey work comprised a multi phased methodology:

- ground assessment survey– identification and preliminary grading of all trees with potential roost features (PRFs) located within the study area;
- tree climbing & ground endoscope survey – comprehensive inspection of PRFs for evidence of bat activity and assessment of suitability of PRFs as bat roost habitat. Determination of grade for each PRF and overall tree grade. Accurate assessment of the abundance of high value habitat present within the study area; and
- dusk emergence & dawn re-entry survey – observation of PRFs during periods of potential peak roost activity to determine whether PRFs are roosts and to collect information on species and numbers to determine type and significance of roost.

Ground assessment

4.2.35 A study area comprising a 100m buffer from the footprint of the scheme (excluding borrow pits) was surveyed to identify all trees with the potential to support roosting bats. All trees within and on the perimeter of borrow pits were also assessed (a 100m buffer of the borrow pits was not included as it was considered disproportionate to the level of impact to the borrow pits). The initial ground assessment work was undertaken on behalf of the Highways Agency in 2013, with further survey work of additional areas not surveyed in 2013 being undertaken in 2014. To ensure a consistent survey approach, the 2013 survey methodology was applied during the 2014 season. The methodology used for surveys was derived from best practice guidance (*Hundt, 2012*).

4.2.36 Ground assessments comprised a comprehensive inspection of each tree, using binoculars and 1 million candle power torches (Make/Model: Clulite/Clubman Deluxe) as required to observe any PRFs. PRFs included, but were not exclusive to:

- knot holes (cavities with collar resulting from natural branch loss and fungal infection);
- woodpecker holes and cavities created by fungal infection;
- tear outs (cavities within an inverted tear shape wound created when a limb was torn from the main stem or other major limb);
- impact shatters (cavities extending longitudinally into limb originating from a break along its length typically caused by impact with part of another tree);
- butt rot (hollow section of main stem resulting from fungal infection); and
- lifted bark (substantial areas of lifted bark typically resulting from fungal infection).

4.2.37 Where the ground assessment process determined that a tree required further survey, the tree was given a unique alphanumeric identification code and information about the tree was recorded using geographic information system software (ArcPad) on a mobile mapper (Model: Trimble Juno T41/5). The following information for each tree was recorded to determine the most appropriate options for further survey and in order to facilitate the location of the tree and the PRFs within the tree during further survey:

- location;
- species;
- maturity;
- relative location of tree (including reference to geographic features such as walls and watercourses);
- climbing safety (assessment of structural integrity of tree and proximity to roads, power lines etc.); and then for each PRF;
- PRF type (e.g. knot hole, woodpecker hole, lifted bark);
- PRF height;
- PRF aspect;
- PRF description (e.g. appearance of feature and location of feature within tree); and
- PRF grade (e.g. potential for bats in accordance with *Hundt (2012)*.

4.2.38 The information collected during the ground assessment work during 2013 and 2014 was used to determine which trees within the study area required further survey. This was achieved by recording a preliminary grade for each PRF within each individual tree and determining the preliminary overall tree grade from the highest grade PRF e.g. a tree with one feature of grade 2 and a second feature of grade 1 would have an overall tree grade of 1. The grading system used for the trees was adapted from *Hundt (2012).*

4.2.39 The information collected during the ground assessment was used to determine which trees were appropriate for tree climbing surveys (based on health and safety considerations such as the condition of the tree and presence of nearby hazards such as power cables). Where possible all trees that had been determined as requiring further survey work were subject to a climbing survey.

4.2.40 Those trees that had been determined as requiring further survey and only had PRFs below 1.5m in height were subject to ground based endoscope survey only. Those trees that had been determined as requiring further survey and had PRFs above 1.5m, but were considered not suitable to climb, were subject to dusk emergence and dawn re-entry surveys only.

4.2.41 In some instances, where a high level of confidence could be placed in the tree grade that was determined during the ground assessment, it was considered unnecessary to undertake further surveys to verify the tree grade. This method was typically adopted where trees were determined to have low conservation significance and were located beyond 25m from the foot print of the scheme.

Tree climbing

4.2.42 All trees that were determined as requiring further survey, with PRFs above 1.5m in height and were considered to be safe to climb were subject to a tree climbing survey.

4.2.43 Initial tree climbing surveys took place during February and March 2014. Winter tree climbing surveys benefit from the lack of foliage present on trees, making it easier to locate PRFs. However, due to low levels of bat activity in winter the primary objective of tree climbing surveys in winter is the comprehensive inspection of PRFs identified during the ground assessment surveys and determination of accurate grades for each PRF. The information collected during the tree climbing survey was used to revise, where appropriate, the original grade for each PRF that was inspected and consequently the overall tree grade for each tree. The revised overall tree grades for each tree were used to accurately determine the requirement for further survey work, which comprised a combination of dusk emergence surveys, dawn re-entry surveys and a second climbing survey.

4.2.44 Further tree climbing surveys, undertaken in June and July 2014, comprised a re-inspection of trees with suitable PRFs that were climbed in the winter and the first climbing survey of trees that were identified since the winter climbing surveys were completed. Tree climbing surveys undertaken during the summer months when bat activity is greatest provide the highest probability of finding evidence of bat activity within PRFs, if bats are actually using the PRF. The re-inspection of suitable PRFs was to identify any recent evidence of bat activity resulting from presence of bats during the period since the first climbing survey took place. The methodology was identical to that of the first climbing survey with a record of any changes to the physical attributes of each PRF being made in addition to any evidence of bat activity.

4.2.45 The tree climbing survey comprised the close inspection of all PRFs within each tree by appropriately qualified and licensed ecologists (NPTC CS38 tree climbing and aerial rescue, Natural England Bat Licence Class 2). Inspections were undertaken using a small torch (Make/Model: Petzl/ Tikka xp) and endoscope (Make/Model: Ridgid/Seesnake CA100) as required in order to determine the degree of suitability of each PRF to support roosting bats and to search for any evidence of bats having previously been present.

4.2.46 In addition to the information collected during the ground assessment, the following information was recorded during the tree climbing survey for each PRF:

- approximate dimensions of entrance;
- approximate internal dimensions;
- dry or wet;
- evidence of use by birds, squirrels or other non-bat species;
- clean or dusty/dirty;
- evidence of bat activity (smoothing of internal surfaces, droppings, feeding remains, staining); and
- presence, number and species of bats observed.

Ground based endoscope inspection

4.2.47 During the initial ground assessment survey, all trees with PRFs below 1.5m in height were subject to close inspection, using either a small torch or an endoscope. Due to the low height of the PRFs, a comprehensive assessment could be completed during the ground assessment resulting in accurate grading of the PRFs.

4.2.48 Where PRFs occurred below 1.5m, it was considered far more efficient to undertake all survey work using an endoscope rather than dusk emergence or dawn re-entry surveys. As such, ground based endoscope surveys replaced dusk and dawn surveys, with the number of survey visits for each tree remaining the same. The number of survey visits for each tree being determined through a combination of tree grade and location of the tree relative to the proposed scheme as detailed in *Table 4.2*.

4.2.49 Follow-up ground based endoscope survey visits were undertaken during the summer months, when bat activity was at its greatest and the probability of finding evidence of bat presence within a PRF was highest.

4.2.50 The method used during the ground endoscope survey was identical to that used during the tree climbing survey as described in above (without the need for climbing techniques).

4.2.51 Invasive techniques, as used during tree climbing surveys and ground based endoscope survey, allowed a comprehensive inspection and accurate grading of each PRF. The grading information for each tree was used to determine the abundance of high value (grade 1* and 1) roosting habitat present within the study area.

Dusk emergence and dawn re-entry

4.2.52 All trees determined to have moderate to high potential to provide suitable habitat for roosting bats from the results of the climbing survey (or ground assessment where a climbing survey was not feasible) were subject to a minimum of one dusk or dawn survey. No dusk or dawn surveys were undertaken on trees with PRFs below 1.5m in height as these trees were subject to ground based endoscope survey only.

4.2.53 The overall tree grade (*Hundt, 2012*) combined with the location of the tree relative to the footprint of the scheme, and whether the tree was within an online or offline section of the scheme was used to determine the number of dusk emergence and dawn re-entry surveys carried out for each tree. This ensured the level of survey effort was proportionate to the likely impact of the scheme in accordance with *Hundt (2012).*

4.2.54 *Table 4.2* summarises the number of dusk/dawn surveys undertaken for each tree.

Table 4.2: Number of dusk/dawn surveys undertaken for trees

Roost status	Offline		Online	
	Up to 50m	50-100m	Up to 25m	25-100m
Confirmed roost	3	2	3	2
1*	3	2	3	2
1	2	1	2	0
2	1	0	1	0

4.2.55 For any trees that were to be subject to more than one dusk or dawn survey, and that were suitable for climbing, a second tree climbing survey during the summer months was substituted for one of the dusk or dawn surveys. This approach was undertaken as it is considered a climbing inspection during summer months was more likely to detect evidence of bat activity as it would allow the identification of signs of recent use (for example droppings) even it live bats were not present. In comparison, dusk or dawn surveys provide only a snapshot of the use of a tree roost, and can be ineffective at location roosts particularly considering the highly transitional nature of roosts within trees. This approach was agreed with Natural England during a meeting prior to the commencement of surveys.

4.2.56 Dusk emergence and dawn re-entry surveys were considered identical in terms of survey effort. Trees requiring multiple dusk emergence or dawn re-entry surveys were subject to a combination of dusk and dawn surveys where possible. In some instances, it was not feasible to subject a tree to a combination of dusk and dawn surveys and instead the tree was subject to two dusk or two dawn surveys.

4.2.57 All surveys were undertaken with reference to *Hundt (2012)* with dusk surveys being undertaken from 15 minutes before sunset until two hours after sunset. Dawn surveys began two hours before sunrise and finished shortly after sunrise.

Woodland Backtracking Surveys

4.2.58 All woodlands within 100m of the scheme with significant potential to support bat roosts were scoped during the day. Following a daytime assessment of the woodland (to locate appropriate survey positions and confirm the number of surveyors required), ecologists surveyed for bats from 30 minutes before sunset to search for bats emerging from the woodland, noting the time and species of bats that were encountered and the direction and height of flight. Surveyors moved in the opposite direction to flying bats at dusk to identify their commuting routes. Surveys ended at one and a half to two hours after sunset.

4.2.59 The information was recorded on a detailed plan and was pooled from all the dusk surveyors on to a map to identify potential commuting routes and possible roost site locations.

4.2.60 The information gathered during the dusk component was used to target survey effort during the subsequent pre-dawn period. Beginning two to two and a half hours before dawn, ecologists surveyed for returning bats, starting with the potential flight routes identified the previous evening. Being particularly vigilant for a concentration of flight activity as bats return to their roosts. Surveyors moved in the same direction as returning bats at dawn to look for roosting sites.

4.2.61 Sound recordings were taken and retained for analysis/evidence. Weather conditions were recorded.

4.2.62 Equipment used included:

- bat Box Duet and Pettersson bat detectors;
- edirol, Sony Record and Handy Zoom H2 digital recorders; and
- head torches.

4.2.63 Surveyors recorded the locations of any confirmed or probable roosts identified during the surveys, or approximate locations where the exact tree could not be identified.

4.2.64 Surveyors also recorded observations on foraging and commuting activity with the approximate number of passes for each species, within each woodland, on any one survey, assessed to give an indication of activity levels for that woodland.

Sound analysis

4.2.65 Sound recordings were made by surveyors during the surveys. Where surveyors were uncertain as to the species of bat heard, field recordings taken in the field during the surveys were analysed in the office. Analysis was conducted using 'WaveSurfer 1.8.8' sound analysis software. Sonograms of bat calls were analysed according to the methodology and information contained in *Russ (2012).*

4.2.66 Recordings were only analysed:

- where field surveyors were not sure of a bat species detected and analysis may have confirmed an additional species utilising the area;
- when rare or unusual species were recorded; and
- to confirm the species of a bat observed emerging or returning to a roost.

4.2.67 A degree of consideration of the experience of the field surveyors and the importance of the activity recorded was utilised when determining which recordings to analyse.

4.2.68 Where both soprano and common pipistrelle species were confirmed to be active during a given survey and surveyors were uncertain on some calls, analysis was not always utilised to differentiate between these two species, unless to confirm the species of a roosting bat(s).

4.2.69 Bats in the genus *Myotis* were only identified to genus level.

Data interpretation

4.2.70 Locations of confirmed or probable roosts have been plotted on site plans to inform the impact assessment (*Figure 11.10*).

4.2.71 In the absence of guidance on criteria for allocating relative activity levels, this method was developed to enable a robust comparison between the activity in the woodlands surveyed and will enable mitigation to be targeted at the most important areas if applicable. The method was developed in parallel with interpretation methods used for transect, static and culvert survey data to help the consistency of approach between allocating activity values across a range of different survey techniques.

4.2.72 The number of bat passes for each species, for each survey, has been assessed as high, moderate or low based on the following criteria set out in *Table 4.3*.

Table 4.3: Criteria for assessing bat activity levels in woodland surveys

Value	Common pipistrelles, soprano pipistrelles and *Pipistrelle sp*.	*Myotis sp.,* serotine, noctule and brown long-eared
High	20+ calls	5+ calls
Moderate	10 to 19 calls	3 to 4 calls
Low	1 to 9 calls	1 to 2 calls

4.2.73 As no rare barbastelle were found, there was no requirement to take special consideration of the presence of these during the data interpretation. Nathusius pipistrelles were recorded in woodland 2A and so their presence was valued as high.

4.2.74 To give an overall score for each woodland, three, two or one points were awarded for each high, moderate, or low species recorded respectively for each survey. These values were then added to give a total score for the woodland. This method enabled species diversity to be taken into account as woodlands with more species would receive more points.

4.2.75 The overall value of the woodland was assessed as high, moderate or low based on the following total scores:

- high = 16 or more points;
- moderate = eight to 15 points; and
- low = seven or less points.

4.2.76 This method of interpretation enables a robust comparison between the activity in the woodlands surveyed and will enable mitigation to be targeted at the most important areas if applicable.

Activity transects

4.2.77 In 2013, fourteen activity transects (1-14, *Figure 11.9*) were undertaken along the scheme. In 2014, six additional activity transects (15-20, *Figure 11.9*) were undertaken for new sections for the scheme along the A1 widening to the north of Brampton Hut, and between Junctions 32 and 33 of the A14. Therefore a total of 20 transects were surveyed along the length of the entire scheme across both years where safe access permitted (as described in the limitations section). These locations were selected to give a representative sample of likely important bat commuting and foraging habitats across the scheme including, woodlands, hedgerows, rivers, drains, lakes, wetlands and ponds and were selected in accordance with best practice guidance contained in *Hundt (2012).*

4.2.78 Where it was not possible to complete all of the 14 original transects in 2013 due to bad weather (in particular May 2013 was a poor month for bat surveys due to bad weather conditions) they were completed in 2014.

4.2.79 Most transects were surveyed once a month from May until September with one dusk and dawn survey within 24 hours within one of the months, with the exception of transects 4, 10, and 14 (as described in the limitations section). However, when 2013 survey data was reviewed at the end of the survey season, it was decided to reduce the overall survey effort for some transects in areas of low quality bat habitat to a minimum of one survey per season (spring, summer, autumn) in line with good practice guidelines (*Hundt 2012*) for major infrastructure projects. Transects 8 and 10 were surveyed twice in September 2013.

4.2.80 Transects surveyed in 2014 only (15-20) were all in low quality bat habitat and therefore have only been surveyed once per season in accordance with good practice guidelines. However due to the programme for the scheme, the September survey had to be completed earlier than would be normally expected (as described in the limitations section). Details of the number and dates of surveys undertaken for each transect are available upon request.

4.2.81 Linear transects were walked by bat surveyors carrying broadband bat detectors and Batbox Duet Detectors linked to EM3 recorders (2013) and BatBox Duet and AnaBat SD2 detectors (2014). AnaBat SD2 detectors were connected to BatNav GPS units to record the location of the calls. Any deviation from the predefined survey route was marked on plans.

4.2.82 Dusk surveys started half an hour to 15 minutes before sunset until an hour and a half after sunset, and dawn surveys started two hours before sunrise until sunrise. Typically the first proportion of each transect was covered twice, resulting in the areas covered between half an hour before sunset and when bat activity increased after emergence being covered later in the evening when activity was higher.

4.2.83 Temperature, cloud cover, precipitation, wind speed and insect activity levels (2014 surveys only) were recorded at the start of each survey.

4.2.84 Listening points were established at regular intervals along the route with surveyors stopping at these for five minutes.

4.2.85 Any activity recorded was noted on survey forms and plans.

Sonogram analysis

4.2.86 Recordings from the EM3 detectors were analysed using AnaLook.

4.2.87 AnaBat files have been analysed using AnaLook version 20.14.5.3. Calls have been identified to species level where possible with reference to *Russ (2012)* and notes from training courses (*Level 2 and Level 3 AnaBat Course, Sandie Sowler*).

4.2.88 Where possible, *Myotis* calls were analysed to species level using slope analysis.

Data interpretation

4.2.89 Once sonograms were analysed, summary tables of data were exported into Microsoft Excel. Pivot tables were used to summarise the number of calls for each species for each transect. Data was compiled into an overall summary table for all transects.

4.2.90 In the absence of guidance on criteria for allocating relative activity levels, this method was developed to enable a robust comparison between the transects surveyed and will enable mitigation to be targeted at the most important areas if applicable. The method was developed in parallel with interpretation methods used for woodland backtracking, static and culvert survey data to help the consistency of approach between allocating activity values across a range of different survey techniques.

4.2.91 The aim of the data interpretation was to provide an overall value of each transect for bats to allow comparison between different parts of the site and identification of the most valuable areas for mitigation. In order to complete this valuation the following factors were considered:

- overall activity levels (for all species) as those areas supporting larger numbers of foraging or commuting bats would be deemed most valuable;

- species diversity as those areas supporting a higher diversity of bats would be deemed most valuable; and
- presence of rare species.

4.2.92 An activity index was calculated for each species for each transect, and for the total number of species for each transect, by dividing the number of calls by the number of surveys undertaken for that transect to take into account the different survey efforts for each transect (the number of repeats of each transect varied).

4.2.93 The activity index for each transect was then reviewed and a bat activity level of high, moderate or low was assigned to each transect using the following criteria:

- high = 75.0 calls per survey or more;
- moderate = 25.0 to 74.9 calls per survey; and
- low = 24.9 calls per survey or less.

4.2.94 In addition, species diversity was calculated for each transect (a count of the number of species recorded) and was assessed as being high, moderate or low based on the following criteria:

- high = eight or more species;
- moderate = five to seven species; and
- low = four or less species.

4.2.95 Two species of rare bat, barbastelle and Nathusius pipistrelle were recorded during transects. Relatively low numbers of barbastelles were recorded and therefore only their presence or absence was noted. Higher numbers of Nathusius pipistrelle were recorded and therefore their levels were assessed as high, moderate or low using the following criteria:

- high = five or more calls per survey;
- moderate = one to five calls per survey; and
- low = Less than 0.99 calls per survey.

4.2.96 An overall value for the transect was then assigned using a points system taking into account all of the above factors. High, moderate and low activity levels, species diversity and Nathusius activity levels were assigned three, two or one points respectively. Transects where barbastelles were present were assigned a further two points. The overall score was assessed as high, medium or low using the following criteria:

- high = seven or more points;
- moderate = four to six points; and
- low = three or less points.

Static monitoring surveys

4.2.97 In 2013, static monitoring was undertaken at 38 locations along the scheme (1-38, *Figure 11.9*). In 2014, monitoring at nine additional locations was undertaken (39-47, *Figure 11.9*) to cover sections for the scheme along the A1 widening to the north of Brampton Hut, and between Junctions 32 and 33 of the A14. The sampling effort and locations of static monitoring devices was determined in accordance with best practice guidance (*Hundt, 2012*) and aimed to monitor likely key linear commuting routes that may be impacted by the scheme.

4.2.98 Due to poor weather conditions, it was not possible to complete all of the static monitoring surveys in May 2013. These missing surveys were therefore undertaken in 2014 to complete the data set.

4.2.99 A combination of SM2 and AnaBat detectors were used in 2013, AnaBat Express and AnaBat SD1 detectors in 2014.

4.2.100 Detectors were deployed for a minimum of five nights per location per month surveyed. Most locations were surveyed every month between May and September as per BCT guidelines however SD13, SD14, SD15, SD27, SD28, SD30, SD31, SD32, SD33, SD37 and SD38 were not surveyed in June and SD26 was only surveyed in three months (May, June and September), as described in the limitations section.

4.2.101 Temperature and humidity were recorded throughout the 2014 survey period using a TinyTag Plus 2 TGP-4500 data logger. The data logger recorded the temperature and humidity every hour throughout the day.

Sonogram analysis

4.2.102 SM2 calls were converted using Kaleidoscope software for initial analysis with difficult calls subsequently converted into Waveform Audio File format (WAV) files.

4.2.103 Otherwise sonograms were analysed and data was interpreted as per the activity transects (paragraphs 4.2.77 to 4.2.85). The first five nights of data were analysed for each static detector.

Data interpretation

4.2.104 The mean temperature and humidity for each night was calculated by averaging recordings between sunset and sunrise for each month. Sunset and sunrise were taken as the latest and earliest (respectively) times for each month.

4.2.105 Once sonograms were analysed, summary tables of data were exported into Microsoft Excel. Pivot tables were used to summarise the number of calls for each species for each static location. Data was compiled into an overall summary table for all static locations.

4.2.106 In the absence of guidance on criteria for allocating relative activity levels, this method was developed to enable a robust comparison between the static locations surveyed and will enable mitigation to be targeted at the most important areas if applicable. The method was developed in parallel with interpretation methods used for woodland backtracking, transects and culvert survey data to help the consistency of approach between allocating activity values across a range of different survey techniques.

4.2.107 The aim of the data interpretation was to provide an overall value of each static location for bats to allow comparison between different parts of the site and identification of the most valuable areas for mitigation. In order to complete this valuation the following factors were considered:

- overall activity levels (for all species) as those areas supporting larger numbers of foraging or commuting bats would be deemed most valuable;
- species diversity as those areas supporting a higher diversity of bats would be deemed most valuable; and
- presence of rare species.

4.2.108 An activity index was calculated for each species for each static location, and for the total number of species for each static location, by dividing the number of calls by the number of nights surveyed for that location to take into account the different survey efforts for each location (the number of nights surveyed varied).

4.2.109 The activity index for each static location was then reviewed and a bat activity level of high, moderate or low was assigned to each using the following criteria:

- high = 200 calls per survey or more;
- moderate = 75.0 to 199.9 calls per survey; and
- low = 74.9 calls per survey or less.

4.2.110 In addition, species diversity was calculated for each static location (a count of the number of species recorded) and was assessed as being high, moderate or low based on the following criteria:

- high = 12 or more species;
- moderate = nine to 11 species; and
- low = eight or less species.

4.2.111 Two species of rare bat, barbastelle and Nathusius pipistrelle were recorded during static monitoring. Levels of Nathusius pipistrelle were assessed as high, moderate or low using the following criteria:

- high = more than 20 calls per survey;
- moderate = eight to 19.99 calls per survey; and
- low = Less than 7.99 calls per survey.

4.2.112 Levels of barbastelle were assessed as high, moderate or low using the following criteria:

- high = more than two calls per survey;
- moderate = 0.5 to 1.9 calls per survey; and
- low = Less than 0.5 calls per survey.

4.2.113 An overall value for the static location was then assigned using a points system to take into account all of the above factors. High, moderate and low activity levels, species diversity, Nathusius and barbastelle activity levels were assigned three, two or one points respectively. The overall score was assessed as high, medium or low using the following criteria:

- high = eight or more points;
- moderate = five to seven points; and
- low = four or less points.

4.2.114 In the absence of guidance on criteria for allocating relative activity levels, this method was developed to enable a robust comparison between the locations surveyed by static detectors and will enable mitigation to be targeted at the most important areas if applicable. The method was developed in parallel with interpretation methods used for woodland backtracking, transect, and culvert survey data to help the consistency of approach between allocating activity values across a range of different survey techniques.

4.3 Evaluation

4.3.1 The overall population of bats within the study area was valued using *Chartered Institute of Ecology and Environmental Management guidance on Ecological Impact Assessment* (2006). This method is in line with the most recently published guidance and represents best practice guidance *Interim Advice Note (IAN) 130/10 ' Ecology and Nature Conservation: Criteria for Impact Assessment* (*Highways Agency, 2010*). The evaluation uses a framework linked to a geographical scale at which the receptor has been valued (i.e. international, national, regional, county, local or site).

4.4 Limitations

Bridge and culvert surveys

4.4.1 An automated detector SD4 malfunctioned and only recorded for four nights instead of five in July. This was not considered to pose a significant constraint, considering that five nights of data were obtained in June.

4.4.2 There was no access to scope features 11, 12 and 13; this poses a significant limitation, as it was not possible to assess the potential of these features to support roosting bats, or their value to bats for commuting or foraging. Feature 25 also could not be accessed, but this is not considered to pose a significant constraint, as previous surveys indicate the structure of this feature is not suitable for bats.

4.4.3 Feature 5 was assessed as having a moderate potential to support roosting bats and could also provide a potential commuting corridor under the A14. This feature could not be surveyed at dusk or dawn due to health and safety issues associated with an adjacent traveller's site. This is considered to pose a limitation, as the importance of this feature could not be fully determined, so results should be treated with caution.

4.4.4 Feature 20 was considered to have a potential to provide valuable commuting habitat for bats. However, activity surveys were not undertaken for health and safety reasons. The presence of dense vegetation meant that this feature could only be accessed during the day. However, a static detector was deployed at this location as part of the static monitoring surveys, and therefore this is not considered to pose a significant limitation.

4.4.5 Access was not obtained to survey the southern side of feature 19. This bridge could therefore only be surveyed from the north. Furthermore, since this large bridge could only be surveyed at a distance, it was considered that an emergence survey would not be worthwhile. This was not considered to pose a significant limitation, since no bat activity was recorded in the vicinity of feature 19.

4.4.6 Features 16 and 27 were also only subject to a return survey due to access restrictions, although coverage of these features was improved through access to survey from both the north and south (16) and east and west (27). Similarly, no activity was recorded at feature 27 and only low levels of activity at feature 16 (not close to sunrise). It was not possible to survey features 30 and 31 from the east, as access could not be obtained. This was not considered to pose a significant limitation with respect to feature 31 as this feature was only considered to have a potential to provide important foraging and commuting habitat, which could be assessed adequately from the west. Conversely, feature 30 was considered to have potential to support roosting bats, which could have emerged at the eastern end of the culvert, meaning that the lack of access is considered to pose a limitation, as the importance of this feature could not be fully determined, so results should be treated with caution.

4.4.7 To summarise, of the 37 features identified, four could not be accessed for scoping (11, 12, 13 and 25) and, of the 13 identified for further emergence, return and activity surveys, two could not be surveyed (5 and 20). Partial access was obtained to survey three of the 11 features subject to emergence, return and activity surveys (19, 30 and 31).

4.4.8 Surveys were completed during June and July 2014, which does not include the full active season. However, as this incorporates some of the optimal months for bat survey and includes the end of the maternity roost period, this is not considered to significantly limit the robustness of the results.

Building surveys

4.4.9 The building inspection was restricted to a ground-level, external inspection. It is considered the level of survey was more than adequate to characterise the area and evaluate the population of the purposes of the environmental impact assessment.

4.4.10 Dusk/dawn surveys were not spaced throughout the season as is recommended although the surveys were undertaken at the peak of the activity season and in optimal weather conditions. The surveys also covered the maternity period and therefore would have detected any maternity roosts if present. Therefore this is not considered likely to have affected the robustness of this assessment.

4.4.11 The mobility of bats, and the range of structural features that have roost potential, means that finding all roosts from a limited number of surveys cannot be guaranteed.

4.4.12 Buildings were surveyed where access was permitted. Un-accessed buildings are listed within the scoping results.

4.4.13 Buildings 14, 15, and 16 were assessed during the scoping stage to offer some potential for roosting bats. Due to lack of access, targeted emergence and re-entry surveys on these buildings were not possible.

4.4.14 Lack of access to buildings poses a limitation, as the importance of this feature could not be fully determined, so results should be treated with caution.

Tree surveys

4.4.15 A large proportion of the ground assessment surveys took place during winter 2013/2014, which is the optimal season for this type of survey. However, the ground assessment surveys were not completed until July 2014 meaning that a considerable proportion of the work was undertaken while trees had full foliage and dense ground flora was present within parts of the study area.

4.4.16 It is nearly impossible to confirm a tree PRF as a bat roost without finding either a bat or bat droppings present within it. Due to the frequency that bats move between tree roosts the probability of find a bat within a PRF during a climbing survey is low. Bat droppings remain present in a PRF for longer than the bats themselves, but may not be present in great numbers to begin with and droppings degrade over time (especially if droppings are on the outside of the PRF entrance and exposed to the elements). Smoothing of internal surfaces is an important indicator that something is using the PRF but cannot be considered conclusive evidence of bat activity. Staining and scratches are abundant on trees and can be the result of a multitude of different factors and are thus rarely conclusive evidence of bat activity.

4.4.17 Bats move between tree roosts frequently and despite following good practice guidelines, the probability of finding bats using a particular PRF on the same occasion that the tree is scheduled for a dusk emergence or dawn re-entry survey is low. By undertaking a second climbing survey during summer months (where safe to do so), the robustness of surveys is considered to have been improved.

4.4.18 Restrictions on land access due to the refusal of particular land owners to grant permission for surveys to take place on their land resulted in either an incomplete suite of surveys or no surveys being carried out on trees in some parts of the study area. This may have resulted in some roosts not being identified.

4.4.19 A single dawn/dusk survey of trees N1.1, N2.1 and N7.1, and two dawn/dusk surveys of trees N7.6 and BP1.5 were accidentally omitted from the survey schedule. However the omission of these surveys is not considered a significant constraint on the assessment of the impact on the scheme on bats given the overall survey effort with respect to this group. In order to ensure legal compliance, further surveys of these trees would be completed pre-construction.

4.4.20 The presence of some trees in hazardous locations e.g. adjacent to the A14 carriageway resulted in either a reduced thoroughness of survey or absence of surveys.

Woodland backtracking surveys

4.4.21 During the survey period one backtracking survey (one dusk and one dawn) was carried out on each woodland. This gave a snapshot of the overall levels and type of bat activity within each woodland and an indication of likely or confirmed roosts within the woodland. Repeated surveys may give a fuller picture of the level and type of bat activity at any woodland given bats' temporal and spatial variations in activity, as discussed above.

4.4.22 Woodland 2b was surveyed as a proxy for woodland 2a due to health and safety concerns at the time of survey (surveyor positions too close to a live road environment).

4.4.23 The ability to determine a roost in a woodland was limited by the size and shape of the woodland and the number of surveyors. It was more difficult for surveyors to cover the perimeter of larger woodlands with multiple features offering roosting potential than was the case for smaller, more evenly-shaped woodlands.

4.4.24 Two surveys have been repeated in order to address the issues outlined above and to provide a more robust assessment. Overall, the data is sufficient to characterise and value the site and to identify areas of general potential for roosting bats.

4.4.25 Woodlands 6 and 8 could not be accessed and therefore backtracking surveys could not be completed. The woodlands have therefore been assessed as being of high value, to assume a 'worst'-case' approach.

Activity transects

4.4.26 No safe access was available for transect 20 and transect 8 and therefore surveys could not be completed.

4.4.27 Surveys of transects 4, 10 and 14 were not undertaken in June 2013. Following a gap analysis, it was decided surveys of these transects in June was not required as the habitat was of low potential for bats (and therefore only three surveys per transect were required over the season in accordance with BCT guidance) and each of the transects had already been surveyed in July providing data on summer activity of bats in these areas.

Static monitoring

4.4.28 No safe access was available for static monitoring points 46 and 47 and therefore surveys could not be completed.

4.4.29 Static monitoring points SD13, SD14, SD15, SD27, SD28, SD30, SD31, SD32, SD33, SD37 and SD38 were not surveyed in June 2013 but were surveyed in July, providing data on summer activity in these areas. The following year, it was decided that these locations did not need surveying in June as the habitat was of low potential for bats (and therefore only three surveys were required over the season in accordance with BCT guidance). Similarly, it was decided to only survey SD26 in spring, summer and autumn in 2014.

General

4.4.30 Surveys only provide a snap shot of information temporally and spatially from which behaviour is extrapolated to make an ecological evaluation. Bats are mobile creatures and move roosts on a regular basis, both seasonally and annually. The assessment and surveys of roosts (trees, bridges, culverts and buildings) undertaken meet good practice which recognises these limitations. Survey results therefore have a limited “shelf life” in describing the existing baseline.

4.4.31 An absence of a species record within an area does not necessarily reflect an absence of that species from the same area. Similarly the distribution of species records may reflect survey effort rather than an accurate distribution of that species. As such, historic records should be assessed with caution.

4.4.32 A survey can only assess the site as it was found at the time of the survey. Species may move in and out of the site at different times and habitats are subject to change. Whilst the results of this survey may no longer be fully representative of the site at the time of construction, nationally recognised standard survey methodologies have been used.

4.4.33 The limitations to the surveys do not represent a significant constraint to adequately assessing the value of bats for the purposes of undertaking an appropriate ecological impact assessment, with a high degree of confidence in the outcome.

4.4.34 Likely significant effects on and mitigation for bats are considered in the *Chapter 11 of the ES*.

5 Results

5.1 Desktop data and incidental records

5.1.1 Surveys to inform the ES for the A14 Ellington to Fen Ditton scheme (Atkins, 2009) identified two bat tree roosts and one possible roost. Dusk emergence surveys on 28th May 2008 identified a single common pipistrelle emerging from a crack willow tree adjacent to the river Great Ouse (see *Figure 11.10* in *Volume 2 of the ES* for roost location). Dusk surveys on 17th September 2008 identified two common pipistrelle bats emerging from the canopy of the most southerly of two mature oak trees within a hedge line east of Madingley Road (see *Figure 11.10* in *Volume 2 of the ES* for roost locations). Surveys of the woodland belt north of Huntingdon police station concluded likely roosts in trees in this area.

5.1.2 CPERC returned 167 records of bats in the data search undertaken by the Highways Agency in 2013 for the main scheme. 114 bat records were returned by CPERC in 2014 for the A1 widening section of the scheme.

5.1.3 Many of the records were for 'bat species' and bats had not been identified to species level, however there were records for Brandt's bat (two), brown long-eared bat (36), common pipistrelle (20), Nathusius pipistrelle (one), Daubenton's bat (four), Leisler's bat (three), long-eared bat species (four), Natterer's bat (three), noctule (seven), *Pipistrelle* species (56), serotine (three), soprano pipistrelle bat (18), *Myotis* species (five), barbastelle (four) and whiskered bat (one).

5.1.4 Cambridgeshire Bat Group returned 481 records for the main scheme and 64 records for the A1 widening (NB there may be partial overlap between these areas). Species recorded were serotine, Natterer's, Daubenton's, barbastelle, noctule, whiskered, Brandt's, brown long-eared, soprano pipistrelle, *Pipistrelle sp.*, common pipistrelle and Nathusius pipistrelle with some records for unidentified species.

5.1.5 A minimum of 12 species have been recorded within 1km of the site. No great horseshoe, lesser horseshoe, grey long-eared, Bechstein's or Alcathoe have been recorded within the desktop study area.

5.1.6 CPERC and Cambridgeshire Bat Group records have been plotted in ArcGIS to determine how close they are to the scheme. Where a full gird reference was not provided, the 1km grid square in which the record is located was drawn to determine if there is overlap with the scheme or a 100m radius.

5.1.7 There are records of 34 roosts within 1km of the site (*Table 5.1* and *Figure 11.10*). None of the roosts are located within the footprint of the scheme (including the borrow pits).

Table 5.1: Proximity of bat roosts to the scheme

Bat species	Grid reference/postcode	Distance from scheme
Bat sp.	TL 206 710	Furthest point from scheme 2km, square covers whole western side of Huntingdon works.
Bat sp.	TL 213 707 / PE28 4UF	Furthest point from scheme 2km, square covers whole western side of Huntingdon works.
Bat sp.	TL 214 707	Furthest point from scheme 2km, square covers whole western side of Huntingdon works.
Bat sp.	TL 362 675	1277 – 4026m
Bat sp.	TL 200 710	280m
Bat sp.	Grid square TL 196 7	Grid square partially overlaps scheme due to vague grid reference, however records are associated with Buckden village (more than 700m away).
Bat sp.	TL 235 713	180m
Bat sp.	Grid square TL 326 6	982m
Bat sp.	TL 423 616	190m
Bat sp.	Grid square TL 216 6	Grid square marginally overlaps scheme due to vague grid reference however record is associated with property in Offord Darcy around 1000m south
Brown long-eared bat	TL 316 684 / PE28 9JX	700 – 3000m
Brown long-eared bat	TL 316 686 / PE28 9JQ	700 – 3000m
Brown long-eared bat	TL 396 0 / CB23 8AF	Furthest point from scheme 2500m. Square covers western edge of Girton interchange.
Brown long-eared bat	TL 408 644	1500 - 4300m
Brown long-eared bat	TL 424 610	160m
Common pipistrelle	TL 316 686 / PE28 9JQ	700 – 3000m
Common pipistrelle	TL 396 0 / CB23 8AF	Furthest point from scheme 2500m. Square covers western edge of Girton interchange.
Long-eared bat sp.	TL 471 606 / CB4 1FL	1500 – 2500m
Long-eared bat sp.	TL 226 7 / PE19 5RT	Around 2km. Top quarter covers Brampton interchange area.

Bat species	Grid reference/postcode	Distance from scheme
Myotis sp.	TL 226 7 / PE19 5RT	1300 – 2200m. Offline near Godmanchester junction
Pipistrelle sp.	TL 316 684 / PE28 9JX	700 – 3000m
Pipistrelle sp.	TL 296 6 / PE28 9NA	1700 – 2500. Top quarter of square intersected by offline section near Fenstanton.
Pipistrelle sp.	TL 226 7 / PE19 5RT	1300 – 2200m. Offline near Godmanchester junction.
Pipistrelle sp.	TL 200 713	380m
Pipistrelle sp.	TL 202 710	460m
Pipistrelle sp.	TL 221 675	390m
Pipistrelle sp.	Grid square TL 316 8	135m but grid square does not overlap scheme.
Pipistrelle sp.	TL 472 624	260m
Soprano pipistrelle	TL 262 684	290m
Soprano pipistrelle	TL 289 669	570m

5.2 Field survey results

5.2.1 Detailed field survey results have been excluded from this report for brevity but are available upon request.

Bridge and culvert surveys

5.2.2 *Table 5.2* summarises the features that were assessed as having potential to support roosting bats or provide potential foraging or commuting habitat for bats following daytime scoping surveys, and the further surveys required. The features scoped are described in *Table 5.2.* The full results and photographs of those features identified in *Table 5.2* are available upon request.

Table 5.2: Results of bridges and culverts scoping surveys

Feature	Potential to support roosting bats	Habitat quality	Potential use as a commuting corridor	Number of dawn/dusk surveys required	Static surveys required?
5 – Bridge access to travellers site	Moderate	Low to medium	Yes	2	No
6 – Impington guided busway bridge	Moderate	Medium	Yes	2	No
14 – Girton A14 bridge west	Footpath bridge - low to moderate; M11 bridge - negligible to low	Medium	Yes – footpath bridge	2	Yes
15 – Beck Brook culvert	Low	Medium	Yes	1	Yes
16 - Dry Drayton Road overbridge	Low	Medium	No	1	No
19 – Bar Hill overbridge	Low	Medium	No	1	No
20 – Bar Hill Industrial Estate	Negligible	Medium	Yes	0	No
27 – Alconbury overbridge	Low	Medium	No	1	No
28 – Huntingdon Life Science northern culvert	Low	Medium	Yes	1	No
29 – Northern culvert	Low	Medium	Yes	1	No
30 – Culvert over a Tributary of the Ellington Brook	Low	Medium	Yes	1	No
31 – Culvert over the Ellington Brook	Negligible	Medium to high	Yes	0	No
37 – A1 overbridge	Low	Medium	Yes	1	Yes

5.2.3 The weather conditions recorded during the emergence, return and activity surveys are available upon request.

5.2.4 *Table 5.3* summarises the results of the bridges and culverts emergence, return and activity surveys. Full results are provided below.

Table 5.3: Summary of results of the bridges and culverts emergence, return and activity survey

Feature	Species confirmed foraging/commuting	Key activity	Details
6 – Impington Guided Busway Bridge	Common and soprano pipistrelle, *Myotis sp.*, noctule, brown long-eared bat	Common and soprano commuting corridor and foraging habitat.	Commuting under the bridge and foraging at the southeast entrance and over Orchard Park. Moderate level of activity during all surveys.
14 – Girton A14 Bridge West	Common and soprano pipistrelle and noctule.	Common and soprano pipistrelle commuting and foraging habitat (footpath bridge).	Common and soprano pipistrelle recorded commuting under the footpath bridge. Foraging to southwest of footpath bridge. Low level of activity recorded, with only one bat observed at any one time.
15 – Beck Bridge Culvert	Common pipistrelle, *Nyctalus sp.*, Leisler's bat and noctule.	None	N/A
16 – Dry Drayton overbridge	Common pipistrelle.	None	N/A
19 – Bar Hill overbridge	None	None	N/A
27 – Alconbury overbridge	None	None	N/A
28 and 29 – Huntingdon Life Science culvert	Common and soprano pipistrelle, Leisler's bat, noctule, *Myotis sp.* and probable Daubenton's bat.	Common pipistrelle commuting and foraging activity. Unseen probable Daubenton's bat activity.	Common pipistrelle commuting over the A1 and foraging over willows to the west, with up to two bats being observed at any one time. Moderate level of activity.
30 – Culvert over Tributary of Ellington Brook	Common, soprano and Nathusius' pipistrelle, probable Daubenton's bat and a *Nyctalus sp.*	None	N/A

Feature	Species confirmed foraging/commuting	Key activity	Details
31 – Culvert over Ellington Brook	Common and soprano pipistrelle, *Nyctalus sp.,* Leisler's bat, noctule, *Myotis sp.,* probable Brandt's bat, probable Daubenton's bat, brown long-eared bat.	Common and soprano pipistrelle commuting and foraging activity and probable Daubenton's bat. *Nyctalus* sp. and brown long-eared bat commuting activity.	Common and soprano pipistrelle and probable Daubenton's bat foraging at western end of culvert and within, also commuting through culvert and along the ditch and hedgerow and southwest across the field. Soprano pipistrelle commuting over A1. *Nyctalus* sp. and brown long-eared bat observed commuting through culvert and along the hedgerow on one occasion. Probable Brandt's bat recorded, but not observed. High level of bat activity, with up to two pipistrelle bats recorded at any one time.
37 – A1 overbridge	Common and soprano pipistrelle, *Nyctalus sp.*, noctule, Leisler's bat, brown long-eared bat, *Myotis sp.*, probable Daubenton's and probable Barbastelle.	Common and soprano pipistrelle commuting and foraging activity.	Commuting under the bridge and foraging at the bridge entrances, over the roundabout and along the eastern embankment. Soprano pipistrelle also commuting over the A1.

5.2.5 *Table 5.4* summarises the results of the automated survey. Full results are available upon request.

Table 5.4: Summary of results of the bridges and culverts automated survey

Species	Bat activity indices					
	Feature 14 – Girton A14 bridge west		Feature 15 – Beck Brook		Feature 37 – A1 overbridge	
	SD1A	SD2A	SD3A	SD4A	SD5A	SD6A
Common pipistrelle	16.1	4.0		78.7	480.3	381.9
Soprano pipistrelle	6.5	2.5		1.3	164.8	101.2
Pipistrelle sp.	1.1	6.0		1.0	98.4	30.7
Myotis sp.					4.7	0.8

Species	Bat activity indices					
	Feature 14 – Girton A14 bridge west		Feature 15 – Beck Brook		Feature 37 – A1 overbridge	
	SD1A	SD2A	SD3A	SD4A	SD5A	SD6A
(Probable) Daubenton's bat	0.3				0.9	
Big bat					0.1	0.3
***Nyctalus* sp.**			0.1	15.1	92.3	0.6
Noctule		0.7	0.2	6.6	257	0.1
(Probable) Leisler's bat		0.7	0.1	2.2	4.6	
Probable brown long-eared bat					0.1	
Total	24.0	13.9	0.4	104.9	1099.6	515.6
Species count	4	5	3	6	10	7
Value	Low	Low	Low	Moderate	High	Moderate

Feature 6 – Impington guided busway bridge

5.2.6 During the survey on 24 June, the first recording was a pipistrelle bat commuting to the north of the bridge at 22:09. No evidence was recorded to indicate the presence of a roost. Common pipistrelle was recorded foraging under the bridge and at the south-east entrance, between 22:21 and 22:24. Further pipistrelle commuting activity was observed, with common pipistrelle recorded commuting under the bridge in both directions at 22:27, 22:33, 22:35, 22:43 and 22:44, with brief foraging activity also noted. A soprano pipistrelle was also recorded commuting under the bridge towards the south-east at 22:32. Further pipistrelle foraging and commuting activity was recorded throughout the survey; much of this activity was not observed, but included passes across the busway. A *Myotis sp.* bat was also recorded at 22:21, but was not seen.

5.2.7 During the survey on 2 to 3 July, more bat activity also noted. Similarly, common (21:56, 21:58, 21:59, 22:07, 22:08) and soprano pipistrelle (22:05) were recorded commuting under the bridge. Common pipistrelle was also recorded foraging under the bridge and around the south-east entrance, with brief soprano pipistrelle and social calls. Common pipistrelle was also recorded commuting along or over the A14. Much of the foraging activity was recorded over Orchard Park to the south of the bridge. A greater diversity of species was recorded on 3 July, comprising a noctule pass at 03:50 and brown long-eared bat 03:52 and 03:55, which were not seen. Most other activity was faint and not observed, including common pipistrelle foraging and commuting activity, with some soprano pipistrelle passes also recorded. Common pipistrelle was observed commuting and foraging under the bridge at 03:02, 03:22 and 03:33.

Feature 14 – Girton A14 bridge west

5.2.8 A low level of bat activity was recorded during the surveys on feature 14. No bats were observed during the survey on 25 June, although three common pipistrelle passes were recorded at 21:58, 21:59 and 22:18. No evidence was recorded to indicate the presence of a roost associated with the M11 bridge and no foraging or commuting activity was noted.

5.2.9 During the survey on 14 July, higher levels of activity were recorded, associated with the footpath bridge. This comprised brief common and soprano pipistrelle calls between 21:52 and 23:07, including a common pipistrelle observed flying under the bridge towards the south-west at 23:05. Soprano pipistrelle was observed commuting out of the bridge at 22:47 at the south-west side, but was not seen at the north-east end. Common and soprano pipistrelles were also recorded foraging at the south-west entrance and under the bridge, with only one bat recorded at any one time.

5.2.10 During the survey on 15 July, a common pipistrelle was recorded at 03:04, as well as a noctule at 03:15 and 03:47, but these bats were not seen.

Feature 15 – Beck Brook culvert

5.2.11 A low level of bat activity was recorded. During the survey on 17 June, the surveyors located at the eastern end of the culvert observed a pipistrelle bat flying around the culvert entrance at 22:14, but was not thought to have flown through as it was not recorded by the surveyors at the western end. A noctule was recorded at 21:45, but was not seen. A common pipistrelle was heard at the western end at 22:31, but was not recorded.

5.2.12 On 7 July, a common pipistrelle was heard foraging above the tree canopy adjacent to the culvert at the eastern end between 22:47 and 22:51, but no bat calls were recorded. A common pipistrelle was also recorded commuting at the western end at 22:31, but was not seen.

5.2.13 During the dawn survey on 8 July, a common pipistrelle was recorded commuting above the tree canopy adjacent to the culvert at the eastern end at 03:14. At the western end, higher levels of bat activity were recorded, but no bats were seen. A common pipistrelle was recorded at 02:51, followed by a Leisler's bat at 02:54, a *Nyctalus sp.* at 02:55 and 03:05 and a noctule at 02:58. Only one bat was recorded at any one time.

Feature 16 – Dry Drayton Road overbridge

5.2.14 A low level of bat activity was recorded, comprising occasional common pipistrelle calls between 03:31 and 04:07. Only one bat was observed during the survey, commuting along the northern side of the A14 towards the south-east.

Feature 19 – Bar Hill overbridge

5.2.15 No bats were seen or recorded during the survey.

Feature 27– Alconbury overbridge

5.2.16 No bats were seen or recorded during the survey.

Features 28 (Culvert at TL19741305) and 29 (Culvert at TL19731997)

5.2.17 During the dusk survey on 23 June, a noctule was recorded commuting west over the A1 at 22:00, flying high overhead and following the tree line and culvert. Further unseen noctule activity was also noted at 22:29 and 22:32. Two common pipistrelles were seen commuting over the A1 towards the north-west at 22:12 and south-west at 22:32. Up to two common pipistrelles were recorded foraging around the willow *Salix sp*. trees to the west of the western end of culvert 28 frequently between 22:13 and 22:31. Other unseen common pipistrelle commuting and foraging activity was recorded throughout the survey. A *Myotis sp.* was also recorded between 22:44 and 23:08, including probable Daubenton's bat (identified from slope analysis). None of this activity was observed. Leisler's bat was also recorded at 23:05, but was not seen.

5.2.18 A lower level of bat activity was recorded during the dawn survey on 24 June, with common and soprano pipistrelle and probable Daubenton's bat recorded, but not seen at the western end. A pipistrelle and a *Myotis sp.* were recorded at the eastern end, but were not seen.

5.2.19 During the survey on 28 July the majority of bat activity was not seen, with the exception of a common pipistrelle foraging above and around the willows on the west side and then flying over the A1 towards the east at 22:02. A probable Daubenton's bat was recorded faintly on the east side between 22:17 and 22:21 and on the west side between 22:22 and 22:34. Otherwise, activity comprised common and soprano pipistrelle passes between 21:52 and 22:51, generally comprising brief, distant calls.

Feature 30 – Tributary of the Ellington Brook

5.2.20 The majority of the bat activity recorded on 24 June was not seen, comprising common and soprano pipistrelle commuting, in addition to Nathusius' pipistrelle recorded at 23:07. However, a soprano pipistrelle was also recorded commuting east along the ditch and then south along the A1 at 22:37.

5.2.21 During the dawn survey on 25 June, lower levels of bat activity were recorded, with only soprano pipistrelle recorded at 02:43, but not seen.

5.2.22 During the survey on 29 July, no bats were observed, but a common pipistrelle was recorded commuting occasionally between 21:51 and 22:41. Probable Daubenton's bat was also recorded at 22:16, as well as a *Nyctalus sp.* at 22:45 and soprano pipistrelle at 22:48.

Feature 31 – Ellington Brook

5.2.23 A high level of bat activity was recorded throughout the survey on 16 June from 22:05, including a variety of different species. Common and soprano pipistrelles were recorded foraging over the stream adjacent to the culvert and within the culvert, including up to two bats at one time. Social calls were heard. These species were also recorded commuting into and out of the culvert and along the ditch and hedgerow, also flying south-west across fields. A *Myotis sp.* including probable Daubenton's and Brandt's bat, were also recorded. Probable Daubenton's bat was recorded commuting out of the culvert, flying west along the ditch and hedgerow, also foraging within the culvert. Probable Brandt's bat was recorded at 22:23, but was not seen. A *Nyctalus sp.* was seen commuting through the culvert and along the ditch and hedgerow towards the west at 22:18, but was not recorded. Four further unseen noctule passes were recorded between 22:12 and 22:42. Brown long-eared bat was recorded during the latter part of the survey, with three possible or confirmed recordings between 23:13 and 23:19. At 23:19, brown long-eared bat was observed commuting out of the culvert and flying west along the hedgerow.

5.2.24 Similar bat activity was recorded during the dawn survey on 17 June, with respect to pipistrelle and *Myotis sp.* foraging and commuting activity. However, most commuting activity was associated with passes into the culvert towards the east, rather than out of the culvert to the west. In addition, a soprano pipistrelle was recorded commuting over the A1 towards the west and then along the A1 to the south. Brown long-eared bat was not recorded, but Leisler's bat was recorded at 02:46, but was not observed.

5.2.25 Soprano and common pipistrelle foraging and commuting activity was also recorded during the dusk survey on 8 July, with other species only recorded during the latter part of the survey. This comprised probable Daubenton's bat, recorded between 22:39 and 23:04, including foraging activity within the culvert. Noctule was also recorded at 22:56; this was a brief unseen pass.

Feature 37 – A1 overbridge

5.2.26 Common and soprano pipistrelles were recorded during the dusk survey on 18 June, between 22:06 and 22:56. The first pass comprised a common pipistrelle commuting under the bridge towards the east. At 22:19, a soprano pipistrelle was observed commuting over the A1 towards the north-west at an estimated height of 13m. Common pipistrelle was recorded foraging around the street light to the south of the A1 and east of feature 37 at 22:28 and foraging and commuting to the west of feature 37, flying north. During the dawn survey on 19 June, the majority of the bat activity comprised common pipistrelle, foraging around trees on the east-facing embankment and commuting under the bridge in both directions. In addition, probable barbastelle bat was recorded at 02:42 (80% confidence), but was not seen. Other species recorded comprised noctule between 02:42 and 02:44, *Myotis sp.* at 02:59 and brown long-eared bat at 03:09. None of these bats were seen. Soprano pipistrelle was also recorded at 03:19 and 03:34.

5.2.27 During the dusk survey on 3 July, near continuous common and soprano pipistrelle foraging and commuting activity was recorded throughout the survey, from 22:07. Soprano and common pipistrelle were observed foraging at the bridge entrances and commuting under the bridge, over the cars. Two soprano pipistrelle bats were also observed commuting over the A1 towards the east at 22:23, appearing to be quite low. Soprano pipistrelle was recorded foraging over the grassland within the roundabout to the west of the A1, with much unseen common and soprano pipistrelle foraging activity likely to be associated with activity in this area. Other species recorded comprised probable Daubenton's bat, brown long-eared bat, noctule, Leisler's bat and *Nyctalus sp.* These bats were not seen, apart from brown long-eared bat observed commuting over the A1 at 22:32, towards the west.

Building surveys

5.2.28 The results of the ground based scoping assessments are available upon request.

5.2.29 Eight roosts (buildings B.26, B.27, B.31, B.41A, B.41B, B.41C, B.43E, and B.45H) were confirmed during dusk emergence and dawn re-entry surveys of buildings. *Table 5.5* summarises the results of the survey.

Table 5.5: Summary of results of buildings surveys

Building	Summary of results
B.26 Crematorium	The building (east chapel, west chapel and cloisters complex) was confirmed to be a roost for individual common pipistrelle and pipistrelle bats, and for four brown long-eared bats which were observed roosting together behind a memorial stone against a wall. A brown long-eared bat feeding perch was also confirmed in the porch of the main crematorium building. Although not observed during the surveys, the high bat activity and previous maternity roost record indicate that the building complex is of high value for roosting bats and supports significant roosts. High levels of commuting and foraging activity were recorded in the areas surrounding the building (over 90 passes for common pipistrelle, and pre-roost swarming activity for brown long-eared). Species recorded during surveys included common and soprano pipistrelle, brown long-eared, serotine and possible noctule and *Myotis* species.
B.27 Cemetery barn	The building was confirmed to be a roost for one pipistrelle and one soprano pipistrelle bat which exited the barn from different points, with one (unknown species) returning to roost during the dawn survey. A soprano pipistrelle also re-entered the building during a subsequent dawn survey. Additional foraging and commuting bat activity recorded was low (nine passes recorded for both pipistrelle species). Pipistrelle species only were recorded. The building is located at the south-west corner of the Cambridge City Crematorium grounds. Along the boundary is a tree line, which to the east leads to a memorial woodland. To the east of the building is an open grassy area of crematorium grounds. To the north, west and south are arable fields, with one hedgerow running west from the barn along a field boundary.

Building	Summary of results
B.31 The Cottage, Offord Road	The building was confirmed to be a roost for a single common pipistrelle which re-entered the building during a dawn survey on two occasions under lead flashing on the southerly chimney stack.
B.41A	Bat dropping in cobwebs under porches at both ends of house. Possible *Pipistrelle sp.* roost in tree in eastern side of garden.
B.41B	Open sided timber framed barn. Possible emergence of brown long-eared bat on 13 August 2014
B.41C	During first survey, non echolocating bat emerged from in barn C. Bat droppings behind wooden cladding at access point exit. Probable emergence for soprano pipistrelle from a different exit. Emergence of possible *Pipistrelle sp*. or brown long-eared during second survey. Emergence of a single common pipistrelle from ~1.5m above ground on 13 August 2014. A single common pipistrelle re-entered building on 14 August 2014. Re-entry of a single soprano pipistrelle between wooden cladding on south facing wall on 19 August 2014.
B.43E	Possible common pipistrelle emergence on 21 August 2014.
B.45H	Bat sp. may have emerged from barn during first survey (12 August 2014). Two (possibly three) common pipistrelles emerged from roof during third survey (20 August 2014).

Tree surveys

Ground assessment and tree climbing

5.2.30 As far as reasonably practicable all trees within the 100m buffer study area and around the perimeters of the borrow pits were surveyed for suitability to support roosting bats. A total of 296 trees and 21 trees within 100m of the scheme and perimeters of the borrow pits respectively, were identified as having PRFs. Some additional trees were also surveyed however these now lay outside of the 100m study area due to design changes. Of all of the trees identified, 183 were subject to climbing surveys, 25 were subject to ground based endoscope inspections, and the remaining 83 could not be climbed due to health and safety. The remaining seven trees had low grade PRFs and were located beyond 25m of the existing A14 or beyond 50m of the proposed scheme footprint (excluding the borrow pits) and therefore did not require further survey in accordance with the methodology.

5.2.31 The climbing surveys identified a total of five bat roosts in trees including one within a bat box. The details of the roosts are shown in *Table 5.6* and the locations of roosts are shown of *Figure 11.10.*

Table 5.6: Details of bat roosts identified during climbing surveys (*suspected species based appearance of droppings)

Tree	Roost tree location (x,y)	Roost tree distance from scheme (m)	Roost tree feature type	Bat species	Evidence of bat activity
BT3.1b	521349, 268400	25.3	Butt rot	Brown long-eared/ *Myotis* species *	Droppings
BT12.3	522889, 272030	84.3	Tear out	Pipistrelle species	One bat
J2.1	541037, 261200	0.0	Tear out	Brown long-eared/ *Myotis* species *	Droppings
K2.5	539790, 262350	82.3	Bat box	Pipistrelle species*	Droppings
BP1.5	519337, 271921	64.8	Knot hole	Natterer's	One bat

5.2.32 The use of climbing and ground based endoscope surveys permitted an accurate assessment of the abundance of high value bat tree roost habitat to be made. Trees with PRFs graded as 1* are considered to be highly suitable for groups of bats to roost within. A total of 38 trees graded 1* were identified (this figure includes four trees with bat boxes that have not been confirmed as roosts).

Dusk emergence and dawn re-entry survey

5.2.33 A total of 144 trees were subject to dusk emergence/dawn re-entry surveys. The surveys identified a total of seven bat roosts in trees, the details of which are shown below in *Table 5.7* and the locations of which are shown on *Figure 11.10*.

Table 5.7: Details of bat roosts identified during dusk emergence/dawn re-entry surveys

Tree	Tree roost location (x,y)	Tree roost distance from scheme (m)	Roost tree feature type	Bat species observed using roost	Evidence of bat activity
21	519267, 273293	6.3	Unknown (obscured by ivy)	Common pipistrelle	Two bats seen entering tree roost
BT2.3	520323, 268971	0.9	Woodpecker hole	Brown long-eared bat	Four bats seen entering tree roost
BT2.4	520343, 268974	5.1	Woodpecker hole	Brown long-eared bat	Two bats seen entering tree roost
BT6.3c	531994, 266962	10.7	Unknown (obscured by ivy)	Soprano pipistrelle	One bat seen entering tree roost
J2.19	540916, 260969	43.9	Knot hole	Soprano pipistrelle	One bat seen emerging from tree roost

Tree	Tree roost location (x,y)	Tree roost distance from scheme (m)	Roost tree feature type	Bat species observed using roost	Evidence of bat activity
T9.1	545621, 262030	0.9	Unknown (obscured by ivy)	*Pipistrelle sp.*	One bat seen emerging from tree roost
J5.3	540869, 262296	72.9	Woodpecker hole	Common pipistrelle	One bat seen entering roost

Woodland backtracking

5.2.34 Woodland backtracking surveys identified the following roosts/possible roosts within the areas surveyed (see *Figure 11.10* in *Volume 2 of the ES* for roost locations):

- Woodland 2a – Probable common pipistrelle roost;
- Woodland 3 – Soprano pipistrelle roost;
- Woodland 3 – Likely *Pipistrelle sp*. roost;
- Woodland 7 – Possible common pipistrelle roost (four bats);
- Woodland 7 – Soprano pipistrelle roost;
- Woodland 9 – Possible common pipistrelle emergence from a large oak tree; and
- Woodland 9 – Possible soprano pipistrelle roosts.

5.2.35 *Table 5.8* summarises the values calculated for each of the woodlands (more detailed information is available upon request). Woodlands 6 and 8 could not be surveyed as access was denied and therefore the woodlands have been assessed as being of high value to assume a 'worst-case' approach.

Table 5.8: Woodland value summary

Woodland	Description	Total score	Value
1 – Impington guided busway	A shelter belt located along arable field margins, adjacent to the A14 and Impington Guided busway both of which are situated immediately south of the woodland. This woodland is surrounded by arable fields to the west, north and east. A lake or reservoir lies approximately 200m to the west, across the guided busway. To the south of the A14 is residential housing and Cambridge Science Park. This woodland has very good connectivity with hedgerows leading from the woodland along field margins to the north and east.	16	High

Woodland	Description	Total score	Value
2A – Girton Ramp	Located adjacent to a slip road taking traffic away from the M11 towards the A14, woodland 2A appears to contain only young, immature trees which would likely offer limited roosting potential. There is a public footpath running along the southern side of the woodland, while the northern and eastern aspects of the woodland are bordered by arable fields. Forming the south-easterly end of the woodland to be surveyed is a stream (Beck Brook). On the southern side of the A14 are farm buildings and additional woodland patches. Woodland 2 has good connectivity with surrounding wooded areas through hedgerows and the stream, and could also have potential flight connectivity with wooded areas south of the A14, although limited by the width of the road.	16	High
2B – Beck Brook/Catch Hall	Plantation woodland located south of the A14, with the Beck Brook running through the centre. The woodland is bordered by arable fields on all other sides. Farm buildings and residential cottages lie to the north west of the woodland (Catch Hall Farm). Woodland 2b is well-connected to other woodland patches to the south of the A14 and is likely to be used for commuting and foraging by bats. More mature trees at the northern end of the woodland may be used for roosting where suitable features occur.	8	Moderate

Woodland	Description	Total score	Value
3 - Cambridge crematorium	Memorial woodland area at the south-eastern corner of Cambridge City Crematorium. To the north of the woodland are the Crematorium buildings and grounds, including an additional area of low-intensity management grassland ('wildflower area'), woodland and a wildlife pond in the north-western corner. To the east, south and west the woodland is surrounded by arable fields. The woodland has good connectivity with the wider area through hedgerows that may be used for foraging. Approximately 350m south of the woodland is situated Beck Brook. Within the woodland are mature trees with a closed canopy and features which appear to provide good roosting opportunities for bats. Several trees also have bat boxes. The understorey comprises mown grass and small shrubs. A ditch runs west to east through the south of the woodland. This was dry at the time of the survey.	21	High
4a + 4b – Bar Hill arterial	Woodlands 4a and 4b are located within the slip roads of Junction 30 of the A14. The woodland is quite dense, so is likely to have fairly low potential for bats to fly through and/or within the woodland., However, the edges of the woodland provide excellent opportunity for foraging bats. There is a large pond located immediately adjacent to both woodland areas, enhancing foraging opportunities for bat species. The trees appear to be mostly immature so may offer limited roosting opportunities.	9	Moderate

Woodland	Description	Total score	Value
5 – Down Spinney	Woodland 5 is located immediately south of the A14, approximately 350m west of Junction 28. To the south, west and east the woodland is surrounded by arable fields, with arable fields also lying to the north of the A14. The woodland contains immature trees, growing close together, however multiple features appearing to offer excellent roosting opportunities are visible (cracks, splits, woodpecker holes). One large mature oak tree is located on the south-west corner of the woodland. The western edge of the woodland appears to have been cut back at some point to create a drainage ditch which runs alongside, which may provide additional foraging opportunities for bat species. Areas of additional bat foraging habitat are located around Junction 28, to the north and south. The woodland has fairly limited connectivity with the wider landscape, although there is another small woodland located to the south-west, and numerous woodland patches occur around Boxworth, 700m to the south.	16	High
6	Located on Potton Road (B1040), Woodland 6 is located immediately south of West brook and a large flooded quarry pit, and is surrounded by arable farmland on the south and east. Additional lakes, wooded areas and arable land lies to the west of the B1040. The large lake is surrounded by overgrown trees and shrubs. A public footpath is situated north of Woodland 6 and enclosed by trees. This area provides good opportunities for bat foraging and bats may forage between Woodland 6 and along hedgerows to the north, south and east.	N/A – no access for surveys	High (assumed)
7	Woodland 7 is situated alongside the A1198, south of Godmanchester. North of woodland 7 is Wood Green Animal Shelter, with the A1198 immediately to the west. The woodland comprises a belt of trees in the shape of a reverse ‘E’, with arable fields to the east and south and two fields enclosed by the woodland and the A1198. West of the A1198 is a narrow woodland strip, connecting in the south to a tree line along a stream. This, together with hedgerows along field boundaries, provides connectivity to the wider landscape, although the surrounding landscape is predominantly arable with few additional wooded areas.	5	High

Woodland	Description	Total score	Value
8	Plantation woodland strip along a field boundary situated 750m west of the A1198 to the south of Godmanchester. The woodland is surrounded by arable farmland and has little connectivity to the wider landscape, although hedgerows along field boundaries may provide commuting flight lines. There is a stream lined with trees approximately 500m to the south, a woodland strip alongside the A1198 to the east and across the A1198 lies Woodland 7, all of which would provide additional foraging and commuting habitat for bats. Surveyors have not been able to access this woodland so the description is limited.	N/A – no access for surveys	High (assumed)
9 – Huntingdon Police HQ	A strip of woodland extending for 1km located south-west of Huntingdon and south-west of the A14. The woodland is adjacent to the A14 to the south-east. To the south of the woodland lie Huntingdon Police HQ, Hinchingbrooke Hospital, and areas of residential housing. West of the woodland is an industrial estate and residential housing to the south-west. North of the woodland (between Woodland 9 and the A14) is an area of amenity grassland (Views Common) with a footpath. The constabulary HQ has an area of parkland with scattered trees/amenity grassland and trees around the boundary which are likely to provide good opportunities for bat foraging. Views Common is used as pasture for cattle which is likely to provide additional foraging opportunities for bats. Woodland 9 contains numerous mature trees with opportunities for roosting bats.	11	Moderate

Activity transects

5.2.36 During activity transects, surveyors noted the flight height of any bats which could be seen. They also recorded how/whether bats were flying over the existing road to determine if this affected flight height. Data collected is available upon request.

5.2.37 Only four bats (a noctule, a common pipistrelle, a pipistrelle species and a whiskered/Brandt's/Alcathoe) were observed travelling over the road. This is considered an insufficient data set to draw any meaningful conclusions about the height of bats crossing the road.

5.2.38 Similarly only low numbers of *Myotis* and whiskered/Brandt's/Alcathoe were recorded flying in habitats adjacent to the road.

5.2.39 The flight height of 64 common pipistrelles was recorded for bats flying adjacent to (as opposed to across) the A14. Minimum heights for individual bats ranged from 2m to 5m, with the majority of bats (38) flying at a minimum of 4m.

5.2.40 Similarly, all the pipistrelle species and the majority (13 out of 16) of soprano pipistrelles were recorded flying at a minimum of 4m.

5.2.41 Of all the bats observed (both flight across and adjacent to the road), 72 out of 99 were flying at a minimum height of 4m or more, with only 17 flying at 2m or less.

Activity transects

5.2.42 *Table 5.9* summaries the bat activity indices (number of bat calls divided by number of nights surveyed).

5.2.43 *Table 5.10* summarises the results of the data interpretation and overall value assigned to each transect. *Figure 11.9* shows the locations of the transects, colour coded to represent their assigned value. A summary of the full data (counts of bat calls) recorded is available upon request.

Static monitoring surveys

5.2.44 *Table 5.11* summaries the static monitoring surveys (number of bat calls divided by number of nights surveyed).

5.2.45 *Table 5.12* summarises the results of the data interpretation and overall value assigned to each static location. *Figure 11.9* shows the locations of the static detectors, colour coded to represent their assigned value. A summary of the full data (counts of bat calls) recorded is available upon request.

Table 5.9: Summary of activity indices from transects

Species	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T10	T11	T12	T13	T14	T15	T16	T17	T18	T19
Bat species	1.2	13.2	4.7	0.7	6.8	7.2	4.5	1.8	10.4	1.0	1.0	3.8	22.3	4.4	0.0	0.0	0.0	0.0	0.0
***Pipistrelle* species**	0.6	0.3	17.3	5.6	0.2	0.3	4.2	0.6	0.4	0.0	3.0	0.6	0.3	0.2	0.0	0.0	0.3	0.0	0.8
Common pipistrelle	9.2	8.3	31.3	12.7	15.8	5.8	28.2	10.4	6.6	4.8	71.8	12.4	7.7	19.4	6.5	5.0	6.5	4.5	106.5
Soprano pipistrelle	11.6	31.8	98.5	16.0	5.8	8.5	19.3	8.8	6.2	0.8	20.0	3.4	7.2	27.0	1.0	0.5	11.0	9.3	7.8
Nathusius pipistrelle	0.0	0.0	9.5	0.1	0.2	0.0	0.3	0.6	0.2	0.0	0.0	0.0	1.8	0.8	0.0	0.0	0.3	0.0	3.0
***Myotis* species**	0.4	6.8	12.8	0.6	0.2	0.2	1.2	0.0	0.0	0.0	0.5	0.0	0.2	0.0	0.0	0.0	0.3	1.0	1.0
Brandt's	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daubenton's	0.0	0.0	0.8	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
Whiskered	0.0	3.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whiskered/ Brandt's	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	2.0
Big bat	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Noctule	1.2	7.2	12.3	3.6	0.8	0.5	6.8	1.0	3.6	0.0	2.3	5.4	0.3	0.2	0.0	0.0	0.3	1.3	0.5
Serotine	0.2	0.5	1.5	0.3	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leisler's	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BLE	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barbastelle	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Total	24.8	71.7	191.0	39.6	30.0	22.5	65.5	23.4	27.4	6.8	98.5	25.8	40.3	52.2	7.5	5.5	18.5	16.0	124.0
No. of species	8	9	13	8	8	6	10	7	6	4	6	6	9	7	2	2	6	4	8

Table 5.10: Valuation of transects

KEY – A = absent; H = high; L = low; M = moderate; N= none; P = present; red = high value; amber = moderate value; green = low value.

Transect	Habitat	Habitat value	Index	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
T 1	Dominated by large arable fields with some hedgerows and wet ditches on field edges. Brampton Wood is located to the west and Lenton Lakes fishing lakes to the south east.	L	24.8	L	N	A	H	4
T 2	Transect includes Lenton Lakes fishing lakes and arable habitat bordered by semi-mature tree lines and hedgerows. Scattered mature trees are located within the fishing ponds and around the field borders.	M	71.7	M	N	A	H	5
T 3	Buckden Gravel Pits County Wildlife Siteand the river Great Ouse with adjacent semi-improved grassland. All watercourses and waterbodies within are bordered by mature tree-lines, hedgerows and areas of wet woodland.	H	191.0	H	H	A	H	9
T 4	Dominated by large arable fields bordered with some semi-mature tree lines hedgerows and scattered mature trees.	L	39.6	M	L	A	H	6
T 5	Arable habitat bordered by broadleaved plantation of mature and semi-mature woodland to the east and hedgerows to the west.	M	30.0	M	L	P	H	6
T 6	Arable habitat with hedgerows and tree-lines consisting of semi-mature and mature trees.	L	22.5	L	N	A	M	3

Transect	Habitat	Habitat value	Index	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
T 7	Arable habitat with some hedgerows and limited areas of tall ruderal and broadleaved woodland. Some individual mature trees are located throughout the field borders.	L	65.5	M	L	A	H	5
T 8	Predominantly arable habitat with some semi-improved grassland and a hedgerow network. Some individual mature trees are located around the field borders, particularly on the Hilton Road side to the west.	L	23.4	L	L	A	M	4
T 9	Arable and semi-improved grassland with a good hedgerow network. Scattered mature trees are located along the field borders.	M	27.4	M	L	A	M	5
T 10	Arable field dominates bordered with hedgerows and some semi-mature trees located to the south of the transect.	L	6.8	L	N	P	L	3
T 11	Semi-improved grassland and arable habitat with some hedgerows and some scattered semi mature trees.	M	98.5	H	N	A	M	5
T 12	Arable habitat with some hedgerows and wet ditches. Some scattered semi-mature trees are located around the field borders, particularly adjacent to the woodland area to the south of Slate Hall Farm.	L	25.8	M	N	A	M	4

Transect	Habitat	Habitat value	Index	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
T 13	Arable habitat surrounded by localised areas of broadleaved plantation. Some hedgerows including a double hedgerow.	M	40.3	M	M	P	H	7
T 14	Semi-improved grassland and amenity grassland with areas of broadleaved plantation and broadleaved woodland. Surrounded by urban habitat in the wider area.	M	52.2	M	L	A	M	5
T 15	Improved and semi-improved grassland to the north of Huntingdon Science Park. Semi mature tree line and hedgerows border the fields with localised conifer plantation tree-line to the north of the transect.	M	7.5	L	N	A	L	2
T 16	Predominantly arable habitat with wet ditches. Limited hedgerows and individual semi-mature and mature trees are located on the border between the fields and the A1 carriageway.	L	5.5	L	N	A	L	2
T 17	Arable habitat with wet ditches. Semi-improved grassland to the south. Semi-mature tree lines and hedgerows border the entire transect.	L	18.5	L	L	A	M	4

Transect	Habitat	Habitat value	Index	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
T 18	Predominantly arable habitat with a fishing lake. Wet ditches located on the field borders through the transect especially alongside A1 carriageway. Semi-improved grasslands to the east of the transect and dense hedgerow plantation along the south east of the transect.	M	16.0	L	N	A	L	2
T 19	A large lake with two densely vegetated islands. Semi-improved grassland, tall ruderals, and semi-mature trees border the transect with some small areas of broadleaved woodland to the east.	M	124.0	H	M	A	H	8

Table 5.11: Summary of activity indices from static monitoring surveys

Static detector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bat species	0.27	0.40	0.25	1.40	3.00	2.97	0.20	3.47	0.60	13.00	7.00	13.46	163.85	0.25	5.60
***Pipistrelle* species**	1.03	8.20	2.10	9.91	30.77	52.40	5.40	23.37	4.60	272.26	206.54	31.15	0.00	3.80	1.17
Common pipistrelle	6.37	62.37	92.43	187.69	656.80	87.97	124.60	66.53	166.13	206.77	303.15	121.09	6.00	26.20	37.00
Soprano pipistrelle	10.73	66.80	28.08	58.10	298.49	395.20	90.00	166.73	55.73	1163.74	1245.06	1477.25	735.75	38.60	42.67
Nathusius pipistrelle	0.40	1.54	2.73	1.74	3.94	4.06	2.80	11.73	2.20	66.71	88.56	19.48	1.77	5.75	2.43
***Myotis* species**	8.13	3.80	13.93	5.43	21.83	8.14	4.60	5.47	5.77	25.71	60.90	9.99	2.15	3.00	2.13
Brandt's	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daubenton's	0.80	0.20	0.00	0.43	1.29	0.43	0.40	0.60	0.00	2.86	14.91	0.29	0.00	0.40	0.00
Whiskered	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
Whiskered/ Brandt's	0.00	0.20	0.00	1.09	2.80	1.29	0.00	3.60	0.20	1.57	5.71	0.14	0.00	0.80	0.00
Natterer's	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Big bat	0.10	0.00	0.53	0.14	0.20	1.60	0.40	0.20	0.00	1.54	0.00	0.34	0.00	0.00	0.00
Noctule	2.23	8.09	15.78	10.25	11.74	13.54	13.00	12.03	31.67	31.57	22.13	33.17	5.67	7.50	2.50
Serotine	0.13	0.40	0.00	0.00	0.54	3.69	0.00	2.60	0.57	0.00	1.83	0.00	0.00	0.00	0.00

Static detector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Leisler's	0.03	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BLE	0.07	0.14	0.33	0.00	0.74	4.00	0.80	3.00	0.00	0.60	1.87	0.40	0.00	0.00	0.00
Barbastelle	0.03	0.60	0.73	0.00	7.69	1.60	0.20	1.10	2.00	0.80	0.73	1.40	0.17	1.80	0.33
Total	**30.9**	**28.8**	**29.8**	**47.5**	**195.6**	**111.4**	**48.5**	**60.3**	**52.4**	**337.8**	**384.3**	**329.2**	**154.2**	**17.5**	**12.5**
Species count	14.0	13.0	10.0	10.0	13.0	14.0	12.0	14.0	11.0	12.0	12.0	13.0	7.0	10.0	8.0

Static detector	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Bat species	0.25	0.25	3.85	24.60	0.20	172.40	62.22	24.20	2.00	6.40	0.00	2.80	211.47	0.45	0.87
***Pipistrelle* species**	1.73	0.40	4.62	15.33	20.20	18.20	65.12	4.60	3.40	5.33	0.40	10.13	64.60	3.80	12.80
Common pipistrelle	44.02	27.27	23.97	266.07	331.63	1191.75	492.32	771.00	57.20	302.43	83.83	1088.30	2256.20	121.35	81.42
Soprano pipistrelle	17.17	11.07	105.70	366.50	144.20	351.95	418.80	413.00	57.80	172.17	3.40	121.20	993.33	70.50	126.32
Nathusius pipistrelle	1.57	1.33	1.73	1.93	10.40	6.50	10.60	12.20	2.00	16.77	2.00	2.70	4.57	0.45	4.46
***Myotis* species**	0.37	0.00	6.62	2.07	1.14	4.00	40.05	16.00	1.60	2.37	0.97	1.60	6.20	1.70	2.80
Brandt's	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daubenton's	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Static detector	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Whiskered	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.17	0.20	0.00
Whiskered/ Brandt's	0.00	0.00	0.33	0.33	0.00	0.00	2.83	0.40	0.00	0.00	0.00	0.80	0.00	0.00	3.80
Natterer's	0.00	0.00	0.00	0.00	0.00	0.00	0.25	2.40	0.00	0.00	0.20	0.40	0.17	0.20	0.00
Big bat	0.00	0.20	0.00	0.00	0.20	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.17	0.00	0.20
Noctule	1.73	2.47	6.08	1.27	5.40	4.65	30.42	2.60	2.40	9.07	9.87	3.53	3.83	3.35	3.08
Serotine	0.00	0.00	0.42	0.00	0.40	0.00	0.00	1.00	0.20	0.20	0.20	0.20	0.17	0.00	1.29
Leisler's	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BLE	0.00	0.00	0.40	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barbastelle	0.00	0.20	0.77	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.00	0.60
Total	**14.2**	**8.9**	**29.5**	**138.9**	**101.0**	**404.8**	**235.5**	**415.9**	**31.7**	**100.5**	**26.0**	**239.5**	**700.0**	**40.3**	**56.0**
Species count	7.0	8.0	11.0	8.0	10.0	8.0	12.0	11.0	8.0	8.0	8.0	11.0	12.0	9.0	11.0

Static detector	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	Grand total
Bat species	0.00	10.20	2.40	0.80	1.40	0.90	9.87	4.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**757.30**
Pipistrelle species	0.20	1.01	2.17	2.80	5.40	0.46	13.72	5.00	6.00	1.40	22.67	5.23	2.03	20.20	0.07	**971.74**
Common pipistrelle	24.89	226.27	38.93	308.60	215.84	16.36	58.37	60.57	46.07	31.80	131.10	50.17	69.10	378.00	17.47	**10963.38**
Soprano pipistrelle	19.37	37.76	19.41	45.20	34.16	4.19	194.93	109.40	3.73	12.40	289.00	97.90	124.03	30.40	0.73	**10268.66**
Nathusius pipistrelle	0.00	0.40	0.20	9.00	3.76	2.69	0.60	1.14	0.33	5.00	8.13	6.50	4.80	0.60	0.80	**339.01**
***Myotis* species**	2.43	4.41	1.69	1.80	4.49	0.69	5.05	2.73	10.87	30.00	18.43	10.63	39.60	3.20	0.07	**404.53**
Brandt's	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.23**
Daubenton's	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	1.40	0.20	0.17	6.00	0.20	0.00	**32.77**
Whiskered	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.51**
Whiskered/ Brandt's	0.00	0.00	0.20	0.00	0.00	0.20	0.00	0.00	2.27	14.20	2.00	0.83	4.60	0.00	0.00	**50.20**
Natterer's	0.14	0.00	0.14	0.00	0.20	0.00	0.00	0.00	0.67	0.00	0.40	0.00	0.00	0.00	0.00	**6.17**
Big bat	0.00	1.20	0.20	0.20	0.00	0.00	0.00	0.00	0.13	0.20	0.20	0.00	0.00	0.00	0.00	**8.15**
Noctule	4.40	11.24	3.10	6.00	6.61	1.39	8.50	49.09	2.13	5.60	13.00	9.47	76.67	5.20	2.40	**515.41**
Serotine	0.20	0.40	0.00	0.20	0.40	0.07	0.00	0.00	0.20	0.60	2.10	0.70	0.20	0.00	0.00	**18.90**
Leisler's	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.43**
BLE	0.20	0.00	0.00	0.00	0.20	0.00	0.00	0.14	0.20	1.60	1.57	1.17	0.00	0.40	0.00	**18.22**
Barbastelle	0.00	0.20	3.60	0.40	2.20	0.00	0.40	0.00	0.00	0.20	2.40	2.00	1.37	0.00	0.00	**34.31**
Total	**10.1**	**45.9**	**15.3**	**75.0**	**43.3**	**7.0**	**52.7**	**38.4**	**72.6**	**34.8**	**170.5**	**65.1**	**109.3**	**144.8**	**21.5**	**144045.91**
Species count	8.0	10.0	11.0	11.0	11.0	9.0	8.0	8.0	11.0	12.0	13.0	11.0	10.0	8.0	6.0	

Table 5.12: Values of bat habitat from static monitoring surveys

KEY – A = absent; H = high; L = low; M = moderate; N= none; P = present; red = high value; amber = moderate value; green = low value

Static location	Habitat	Preliminary assessment of habitat value	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
SD1	Arable, adjacent to wet ditch, along a thick hedge-line south of the A14	High	L	L	L	H	M
SD2	Arable land bordered by a thick hedge-line which includes semi-mature trees, in line with a large wet ditch. South of the A14	High	L	L	M	H	M
SD3	Arable with scattered semi-mature trees. Alongside a dry ditch. West of the A1	High	L	L	M	M	M
SD4	Arable predominantly. Small wooded area to the west. West of the A1	High	L	L	N	M	L
SD5	Arable predominantly. Within scattered treeline along field boundary. West of the A1	High	M	L	H	H	H
SD6	Woodland edge/roadside. Adjacent to Lenton Lakes. East of the A1	High	M	L	M	H	H
SD7	Arable edge/roadside. Within a short hedgerow. West of the A1	High	L	L	L	H	M
SD8	Arable. Within scattered treeline of field boundary/dry ditch. West of the A1	High	L	M	M	H	H
SD9	Arable edge/roadside. Within scattered treeline adjacent to field and Buckden Road. East of the A1	High	L	L	H	M	M

Static location	Habitat	Preliminary assessment of habitat value	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
SD10	Wet woodland. Within treeline that borders lake. Adjacent to large wet ditch. River Great Ouse to the east.	High	H	H	M	H	H
SD11	Wet woodland. Within treeline that borders lake. River Great Ouse to the east.	High	H	H	M	H	H
SD12	On tow path of River Ouse. Bordered by treeline/hedge-line consisting of semi-mature and mature trees	High	H	M	M	H	H
SD13	Arable. On the field boundary adjacent to the mainline railway to the west	Low	M	L	L	L	L
SD14	Arable. On the field boundary adjacent to B1043 to the east. Within scattered tree border.	Low	L	L	M	M	H
SD15	Arable. Within large hedgerow bordering field. Scattered semi-mature trees along the hedge-line.	Low	L	L	L	L	L
SD16	Arable. Within large hedgerow bordering field/Silver street. Scattered semi-mature trees along the hedge-line.	Low	L	L	N	L	L
SD17	Arable. Within scattered treeline of field boundary/dry ditch. South of the A14	Moderate	L	L	L	L	L
SD18	Arable/woodland plantation. Within treeline consisting of large mature trees and semi mature trees that border the field. South of the A14	Moderate	L	L	M	M	M
SD19	Arable. Within large hedge-line also consisting of semi-mature trees. South of A14	Moderate	M	L	N	L	L

Static location	Habitat	Preliminary assessment of habitat value	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
SD20	Arable. Within large hedge-line also consisting of semi-mature trees. South of A14	Moderate	M	M	N	M	M
SD21	Arable. Adjacent to a large veteran oak in corner of field that is bordered with hedgerows and dry ditches. South of A14.	Moderate	H	L	L	L	M
SD22	Arable edge/roadside. Adjacent to single carriageway B1040. In line with wet ditch that borders field. South of A14	Moderate	H	M	N	H	H
SD23	Arable. Within semi-mature tree-line that borders the field and the Hilton Road. South of A14	Moderate	H	M	N	M	M
SD24	Arable. In large hedgerow that borders the field. South of A14	Moderate	L	L	N	M	L
SD25	Mixed grassland meadow. Within hedgerow border consisting of some scattered semi-mature trees. South of A14	Low	M	M	N	L	M
SD26	Arable. Within scattered tree-line of mature trees in-line with roadside and wet ditch. South of A14	Low	L	L	N	L	L
SD27	Arable. Within large hedgerow which borders field. North of A14	Low	H	L	L	M	M
SD28	Arable. Within large hedgerow with scattered semi-mature trees. In-line with wet drainage channel/ditch. North of A14	Low	H	L	L	H	H

Static location	Habitat	Preliminary assessment of habitat value	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
SD29	Arable. Within woodland plantation of semi-mature and mature trees which borders the field and runs parallel to A14	Moderate	L	L	N	M	L
SD30	Arable. Within hedgerow that borders field and the A14.	Moderate	L	L	M	M	M
SD31	Arable. Within hedgerow that borders field adjacent to A14	Moderate	L	L	N	L	L
SD32	Arable. Within hedgerow that borders field and runs parallel to A14	Moderate	L	L	L	M	L
SD33	Arable and small woodland plantation. Within semi-mature tree plantation adjacent to A14 and Junction 30.	Moderate	L	L	H	M	M
SD34	Arable. Within broken tree-line of mature cypress trees that borders field. South of A14	Low	M	M	L	M	L
SD35	Arable . Within large thick hedgerow that borders field. South of A14	Low	L	L	H	M	M
SD36	Arable. Located in-line with dry ditch that borders field. South of A428/ West of M11	Moderate	L	L	N	M	L
SD37	Woodland broadleaved. Within scattered tree-line of large wooded area that borders Cambridgeshire Constabulary HQ and Common land. West of A14	Low	L	L	L	L	L

Static location	Habitat	Preliminary assessment of habitat value	Bat activity level	Nathusius	Barbastelle	Species diversity	Overall value
SD38	Common land/livestock pasture. Within tree-line of semi-mature trees that borders the field and back onto the A14 to the South	Low	L	L	N	L	L
SD39	Woodland plantation. Within woodland of semi-mature trees that run alongside A1 and wet ditch. West of A1	High	L	L	N	M	L
SD40	Arable. Within scattered mature tree-line that borders fields and runs alongside wet ditch and A1. East of A1	Low	L	L	L	H	M
SD41	Arable. Within thick hedgerow that borders the fields. East of A1	Low	M	M	H	H	H
SD42	Arable. Within thick hedgerow that borders fields and A1. Location adjacent to large culvert with stream. West of A1/North of A14	Moderate	L	L	H	M	M
SD43	Arable. Within thick hedgerow that borders fields and A1. Location adjacent to large culvert with stream. Fishing lakes to the East. East of A1/North of A14	Moderate	M	L	M	M	M
SD44	Arable. Within mature tree-line that borders the field. Adjacent to guided bus route. Large lake to the West. North of A14	Moderate	M	L	N	L	L
SD45	Semi-mature tree-line and scrub margin between A14 and Housing estate. Adjacent to guided bus route. South of A14	Low	L	L	N	L	L

6 Evaluation

6.1 Bat species

6.1.1 Surveys throughout the scheme and the desktop study have confirmed the presence of the species listed in *Table 6.1*.

6.1.2 Greater and lesser horseshoes and Bechstein's bats were absent, however this is unsurprising as the site is outside the known range of these species. It has been assumed that any long-eared bats recorded on site are brown long-eared as opposed to the rarer grey long-eared due to the restricted range of the latter species in the south of England. There are no records for grey long-eared from the desktop data searches and therefore this is a reasonable assumption.

Table 6.1: Status of UK Bat Species (BCT, 2013)

Species	Abundance	Population estimate	Distribution
Brown long-eared	Common	245,000	Widespread across UK
Common pipistrelle	Common	2,430,000	Widespread across UK
Daubenton's	Common	560,000	Widespread across UK
Soprano pipistrelle	Common	1,300,000	Widely distributed across most of UK
Natterer's	Uncommon	148,000	Widespread through British Isles
Serotine	Uncommon	15,000	Mainly restricted to southern England and Wales
Brandt's	Scarce	30,000	Throughout England and Wales
Noctule	Scarce	50,000	Widespread through England and Wales
Whiskered	Scarce	64,000	Throughout England and Wales, into Scotland and Northern Ireland
Barbastelle	Rare	5,000	Restricted to southern and central England, and Wales
Nathusius pipistrelle	Rare	16,000	Widespread through British Isles

6.2 Known roosts

6.2.1 A total of 12 tree roosts and eight building roosts were identified from field surveys undertaken in 2013 and 2014. No evidence of roosts was recorded in any of the culverts or bridges surveyed. Woodland backtracking surveys identified two confirmed roosts, two likely roosts and three possible roosts. In addition, 36 roosts are known to be located within 1km of the scheme through desktop studies and surveys undertaken to inform the ES for the A14 Ellington to Fen Ditton scheme (Atkins, 2009). Two of these roosts (crack willow adjacent to river Great Ouse and tree roost in oak east of Madingley Road) are in close proximity to the scheme.

6.2.2 The value of these roosts has been assigned based on the species of bat present and the type of roost in accordance with Wray *et al.* (2007), (*Table 6.2*). Where there is uncertainty about the species present, it has been assumed the least common of the possible species was present (i.e. for *Myotis* species it is assumed bats were whiskered/Brandt's which are scarce).

Table 6.2: Summary of confirmed roosts

Reference	Bat species	Species status	Evidence	Roost type	Value
Crack willow adjacent to river Great Ouse	Common pipistrelle	Common	Emergence of one common pipistrelle during surveys in 2008 (Atkins, 2009).	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree roost in oak east of Madingley Road	Common pipistrelle	Common	Emergence of two common pipistrelles during surveys in 2008 (Atkins, 2009).	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree BT3.1b	Brown long-eared/*Myotis* species	Scarce	Droppings observed during climbing survey. No bats observed during two dusk/dawn (D/D) surveys.	Summer roost for small numbers of a scarce species. Not a maternity roost.	District
Tree BT12.3	*Pipistrelle* species	Rare	One bat observed during climbing surveys. No bats observed during dawn survey.	Summer roost for small numbers of a rare species. Not a maternity roost.	District
Tree J2.1	Brown long-eared/*Myotis* species	Scarce	Droppings observed during climbing surveys. No bats observed during two D/D surveys.	Summer roost for small numbers of a scarce species. Not a maternity roost.	District
Tree K2.5	*Pipistrelle* species	Rare	Droppings observed during climbing surveys. No D/D surveys undertaken.	Summer roost for small numbers of a rare species. Not a maternity roost.	District

Reference	Bat species	Species status	Evidence	Roost type	Value
Tree BP1.5	Natterer's	Uncommon	One bat observed during climbing surveys. One D/D survey undertaken.	Summer roost for small numbers of an uncommon species. Not a maternity roost.	District
Tree 21	Common pipistrelle	Common	Two bats seen entering tree roost during second of three D/D surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree BT2.3	Brown long-eared bat	Common	Four bats seen entering tree roost during first and second of three surveys. At least two holes being used.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree BT2.4	Brown long-eared bat	Common	Two bats seen entering tree roost, with a possible further three entering roost during first of three D/D surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree BT6.3c	Soprano pipistrelle	Common	One bat seen entering tree roost on first of three D/D surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree J2.19	Soprano pipistrelle	Common	One bat seen emerging from tree roost during first of three D/D surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Tree T9.1	*Pipistrelle sp.*	Rare	One bat probably seen emerging from tree roost second of four D/D surveys.	Summer roost for small numbers of a rare species. Not a maternity roost.	District

Reference	Bat species	Species status	Evidence	Roost type	Value
Tree J5.3	Common pipistrelle	Common	One bat seen emerging from tree roost during first of two surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
B.26 Crematorium	Common pipistrelle, *Pipistrelle sp*., and brown long-eared (BLE) bats	Common	BLE feeding perch within porch of main crematorium. Individual common pipistrelle and Pipistrelle sp. roosting within the building, and four BLE roosting behind a memorial stone. BLE and common pipistrelle maternity roost previously recorded (desktop records; Atkins, 2013b).	Summer roost for small numbers of a common species (common pipistrelles) and maternity roost for a common species (BLE).	County
B.27 Cemetery barn	Common and soprano pipistrelles	Common	Individual bats of each species emerging from or returning to roost during three of four surveys.	Summer roost for small numbers of a two common species. Not a maternity roost.	Local
B.31 The Cottage, Offord Road	Common pipistrelle	Common	One bat recorded returning to roost during two of four surveys.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
B.41A House on golf course	Unknown	Likely common	Droppings recorded on one survey.	Likely summer roost for small numbers of a (likely) common species. Not a maternity roost.	Local

Reference	Bat species	Species status	Evidence	Roost type	Value
B.41B Barn at Menzies Cambridge golf course	Brown long-eared	Common	Suspected emergence of a single bat on 13 August 2014.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
B.41C Barn at Menzies Cambridge golf course	Common pipistrelle and soprano pipistrelle. Possible brown long-eared.	Common	Non-echolocating bats emerged on 17 July 2014. Bat droppings behind cladding. Soprano pipistrelle emerged during same survey. Emergence of possible Pipistrelle sp. or BLE during second survey. Emergence of single common pipistrelle on 13 August 2014. Re-entry of a single common pipistrelle on 14 August 2014and 19 August 2014.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
B.43E Hacker's Fruit Farm	Common pipistrelle	Common	Possible emergence on 21 August 2014.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
B.45H Barn at Grange Farm	Common pipistrelle	Common	Suspected emergence of a single bat on 12 August 2014. Emergence of two or three bats on 20 August 2014.	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 2 (likely roost)	Common pipistrelle	Common	Likely that bat roosted within woodland	Summer roost for small numbers of a common species. Not a maternity roost.	Local

Reference	Bat species	Species status	Evidence	Roost type	Value
Woodland 3	Soprano pipistrelle	Common	Single bats suspected to roost in tree	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 3 (likely roost)	*Pipistrelle sp.*	Common	Likely that a bat returned to roost	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 7 (possible roost)	Common pipistrelle	Common	Potential emergence of four bats	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 7	Soprano pipistrelle	Common	Roost in dead tree	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 9 (possible roost)	Common pipistrelle	Common	Possible emergence from a large oak tree	Summer roost for small numbers of a common species. Not a maternity roost.	Local
Woodland 9 (possible roost)	Soprano pipistrelle	Common	Potential roosts	Summer roost for small numbers of a common species. Not a maternity roost.	Local

6.3 Potential roosts

6.3.1 The level of survey effort undertaken for buildings and culverts gives high confidence that all bat roosts within these structures would have been identified. Possible exceptions are occasional night roosts or day roosts used at low frequencies however these are of low value to bats and are unlikely to alter the results of the valuation of the site for bats.

6.3.2 Tree roosts are highly transitional (a strategy thought to be used by bats to reduce the likelihood of parasitism and predation) and therefore the chance of detection of a tree roost is reduced in comparison to other structures as the likelihood of presence during any one survey is reduced. For example, for four known tree roosts surveyed for the *A23 Handcross to Warninglid widening environmental statement* (Jacobs, 2013), bats were present during one out of nine surveys, three out of eight surveys, two out of eight surveys, and six out of ten surveys for each of the trees surveyed between 2006 and 2013.

6.3.3 In addition, it is possible the scheme will result in the loss of multiple trees with bat roost potential in any one particular area and therefore there is potential for a greater impact on the local population. It is therefore important to assume a proportion of potential roosts may be used by roosting bats at one time or another.

6.3.4 A total of 38 category 1* trees and 137 category 1 trees have been identified within 100m of the scheme, with a further nine category 1 trees associated with the perimeters of borrow pits. These have potential to be used by the following tree roosting species which are known to be present within the site from transect and static surveys; common pipistrelle, soprano pipistrelle, Nathusius pipistrelle, Brandt's bat, whiskered bat, Natterer's bat, noctule, serotine, brown long-eared and barbastelle. These potential roost sites trees are considered of local value to the local bat population.

6.3.5 Surveys of the culverts and bridges did however provide an indication of potential roost sites nearby (albeit not within the structure itself). Both noctule and pipistrelle social calls, were recorded, particularly on SD5 (at Feature 37, A1 overbridge) in July, with some pipistrelle vocalisations associated with young, indicating the presence of a maternity roost nearby. *Nyctalus sp.* was recorded at 05:08 on 17 July 2014, three minutes after sunrise, also indicating that a *Nyctalus sp.* (likely noctule considering the volume of calls) was roosting nearby. Noctules are unlikely to be roosting in the bridge itself as this species typically roosts in trees.

6.3.6 The timings of calls did not indicate the presence of a pipistrelle roost at feature 37, with no calls being recorded near to sunset or sunrise.

6.3.7 Neither barbastelle nor Nathusius pipistrelle (both primarily woodland roosting bats) were recorded within the woodlands surveyed by backtracking surveys which may indicate that bats of these species recorded commuting within/foraging within the site during other surveys have commuted from woodlands outside of the study area where they roost.

6.3.8 However, barbastelle and Nathusius pipistrelle recordings from static detectors located near woodlands subject to backtracking surveys (woodlands 1, 2b, 3, 4a and 4b, 5 and 7) have been reviewed. Recordings of bats within one and a half hours of sunset or sunrise (i.e. calls close to emergence or re-entry of roosts) were identified as these may indicate proximity to a roost. Where no such recordings exist, this increases the likelihood of the woodlands not supporting roosts of these two rare species.

6.3.9 Woodland 1 is located adjacent to detector 44. This recorded only three Nathusius pipistrelles and no barbastelles over the three months surveyed. Only one of these calls was within one and a half hours of sunset/sunrise and so it is unlikely woodland 1 is used by roosting barbastelles or Nathusius pipistrelles.

6.3.10 Woodland 3 is located between detectors 34 and 35 and woodland 2b is located adjacent to detector 35. These recorded two barbastelle and 45 Nathusius pipistrelle, and 11 barbastelle and 22 Nathusius pipistrelle calls respectively. Of these, only a single barbastelle calls (from detector 34) was recorded within one and a half hours of sunset/sunrise. However, of the Nathusius pipistrelle calls, 40 calls from detector 34 and 6 calls from detector 35 were recorded within an hour and a half of sunset or sunrise. These recordings indicate these detectors are close to Nathusius pipistrelle roosting habitat, possibly within woodlands 3 or 2b.

6.3.11 Detector 33, located close to woodlands 4a and 4b, recorded 27 barbastelle calls but only a single Nathusius pipistrelle call over the five months surveyed. Of the 27 calls, nine were recorded within one and a half hours of sunset/sunrise. These recordings indicate detector 33 is on the flight line to or from a nearby barbastelle roost, possibly within woodlands 4a and 4b however observations from field surveyors indicate the trees within these woodlands lack roosting features.

6.3.12 Detector 28 recorded 41 barbastelle calls and 23 Nathusius pipistrelle calls over the five months' surveys. However this detector is located approximately 1km from woodland 5. Of these calls only one Nathusius pipistrelle was recorded one hour and 27 minutes after sunrise, indicating woodland 5 is unlikely to be used for roosting by either of these two species.

6.3.13 Detectors 17, 18 and 19 located close to woodland 7 recorded low numbers of barbastelle calls (one, four and zero calls respectively) and low numbers of Nathusius pipistrelle calls (seven, nine and nine calls respectively). Only a single barbastelle call was recorded by detector 18 on 12 June 2014, and three Nathusius pipistrelle calls were identified by detector 18 or 19 within one and a half hours either side of sunset/sunrise. It is therefore concluded Woodland 7 is unlikely to support roosts of these species.

6.3.14 Bat activity was highly variable between the months surveyed by the static detectors, even at the same static locations, for example only five bats were recorded within five nights in May at SD13, whereas 2907 bats were recorded over four nights in the same location in August. This is likely to reflect the change in seasonal use of the landscape by bats, likely to be in response to foraging resources although other factors such as weather may have an impact.

6.4 Flight height

6.4.1 Data collected during field surveys suggests the majority of common pipistrelles, soprano pipistrelles and *Pipistrelle* species flying adjacent to (as opposed to across) the A14 were flying at a minimum height of 4m.

6.4.2 Of all the bats observed (both flight across and adjacent to the road), 72 out of 99 were flying at a minimum height of 4m or more, with only 17 flying at 2m or less.

6.4.3 Limited information about the flight height of bats over roads is available in scientific literature. *Stratman (2006)* (cited *Geisler et al., 2009*) identified some species of bats such as *Nyctalus sp.* as open space foragers typically foraging at heights of 10-50m above the ground. Whereas other low flying species including *Myotis sp*., *Eptesicus sp.* and *Pipistrellus sp.* typically forage at 2-6m high (*Schober and Grimmberger 1998, cited Geisler et al., 2009*).

6.4.4 Studies on road casualties give an indication of which are the low flying species most vulnerable to collision with traffic. During a carcass search in 2007 in the Czech Republic and Austria, *Geisler et al. (2009)* found Nathusius pipistrelle and soprano pipistrelle were the most frequently recorded species, followed by Daubenton's bat. This is likely to reflect the abundance of these species as well as their vulnerability due to flight height, as these were also three of the four most frequently recorded species during activity surveys at the same sites. Noctules were also abundant during activity surveys but only a single carcass was located during searches indicating that in general this species flies sufficiently high to avoid impact.

6.4.5 In contrast in a similar study by *Lesinski et al. (2011)*, noctules and brown long-eared bats were the most abundant. Brown long-eared are lower flying species so this is not unsurprising however noctules are thought to be less vulnerable to collision because of their higher flight.

6.4.6 Given the limited data available both from site surveys and scientific publications, a worst case scenario should be assumed for the purpose of impact assessment and mitigation design. Therefore it will be assumed that all of the bat species recorded on site have potential to be impacted by collisions from road traffic along the scheme, although in all likelihood noctules are the least likely to be impacted as generally they do have a much higher flight than other species, despite the evidence from *Lesinski et al. (2011).*

6.4.7 Therefore any areas of high levels of foraging and commuting habitat which have potential for fragmentation by the scheme should be considered in the impact assessment and design of mitigation.

6.5 Foraging and commuting habitat

6.5.1 The following species have been confirmed as foraging within or commuting through the site (ordered from most to least frequently recorded as per the results of the static monitoring surveys at locations SD1 to SD45):

- (bat species);
- common pipistrelle;
- soprano pipistrelle;
- (*Pipistrelle* species);

- noctule;
- Nathusius pipistrelle;
- (*Myotis* species);
- whiskered/Brandt's/Alcathoe;
- barbastelle;
- Daubenton's;
- serotine;
- brown long-eared;
- Natterer's;
- Brandt's;
- whiskered; and
- Leisler's.

6.5.2 Common and soprano pipistrelles were by far the most frequently recorded species within the site with an activity index of 10963.38 and 10268.66 respectively. Ignoring the groups *Pipistrelle sp.* and *Myotis sp.* which would include calls from a range of species, noctules were the next most frequently recorded bat with an activity index of 515.41.

6.5.3 Nathusius pipistrelles were recorded in relatively high numbers (with an activity index of 339.01) considering their rarity and were recorded at every static location surveyed across the site. Static locations 10 and 11 were particular hotspots for this species with activity indices of 66.71 and 88.56 respectively. For SD10 this was due to a very high count of Nathusius pipistrelle in September whereas for SD 11 Nathusius levels were more consistent amongst each month surveyed.

6.5.4 Interestingly, barbastelle activity was higher than the activity levels of some less rare species such as serotine, brown long-eared and Leisler's. A particularly high level of barbastelle activity was recoded at SD5 (discussed below). Barbastelles were recorded during four of the five months surveyed at this location, with particularly high number of calls (25 within five nights) in May. Other locations with high numbers of calls for this species include SD9, SD33, SD35, SD41 and SD42.

6.5.5 The relatively low levels of the individual *Myotis* species (whiskered/Brandt's/Alcathoe/Daubenton's/Natterer's) is likely to be due to the fact most Myotis calls could not be identified to species level, and hence have been grouped as *Myotis sp.*.

6.5.6 The level of brown long-eared activity is likely to have been underestimated due to the fact this species has a particularly quiet echolocation call with a low detectability.

6.5.7 The areas of highest value for bats were SD5, SD6, SD8, SD10, SD11, SD12, SD22, SD28, and SD41. These should be considered key areas to focus mitigation.

6.5.8 SD5 is located on a hedgerow linking Brampton Woods with the scheme. This detector recorded high levels of common and soprano pipistrelles and the highest level (by far) of barbastelle activity recorded throughout the site. The detector also had high species diversity with 13 out of the 16 species/groups being recorded at this location.

6.5.9 SD8 was also valued highly for its species diversity (14 species), moderate activity levels and moderate barbastelle activity. The detector is located on a tree line along a watercourse/ditch which also has connectivity to Brampton Woods.

6.5.10 SD10, SD11, and SD12 are located close to the river Great Ouse and Buckden Gravel Pits County Wildlife Site (areas of high quality foraging habitat). They each recorded high levels of bat activity and a high diversity of species (12, 12, and 13 species respectively). In addition, they all had moderate levels of barbastelle activity and high/moderate levels of Nathusius activity.

6.5.11 SD22 is located approximately 0.25km from Fenstanton Gravel Pits within a predominantly arable landscape. It had high levels of bat activity, moderate levels of Nathusius activity and high species diversity (12 species). As the habitat in the immediate landscape is not of particular note with respect to foraging bats this may be due to the proximity of the gravel pits.

6.5.12 SD28 had high levels of bat activity and high species diversity (12 species) although barbastelle and Nathusius levels were low. The landscape has limited features of particular note for bats although a double hedgerow is present. It is also possible the adjacent sewage works supports a high abundance of invertebrates which may be attractive to bats.

6.5.13 SD6 is valuable for its high species diversity and moderate bat activity and barbastelle levels. SD 41 also had a high species diversity and supported moderate bat activity, Nathusius levels and high barbastelle levels. The high levels of activity at SD6 and SD41 were due to high levels of soprano pipistrelle activity likely to be due to the proximity of the detector to some fishing lakes (soprano pipistrelles have an association with water).

6.5.14 The same species or groups of bats were recorded during transects as in the static monitoring surveys. The relative abundance of each species was broadly similar to the static surveys although fewer barbastelles were recorded compared to other bats.

6.5.15 Transects 3, 5, 13 and 19 are high value for bats. Transect 3 has scored highly due to high levels of bat activity, high species diversity and the presence of high numbers of a rare bat (Nathusius pipistrelle). This correlates with the high value identified from the results of the static monitoring for SD10, 11 and 12 which are in the same vicinity. The high value is due to the presence of high quality bat foraging habitat, the river Great Ouse and Buckden Gravel Pits County Wildlife Site, in this part of the site. These aquatic features and associated surrounding habitat are likely to be an important foraging resource for the local bat population.

6.5.16 Transect 5 scored highly due to moderate levels of activity for a high diversity of bat species, including barbastelles. The habitats around transect 5 are not of particular note for bats although some strips of semi-mature woodland are present.

6.5.17 Transect 13 has scored highly due to medium levels of bat activity, including Nathusius pipistrelle, the presence of barbastelle bats, and a high species diversity. The transect was valued higher than the results of the static detector (SD36) in this area are species diversity and bat and Nathusius levels were higher during the transect surveys. The high activity level was due to high activity from common, soprano and Nathusius pipistrelles. Nathusius pipistrelle is primarily a woodland bat (Altringham, 2003) and so its presence in a primarily arable habitat can only be attributed to the small blocks of broadleaved plantation in the vicinity. The other pipistrelle species will utilise the hedgerows which are present however it is unclear why activity levels are so high here compared to other areas of the site which are comparable in habitat type.

6.5.18 Transect 19 has scored highly due to high levels of bat activity, including moderate Nathusius pipistrelle activity, and high species diversity. As per transect 3, this is likely to be due to the presence of high quality bat foraging habitat because of its proximity to a large lake. Woodland 1, which is also in this vicinity, was also valued as high for bats and contributes to the interest in this area. Superficially this feature would appear to be valuable for bats as it provides a strong commuting line under the A14 to potential foraging habitat to the north, however, SD44 and SD45 located to the west on the Impington guided busway were valued low for bats. There is some lighting to the east of the A14 which may affect its suitability for bats, however much of the busway is unlit. Surveys of the bridge (see below) have shown bats commuting underneath the bridge.

6.5.19 The majority of the other transects had similar, moderate, values for bats (including the transect in Huntingdon town centre). Exceptions were transects 15, 16 and 18, either side of the A1 to the north of Brampton Interchange, transect 6 which is located on an offline section of the proposed scheme, and transect 10 located north-west of the existing A14 which were all assigned a low value. This is generally as a result of low levels of bat activity and an absence of rare species (although a barbastelle was recorded on transect 10).

6.5.20 Based on the results from the transect surveys, land around transects 3, 5, 13 and 19 should be considered priorities for mitigation.

6.5.21 Of the bridges and culverts surveyed, the following were identified as being used by commuting bats:

- Impington guided busway bridge (Feature 6) – common and soprano pipistrelles recorded commuting under the bridge under the A14.
- Girton A14 bridge west (Feature 14) - common and soprano pipistrelles recorded commuting under the footbridge under the M11.
- Huntingdon Life Sciences northern culvert (Feature 28) – common pipistrelles commuting under the A1.

- Northern culvert (Feature 29) - common pipistrelles commuting under the A1.
- Ellington Brook (Feature 31) – soprano pipistrelles commuting over the A1, *Nyctalus sp.* And brown long-eared bats commuting through the culvert.
- A1 overbridge (Feature 37) – common and soprano pipistrelles commuting under bridge. Soprano pipistrelles commuting over A1.

6.5.22 Activity levels at the three structures monitored remotely (Girton A14 bridge west, Beck Brook culvert and the A1 overbridge) varied significantly.

6.5.23 Detectors at the A1 overbridge (Feature 37) recorded the highest activity and had the greatest diversity of species (up to ten species). The land around SD5A is valued as high for bats, based on species diversity and activity levels, whereas the land around SD6A is valued as moderate due to its slightly lower diversity and activity levels. Species recorded included common pipistrelle, soprano pipistrelle, *Myotis sp.*, probable brown long-eared bat, big bat (*Nyctalus* sp. or *Eptesicus* sp.), *Nyctalus* sp. (Leisler's or noctule), and noctule. The majority of activity was from common pipistrelle, and included foraging, commuting and social calls.

6.5.24 It is considered that Feature 37 and the adjacent habitats provide valuable foraging and commuting habitat for pipistrelles and noctules.

6.5.25 Feature 14 (SD1A and SD2A) had low activity levels and species diversity and so the land around detectors SD1A and SD2A is considered low value for bats. Species recorded comprised common and soprano pipistrelle, unconfirmed pipistrelle species, noctule, probable Leisler's bat and probable Daubenton's bat. In June, most activity was recorded by the detector located to the east of the M11 bridge (SD1A), with very little activity to the west of the M11 bridge. The results indicate that bats were not utilising the bridge for commuting or foraging, which corroborates the results of the emergence, return and activity surveys. The activity was most likely associated with the field edges to the east of the M11.

6.5.26 A low level of bat activity was recorded at SD3A whereas moderate activity and a higher species diversity were recorded at SD4A (Feature 15, Beck Brook). Noctule and Leisler's bat were recorded to the east of the M11 (SD3) with the following additional species recorded to the west of the M11 (SD4), common and soprano pipistrelle and *Pipistrelle sp*..

6.5.27 Of the woodlands surveyed (backtracking surveys) woodland 1 (Impington Guided Busway), woodland 2A (Girton Ramp), woodland 3 (Cambridge Crematorium), woodland 5 (Down Spinney) and woodland 7 (unnamed) were valued as high for foraging bats due to the high diversity of bat species supported and the abundance of these species. Woodlands 2B, 4a and 4b and 9 were valued as moderate for foraging bats.

6.5.28 Using the *Chartered Institute of Ecology and Environmental Management guidance on Ecological Impact Assessment 2006* and with reference to the paper '*Valuing Bats in Ecological Impact Assessment*' (*Wray et al., 2007*), bats within the scheme area have been evaluated as being of district value.

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