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## Appendix J Biodiversity

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# **Defence Infrastructure Organisation**

## **Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester**

Baseline Biodiversity Report  
(Appendix to BIC/OPA/DOC10)

September 2011

AMEC Environment & Infrastructure  
UK Limited





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# Defence Infrastructure Organisation

## Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester

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(Appendix to BIC/OPA/DOC10)

September 2011

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UK Limited



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# 1. Introduction

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## 1.1 Background

- 1.1.1 Defence Infrastructure Organisation is seeking to carry out two developments within the existing Bicester Garrison. The first of these covers land on sites formerly known as D Site, E Site and Graven Hill Hilltop (collectively referred to as the Graven Hill Site (central grid references SP588 204) whilst the second development is to occur at C Site (SP606173). See Figure 1.1 for site locations. AMEC Environment and Infrastructure UK Ltd (AMEC) has been appointed to gather baseline ecological data to inform the masterplans for each of these sites, with the aim of informing the scheme design so as to minimise potential negative effects on the habitats and species (collectively referred to as biodiversity within this report) resulting from the proposed developments.

## 1.2 Purpose of this report

- 1.2.1 To inform the environmental impact assessment that will accompany the application for the development of the Graven Hill and C Site an extended Phase 1 habitat survey of the sites was carried out in 2008. This survey identified the presence and/or potential for presence of a number of legally protected and/or priority species (See Box 2.1) on-site or within 2km of the site boundary. Recommendations for detailed surveys for the following species/groups of species were made:
- badger (*Meles meles*) (including a bait marking survey);
  - bats;
  - water vole (*Arvicola amphibious*);
  - dormouse (*Muscardinus avellanarius*);
  - great crested newt (*Triturus cristatus*);
  - reptiles;
  - invertebrates; and
  - birds
- 1.2.2 The Phase 1 habitat survey and desk studies were updated in July 2011 in line with best practice due to the lengthy period between the initial survey and the submission of the planning application.



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- 1.2.3 The remainder of this report presents the methodologies for carrying out the desk study, extended Phase 1 Habitat survey and individual species/group of species surveys. The results of these surveys are also presented. A separate confidential report details the findings of the badger surveys.
- 1.2.4 This report does not discuss the implications of the presence of these species on the scheme design, provide an assessment of the biodiversity value of each receptor or consider the potential effects of the development proposals - these are presented in Chapter 12 of the Environmental Statement (ES).





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## 2. Habitat survey

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### 2.1 Methodology

- 2.1.1 The methodology comprises both a desk study and a Phase 1 habitat survey, extended to include recording of the presence or potential for presence of protected and/or priority species.

#### Desk study

- 2.1.2 Citations and boundary information for local statutory and non-statutory nature conservation sites were obtained from Natural England (<http://www.natureonthemap.naturalengland.org.uk/>) and the government environmental information partnership project, MAGIC (<http://magic.defra.gov.uk/>). Information on areas of ancient woodland and other priority habitat types not included within notified sites were also obtained from MAGIC and from examination of aerial photographs (Microsoft website: <http://local.live.com>).
- 2.1.3 The Thames Valley Environmental Records Centre (TVERC) and Buckinghamshire and Milton Keynes Records Centre were contacted in December 2007 and February 2008 for records of protected and priority species within 2km, and records of non-statutory sites within 1km of the site boundaries. In addition, the Oxfordshire bat, badger and herpetofauna groups were consulted in February 2008 to determine whether they held additional records of protected species within 2km of the site boundaries (records for bat roosts within 2km of the sites were supplied by the bat group). The county mammal recorder for Oxfordshire was not consulted, as mammal society information is shared with TVERC.
- 2.1.4 An additional data request was made to TVERC, Oxfordshire Bat Group and Buckinghamshire and Milton Keynes Records Centre in July 2011 for any new records that have been collected since February 2008. Furthermore, the search area was extended (in line with current best practice) to cover land to a distance 10km from the site boundaries for international statutory nature conservation sites (i.e. Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) and 5km for records of bat roosts.
- 2.1.5 Furthermore a map based exercise was carried out to identify potential GCN (*Triturus cristatus*) aquatic habitat located within 500m of the sites. This was achieved by studying 1:10,000 OS maps, and aerial photographs of the area (Microsoft website: <http://local.live.com>) to identify any waterbodies that occur. In the absence of any barrier to the species' movement between such a water body and the site (main roads, rivers etc.), the potential for the site to provide terrestrial habitat for the species, and



the presence of habitat links between the water body and the site, were assessed during the site survey.

### **Extended Phase 1 Habitat survey**

- 2.1.6 A Phase 1 Habitat survey of the two sites, including land within 100m of the site boundaries where accessible, was undertaken by a team of AMEC ecologists between 4 and 15 February 2008. This was updated on the 19 and 21 and 28 July 2011. Distinct habitats were identified and mapped, and any features of nature conservation interest were subject to a more detailed description in a target note<sup>1</sup>. As the standard Phase 1 Habitat survey methodology is concerned only with vegetation and other land cover, the survey was also extended<sup>2</sup> to collect information about legally protected and other priority species. The methodologies used to establish the presence or potential for presence of such species are summarised below (relating to those species that the desk study or habitats present indicated could occur on the site).

#### **Badger**

- 2.1.7 The sites and features within the sites were assessed for their suitability for badger foraging and sett building, and any signs of badger activity were noted. Such signs include setts, badger trails, snuffle holes, latrines and badger hairs.

#### **Bats**

- 2.1.8 A broad preliminary assessment of the trees and structures on the sites to provide potential suitable habitat for roosting bats was made. This involved a brief visual examination of buildings for features such as roof voids, hanging tiles and soffit boxes, and of trees for cavities, flaking bark etc. An assessment was also made of the suitability of the habitats present to support bat foraging and commuting between roosts and foraging areas.

#### **Water vole and otter**

- 2.1.9 An assessment was made as to whether the watercourses and waterbodies that occur on-site, adjacent to the sites or which are hydrologically linked to the sites, have the potential to support water vole and otter.

#### **Birds**

- 2.1.10 An assessment was made of the sites' potential to support breeding birds and/or wintering birds, as well as any birds of conservation interest or priority species.

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<sup>1</sup> Joint Nature Conservancy Council (1995) *Handbook for Phase 1 Habitat Survey*. Joint Nature Conservancy Council, Peterborough.

<sup>2</sup> Institute of Environmental Assessment (1995) *Guidelines for Ecological Assessment*. Chapman and Hall, London.



## Reptiles

- 2.1.11 An assessment was made of the potential for habitats on the sites to support reptiles of any species.

## Great crested newt

- 2.1.12 Each water body located on-site and within 500m of the sites (where access had been agreed) was visited during the survey and an assessment made of whether the water body had the potential to support GCN. The criteria used to determine the suitability of the water body for GCN was based on the criteria outlined in the Habitat Suitability Index (HSI). In applying these criteria a precautionary approach was adopted.

## Other priority species

- 2.1.13 An assessment was made of the potential for habitats within the sites to support other species of interest particularly if a species of note (see Box 2.1) had, through the desk study, been identified as occurring within the vicinity of the site.

## 2.2 Legislation and Policy Context

- 2.2.1 Certain sites of international or national importance for nature conservation, as well as many species of animal and plant, are afforded some degree of legal protection. These are outlined in Box 2.1, along with non-statutory designations relating to the conservation of biodiversity.

### Box 2.1 Designated wildlife sites and protected and otherwise priority habitats and species

Box 2.1	Designated wildlife sites and legally protected/ conservation priority species
<b>Graven Hill lies within Oxfordshire, whilst C Site lies within Buckinghamshire.</b>	
<b>Statutory nature conservation sites</b>	
Natural England notifies sites that are of international or national importance for nature conservation as Sites of Special Scientific Interest (SSSIs). Internationally important sites may also be designated as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) or Ramsar sites. National Nature Reserves (NNRs) and Local Nature Reserves (LNRs) are also statutory sites which are of importance for recreation and education as well as nature conservation.	
<b>Non-statutory nature conservation sites</b>	
Non-statutory nature conservation sites in Buckinghamshire are notified as Local Wildlife Sites (LWS)s. These sites are designated alongside the statutorily protected areas, as they constitute the most important sites for wildlife in each county. In Oxfordshire, the term <i>County Wildlife Site</i> (Oxon) is used.	
<b>Legally protected species</b>	
Many species of animal and plant receive some degree of legal protection. For the purposes of this study, legal protection refers to:	
<ul style="list-style-type: none"> <li>species included on Schedule 1 of the <i>Wildlife and Countryside Act 1981</i> (as amended) that could breed in the Oxford area, and species on Schedules 5 and 8 excluding species that are only protected in relation to their sale (see Section 9[5] and 13[2]), reflecting the fact that the proposed development does not include any</li> </ul>	



proposals relating to the sale of species;

- species included on Schedules 2 and 5 of *The Conservation of Habitats and Species Regulations 2010 (SI 2010 No. 490)* (known as the Habitats and Species Regulations); and
- badgers, which are protected under the *Protection of Badgers Act 1992*.

#### Habitats and species of nature conservation value

A number of habitats and species, whilst not receiving statutory/legal protection, are of nature conservation importance. These are referred to in this report as 'priority habitats and species', and include the following:

- UK, county and local Biodiversity Action Plan (BAP) priority habitats and species;
- Habitats and species of principal importance for the conservation of biological diversity in England, prepared by the Secretary of State for Environment, Food and Rural Affairs as required under section 41(1) of the *Natural Environment and Rural Communities (NERC) Act 2006*;
- Species listed in the relevant UK Red Data Book (RDB);
- Nationally Scarce species, which are species recorded from 16-100 10km squares of the national grid;
- Important hedgerows as defined using the habitat criteria in *The Hedgerows Regulations 1997*; and
- Ancient woodland.

## 2.3 Survey constraints

- 2.3.1 It should be noted that the original Phase 1 Habitat survey was undertaken in February which is not the optimum time of year to conduct Phase 1 habitat surveys, as many floral species will not be visible or identifiable at this time of year. However the survey were updated in July 2011 to ensure that the February survey had adequately identified the habitat and species of conservation interest present on the site.
- 2.3.2 Note that although some trees with potential as bat roosts have been highlighted in the survey notes for the Phase 1, given the size of the survey area and extent of the woodland and scattered trees present, it was not possible to note all such trees. Similarly, it was beyond the scope of this study to inspect every building in detail for potential bat roost sites. Bats are dealt with in detail within the bat chapter (Chapter 3) of the report.
- 2.3.3 Access to private non-MOD land surrounding the sites was limited; therefore many of the habitats within the 100m zone surrounding the sites had to be assessed from the site boundary and from aerial photographs.

## 2.4 Results - Graven Hill

### Site context

- 2.4.1 The Graven Hill site comprises the secure Bicester Garrison and areas of woodland and agricultural land (used for grazing cattle or to provide a hay crop). The site is largely surrounded by agricultural land, with suburban housing immediately to the north, from which it is separated from the site by the busy A41 trunk road. A railway



line running along the northwest boundary of the site separates it from a sewage works.

## Desk study results

### Designated sites and land classifications

2.4.2 Although there are no European protected nature conservation sites located within 10km of the site boundary, there are five statutory nature conservation sites located within 5km of the site boundary. Table 2.1 presents an overview of these. The full citations for the sites are provided in Appendix A. The locations of these sites are shown in Figure 2.1.

**Table 2.1 Statutory designated sites within 5km of the Graven Hill site**

Site type	Name	Area (ha)	NGR	Distance from site boundary	Summary of interest feature <sup>1</sup>
SSSI	Arncott Bridge Meadows	8.66	SP 608 185	1630m south-east	This site comprises medieval ridge and furrow features. The species-rich flora is attributable to variations in soil wetness.
SSSI	Wendlebury Meads and Mansmoor Closes	73.2	SP562175	2828m south-west	This site comprises a series of traditionally-managed unimproved neutral meadows, supporting a complex variety of plant communities that have developed due to varying management, drainage and soils.
SSSI	Stratton Audley Quarries	8.7	SP600254 and SP602250	3739m north	A large part of the Jurassic White Limestone as well as the entire Forest Marble and Lower Cornbrash have been exposed by quarrying at Stratton Audley.
SSSI	Otmoor	211.6	SP575130	4640m south	Otmoor is a large bowl shaped area of land on the flood plain which until recent times comprised an extensive area of wetland which flooded in winter and was traditionally managed as rough grazing marsh. Much of the land outside the special area has been drained and converted to arable or improved pasture.
LNR	Bure Park	8.39		2165m north	This site comprises the River Bure and associated ponds, mature hedgerows trees, scrub and meadows.

2.4.3 Table 2.2 presents the non-statutory designated sites located within 1km of the site boundary. The locations of these sites are shown on Figure 2.2. One of these, an ancient woodland site (Graven Hill Wood CWS), is located within the centre of the Graven Hill study area. Also the results demonstrate that Bicester wetland reserve is located almost adjacent to the western site boundary (within 40m). This reserve is important for over-wintering wildfowl and there may be a significant degree of ecological interaction between the reserve and the Graven Hill study area.



- 2.4.4 Reference to MAGIC demonstrates that the Graven Hill site is within 280m of the 'Upper Thames Tributaries' Environmentally Sensitive Area (ESA).

**Table 2.2 Non-statutory designated sites within 1km of the Graven Hill site**

Site type <sup>1</sup>	Name	Area (ha)	NGR	Distance	Summary of interest feature
County Wildlife Site (CWS)	Graven Hill Wood	16.3	SP 588 209	0m central to Graven Hill site	This site comprises an area of ancient woodland with an oak/ash canopy with understorey of hazel ( <i>Corylus avellana</i> ), hawthorn ( <i>Crataegus monogyna</i> ), spindle ( <i>Euonymus europaeus</i> ) and wayfaring-tree ( <i>Viburnum lantana</i> ). Ground flora includes bluebell ( <i>Hyacinthoides non-scripta</i> ), dog's mercury ( <i>Mercurialis perennis</i> ), wood anemone ( <i>Anemone nemorosa</i> ), primrose ( <i>Primula vulgaris</i> ) and yellow archangel ( <i>Lamium galeobdolon</i> ). Birds of conservation interest noted on site include willow warbler ( <i>Phylloscopus trochilus</i> ) and grasshopper warbler ( <i>Locustella naevia</i> ).
CWS	Bicester Wetland Reserve	7.7	SP 577 262	40m northwest	<p>This site is mostly maintained as wet grassland by outfall from sewage works. Also a drier field and small area of reedbed occur. The site is important for overwintering wildfowl.</p> <p>The site supports a number of birds of conservation concern including teal (<i>Anas crecca</i>), pochard (<i>Aythya farina</i>), gadwall (<i>Anas strepera</i>), pintail (<i>Anas acuta</i>) and wigeon (<i>Anas penelope</i>), snipe (<i>Gallinago gallinago</i>) and water rail (<i>Rallus aquaticus</i>).</p> <p><i>Wetland plant species:</i> purple loosestrife (<i>Lythrum salicaria</i>), wild angelica (<i>Angelica sylvestris</i>), water figwort (<i>Schrophularia auriculata</i>), common reedmace (<i>Typha latifolia</i>), celery-leaved water crowfoot (<i>Ranunculus sceleratus</i>), water mint (<i>Mentha aquatica</i>), water chickweed (<i>Myosoton aquaticum</i>), redshank (<i>Persicaria maculosa</i>), reed canary-grass (<i>Phalaris arundinacea</i>), common reed (<i>Phragmites australis</i>), reed sweet-grass (<i>Glyceria maxima</i>), jointed rush (<i>Juncus articulatus</i>), soft rush (<i>Juncus effusus</i>), hard rush (<i>Juncus inflexus</i>) and false fox sedge (<i>Carex obtrubae</i>).</p>
CWS	Meadows Northwest of Blackthorn Hill	3	SP 613 213	1000m northeast	This site comprises flower-rich hay meadows with damp areas and evidence of "ridge and furrow" landscape features. Plant species include yellow-rattle ( <i>Rhinanthus minor</i> ), common-spotted orchid ( <i>Dactylorhiza fuchsia</i> ), oxeye daisy ( <i>Leucanthemum vulgare</i> ), knapweed ( <i>Centaurea</i> sp.) and marsh bedstraw ( <i>Galium palustre</i> ).

### Other priority habitat types

- 2.4.5 Reference to MAGIC demonstrates that there are three areas of lowland grazing marsh (BAP priority habitat) within 2km of the study area. There are also several patches of broad-leaved and coniferous woodland, including an area of ancient woodland (Graven Hill Wood, within the site boundary). The landscape surrounding the study area is rural with grassland and to a lesser extent, arable land-use dominating. Most of



the fields in the surrounding landscape are delineated by hedgerows and standard trees.

### Protected and otherwise priority species

2.4.6 The key species records for Graven Hill are summarised below whilst tables with full details of the biological records obtained for each study area are presented in Appendix B, apart from badger records which are listed in a confidential report (the latter should not be placed in the public domain, to avoid potential for illegal interference with setts).

2.4.7 Key species records for Graven Hill:

- **Brown long-eared bat (*Plecotus auritus*):** Records of a roost and grounded bat in the Ambrosden area, approximately 970m from the site boundary. There are four bat boxes containing brown long-eared bats 5km south of the site all recorded in 2002 at Whitecross Green Wood;
- **Leisler's bat (*Nyctalus leisleri*):** One record of a grounded bat in Ambrosden;
- **Natterer's bat (*Myotis nattereri*):** One record of a roost over 2km from the site boundary;
- **Pipistrelle (*Pipistrellus* sp.) bat:** One record of a roost, 900m from the site boundary from 2002; and one record of a grounded bat from Ambrosden;
- **Grass snake (*Natrix natrix*):** One record dated July 1987;
- **Great crested newt (*Triturus cristatus*):** One record from a pond in Ambrosden, approximately 940m southeast of the site boundary, dated 2002. Smooth newts (*Triturus vulgaris*) are also associated with this pond;
- **Wildlife & Countryside Act, Schedule 1 bird species associated with the Bicester Wetlands Reserve (CWS):** Pintail, bittern (*Botaurus stellaris*), merlin (*Falco columbarius*), hobby (*Falco subbutteo*), peregrine, little ringed plover (*Charadrius dubius*), black-tailed godwit (*Limosa limosa*), green sandpiper (*Tringa ochropus*), greenshank (*Tringa nebularia*), barn owl and kingfisher (*Alcedo atthis*). These records were all registered between 2000 and 2004;
- **UK BAP priority bird species:** Lapwing (*Vanellus vanellus*), curlew (*Numenius arquata*), cuckoo (*Cuculus canorus*), yellow wagtail (*Motacilla flava*), grasshopper warbler, marsh tit (*Parus palustris*), willow tit (*Parus montanus*), linnet (*Acanthis cannabina*), twite (*Carduelis flavirostris*), yellowhammer (*Emberiza citrinella*) and reed bunting (*Emberiza schoeniclus*). These records were all registered between 2000 and 2004;
- **UK BAP priority and nationally scarce invertebrate species:** The ground beetle (*Bembidion quadripustulatum*), grizzled skipper (*Pyrgus malvae*), wall moth (*Lasiommata megera*) and a rove beetle (*Philonthus fumarius*). These records date from January 2003 and are associated with the Gavray Drive complex (Bicester).



There are also records of black hairstreak (*Satyrrium pruni*) and brown hairstreak (*Thecla betulae*) butterflies.

- **Other UK BAP priority species:** Common toad (*Bufo bufo*) and hedgehog (*Erinaceus europaeus*) were recorded near to Ambrosden in 1993 and 2005 respectively; and

### Waterbodies within 500m of the site

- 2.4.8 Analysis of Ordnance Survey maps and aerial photographs revealed that there are a total of 30 waterbodies located on-site and 22 waterbodies located within 500m of the site boundary (including three within St. David's Barracks).

## Extended Phase 1 Habitat survey

### General description

- 2.4.9 The site is set on a hill rising out of an otherwise largely flat agricultural landscape. It comprises a set of fenced compounds, a barracks site with residential accommodation and sports facilities, warehouses, office buildings and hardstanding. Areas of species-poor, semi-improved grassland, amenity grassland, scrub, standard trees and hedgerows, drains and waterbodies also occur on-site. There are also a number of areas of coniferous, mixed and broad-leaved woodland/plantation. Two areas of woodland occur on-site, one of these areas is classified as wet woodland whilst the other is notified as Graven Hill Wood CWS.

### Description of on-site habitats

The Phase 1 habitat map for this site is presented in Figure 2.3.

- 2.4.10 *Amenity grassland:* The majority of the secure area at Graven Hill comprises large areas of amenity grassland that are closely mown and support common grass species such as, false oat-grass (*Arrhenatherum elatius*), Yorkshire fog (*Holcus lanatus*), fescues (*Festuca* spp.) and annual meadow grass (*Poa annua*), whilst herbs mostly comprise common bird's-foot-trefoil (*Lotus corniculatus*), meadow vetchling (*Lathyrus pratensis*), self-heal (*Prunella vulgaris*), red clover (*Trifolium pratense*), creeping buttercup (*Ranunculus repens*), creeping cinquefoil (*Potentilla repens*), daisy (*Bellis perennis*), ribwort plantain (*Plantago lanceolata*) and crane's-bills (*Geranium* spp.). Occasional wet patches within the amenity grassland support small clumps of rushes (*Juncus* spp.).
- 2.4.11 *Standard trees:* Broad-leaved standard trees are scattered throughout the site, with well spaced rows of trees along many of the main roads within the garrison. Tree species include horse chestnut (*Aesculus hippocastanum*), cherry (*Prunus* sp.), pedunculate oak (*Quercus robur*), common lime (*Tilia europaea*) and weeping willow (*Salix babylonica*).





- 2.4.12 *Scrub*: Areas of scrub around the site mostly comprise European gorse (*Ulex europaeus*), hawthorn (*Crataegus monogyna*), bramble (*Rubus fruticosus* agg.) and crab apple (*Malus sylvestris*).
- 2.4.13 *Hedges*: The hedgerows located on-site are generally species-poor and dominated by hawthorn with some blackthorn and elder (*Sambucus nigra*). Their structure varies, with some being unmanaged to a height of 4m, whilst others are gappy. Some hedges are flanked by ditches, whilst others are fenced. Mature standard trees located within the hedgerows are predominantly oak and ash (*Fraxinus excelsior*). The hedgebank flora contains an abundance of tufted vetch (*Vicia cracca*), common bird's-foot-trefoil, common nettle (*Urtica dioica*), creeping thistle (*Cirsium arvense*), umbellifers such as upright hedge parsley (*Torilis japonica*), narrow-leaved everlasting-pea (*Lathyrus sylvestris*), lady's bedstraw (*Galium verum*), hogweed (*Heracleum sphondylium*) and creeping buttercup.
- 2.4.14 *Ditches*: A network of drainage ditches covers the site, those within the barracks are principally constructed alongside the roads and railway tracks. The majority of these are either dry or contain minimal amounts of open water. Where water is present, stands of emergent vegetation occur, principally soft rush, hard rush, sharp-flowered rush (*Juncus acutiflorus*), false fox-sedge, spiked sedge (*Carex spicata*) and occasional bulrush (*Typha latifolia*). Other aquatic species include watercress (*Rorippa nasturtium-aquaticum*), water crowfoot (*Ranunculus* sp.), water plantain (*Alisma plantago-aquatica*) and duckweed (*Lemna* sp.). The banks of the ditches support tufted hair-grass (*Deschampsia cespitosa*) and abundant agrimony (*Agrimonia eupatoria*) in parts. Some of the bank tops of ditches also support stands of common spotted orchid (*Dactylorhiza fuchsii*).
- 2.4.15 *Broad-leaved and mixed woodland*: Woodland including Graven Hill Wood, comprising an area of ancient woodland as well as semi-natural mixed woodland, dominated by pedunculate oak, ash and Scots pine (*Pinus sylvestris*), with occasional sycamore (*Acer pseudoplatanus*), silver birch (*Betula pendula*) and field maple (*Acer campestre*) among other tree species found. Understorey vegetation includes wild privet (*Ligustrum vulgare*), hawthorn and hazel (*Corylus avellana*). A localised area of spurge laurel (*Daphne laureola*) occurs on the hillside in the south-east section. A number of ancient woodland indicator species are present, including abundant dog's mercury (*Mercurialis perennis*), enchanter's nightshade (*Circaea lutetiana*), lords-and-ladies (*Arum maculatum*) and, in small clearings and along the edges of rides, dense stands of pendulous sedge (*Carex pendula*). Some of these clearings have been replanted with broad-leaved saplings. Primrose (*Primula vulgaris*), ground ivy (*Glechoma hederacea*) and agrimony were also noted, and extensive patches of bryophytes occur in the wetter areas. Drainage ditches criss-cross the woodland and separate the wood from the adjacent grassland, but at the time of the survey they contained little water and no vegetation. The woodland is flanked by a band of bramble scrub and semi-improved grassland.
- 2.4.16 There is also an area of wet woodland in the north-western part of the site. This is likely to be inundated in the winter or during periods of high rainfall. Tree species comprise mostly willow (*Salix* sp.) and silver birch whilst herb species include nettle,



pendulous sedge, bracken (*Pteridium aquilinum*), gypsywort (*Lycopus europaeus*), water mint, ragged robin (*Lychnis flos-cuculi*), bittersweet (*Solanum dulcamara*), common spotted orchid, meadowsweet (*Filipendula ulmaria*) and bugle (*Ajuga reptans*). A large amount of deadwood and bryophytes also occur in this area of habitat.

- 2.4.17 *Broad-leaved and coniferous plantation*: There is an area of broad-leaved plantation in the north-west section of the site. This comprises mostly mature poplar (*Populus* sp.) and sycamore plantation with elder, hawthorn and hazel. The edges of the woodland support abundant bramble and nettle with bladder campion (*Silene vulgaris*), hemlock (*Conium maculatum*), umbellifers, bittersweet, greater bird's-foot-trefoil (*Lotus pedunculatus*), lesser stitchwort (*Stellaria graminea*), agrimony, oxeye daisy, meadow vetchling, common vetch (*Vicia sativa*), tufted vetch, creeping thistle, hedge bindweed (*Calystegia sepium*), hedge woundwort (*Stachys sylvatica*), small-flowered crane's-bill (*Geranium pusillum*), perforate St. John's-wort (*Hypericum perforatum*) and creeping cinquefoil.
- 2.4.18 *Species-poor semi-improved grassland*: At the time of the July survey, the majority of grassland fields located on-site were either grazed by cattle or were being used to produce a hay crop. One of the fields in the north-western section of the site is prone to periods of inundation and as such supports an abundance of rushes. This is marshy in places.
- 2.4.19 The hay fields located around the base of Graven Hill Hilltop are dominated by Yorkshire fog, along with frequently occurring false oat-grass, Timothy (*Phleum pratense*) and bents (*Agrostis* spp.). More occasional species include perennial ryegrass (*Lolium perenne*), crested dog's-tail (*Cynosurus cristatus*), erect and barren brome (*Bromus erectus* and *Bromus sterilis*) and cock's-foot (*Dactylis glomerata*). Herbs within the sward include common vetch, black medic (*Medicago lupulina*), white clover (*Trifolium repens*), creeping buttercup, meadow buttercup (*Ranunculus acris*), hogweed, ragwort (*Senecio jacobaea*), nettle, spear thistle (*Cirsium vulgare*) and creeping thistle. Agrimony, meadowsweet, umbellifers and dove's-foot crane's-bill (*Geranium molle*) occur around the field edges.
- 2.4.20 *Tall ruderal vegetation*: Tall ruderal vegetation located on-site comprises nettle, teasel (*Dipsacus fullonum*), rosebay willowherb (*Chamerion angustifolium*), great willowherb (*Epilobium hirsutum*), ribbed melliott (*Melilotus officinalis*), great mullion (*Verbascum thapsus*), silverweed (*Potentilla anserina*), ragwort, perforate St. John's-wort and bristly ox-tongue (*Picris echioides*).
- 2.4.21 *Water tanks*: There is a number of concrete water storage tanks located on-site. These are 10m x 10m in size, with a slightly raised 0.5m-wide concrete rim, and are surrounded by a narrow band of gravel. The floor of the tanks slope downwards to a final estimated depth of between 1-2m. Most of the tanks do not contain vegetation, but where present, this is limited to duckweed (*Lemna* sp.) and pondweed (*Potamogeton* sp.).



- 2.4.22 *Ponds:* There is a number of waterbodies located on-site, better described as ponds. One of these is situated within an area of woodland and is surrounded by alder (*Alnus glutinosa*) and silver birch. It supports yellow iris (*Iris pseudacorus*), skullcap (*Scutellaria galericulata*), rushes and bur-reed (*Sparganium* sp.). The others are situated within the semi-improved grassland areas and or dense scrub, albeit these were mostly dry during the spring.
- 2.4.23 *Buildings:* The majority of the buildings on-site are large, hangar-like warehouses with the lower walls constructed of brick and the upper walls and roof generally of corrugated alloy and an open roof void. A few flat-roofed office buildings and small storage sheds also occur within the barracks, and a few farm buildings within the agricultural areas surrounding the site.

#### **Potential for legally protected/priority species**

- 2.4.24 *Badger:* See Confidential Badger annex.
- 2.4.25 *Bats:* Some of the mature/dead trees located on-site contain cavities which could be used by roosting bats. Additionally, although the majority of buildings are considered to be unsuitable to support roosting bats, the office buildings provide a limited amount of potential roosting habitat. Additionally, the air-raid shelters may provide suitable hibernacula for bats, although their draughty nature currently limits their suitability in this respect. The woodland, scrub, grassland, drainage ditches, waterbodies and standard trees provide good foraging areas for a range of bat species.
- 2.4.26 *Dormouse:* The woodland and dense scrub located on-site has the potential to support a small population of dormice.
- 2.4.27 *Water vole:* The network of seasonal ditches and ponds located on-site provide only a small amount of suitable foraging and burrowing habitat for this species. Most of the ditches within the secure area are heavily managed and subject to high levels of human disturbance, reducing the likelihood that they could be used by water voles. This said, some of ditches and ponds around the periphery of the site could provide sufficient undisturbed shelter for water vole to occur. Langford Brook (which flows at its closest point, 40m from the site boundary and receives run-off from the A41) is heavily modified and shaded along this reach. No evidence of water vole was recorded during the Phase 1 in this section of the watercourse and considering the polluted nature of the brook, it is unlikely that this species would utilise the brook for their habitat requirements
- 2.4.28 *Otter:* The drainage ditches located on-site are too small and contain insufficient flow to provide suitable habitat that could be used by otter. Considering the small dimensions and quality of aquatic habitat present at Langford Brook (which flows at its closest point, 40m from the site boundary and receives run-off from the A41), it is considered to be very unlikely that otter would regularly use this watercourse for their habitat requirements, albeit possible that the brook is occasionally used by migrating otter as they move through their territories.



- 2.4.29 *Great crested newt*: Although somewhat shaded, the waterbodies located on-site offer some potential breeding habitat for GCN, as do the wetter ditches. The square water tanks also offer potential breeding habitat for GCN albeit this is general sub-optimal. Furthermore the ditches, areas of wet and marshy grassland, woodland edges and hedgerows provide good habitat connectivity across the site and with the wider area, as well as shelter and potential hibernacula.
- 2.4.30 *Reptiles*: The woodland and semi-improved grassland field margins, areas of scrub and tall ruderal vegetation that occur on-site offer foraging and shelter for common reptile species, with the extensive areas of ditches, and wet/marshy semi-improved grassland providing especially good habitat for grass snake. Of particular note in this respect are the larger areas of scrub, ruderal vegetation and hardstanding.
- 2.4.31 *Birds*: The trees, woodland/plantation, scrub and grassland located on-site provide potential nesting habitat for a range of common and priority bird species. The less managed areas of grassland could also provide nesting habitat for rarer ground-nesting birds such as skylark (*Alauda arvensis*), lapwing (*Vanellus vanellus*) and snipe (*Gallinago gallinago*). These areas could also provide good foraging habitat for notable species such as barn owl and wintering redwing (*Turdus iliacus*) - indeed a flock of the latter species was seen foraging on road verges within the site during the survey. Owl boxes were found on some of the trees (e.g. in the corner of one of the agricultural fields in the north-west of the site). A little owl (*Athene noctua*) was observed during one of the site visits.
- 2.4.32 *Invertebrates*: The woodland/plantation, semi-improved grassland, waterbodies and wet ditches provide habitat that could support a variety of locally common, priority invertebrate species.
- 2.4.33 *Other priority species*: The woodland/plantation, semi-improved grassland, scrub, tall ruderal vegetation wet ditches, waterbodies and water tanks provide habitat that could support populations of priority species such as toad and hedgehog.

## 2.5 C site

### Site context

- 2.5.1 C site lies adjacent to the village of Upper Arncott. The wider landscape and land immediately surrounding the site comprises arable and improved grassland fields. Other small settlements and army barracks are also located nearby.

### Desk study results

#### Designated sites and land classifications

- 2.5.2 Although there are no European protected nature conservation sites located within 10km of the site boundary, there are eight statutory designated sites located within 5km of C site. Further details of these are provided in Table 2.3. The full citations for



the sites are provided in Appendix A, whilst the locations of the sites are shown in Figure 2.4.

**Table 2.3 Statutory designated sites within 5km of C Site**

Site Type	Name	Area (ha)	NGR	Distance	Summary of interest feature
SSSI	Muswell Hill	0.2	SP 640 153	3500m south-east	Note this is designated for its geological and not nature conservation interest.
SSSI	Whitecross Green & Oriel Woods	64.1	SP 603 144	1645m south-west	Ancient woodland extremely rich in plant and animal life. Formerly part of two royal forests. Primarily designated for its diverse botanical interest and invertebrate assemblage. Managed by BBOWT.
SSSI	Arncott Bridge Meadows	8.66	SP 608 185	50m north	Medieval ridge and furrow features. Species rich flora attributable to variations in soil wetness.
SSSI	Murcott Meadows	22.8	SP 593 139	2730m south-west	Series of unimproved meadows traditionally managed for hay. A wide range of plant and invertebrate species and presence of willow warbler, reed warbler, snipe and other overwintering waders. Managed by BBOWT.
SSSI	Otmoor	211.6	SP575130	3010m south-west	Otmoor is a large bowl shaped area of land on the flood plain, which until recent times comprised an extensive area of wetland which was flooded in winter and was traditionally managed as rough grazing marsh. Much of the land outside the special area has been drained and converted to arable or improved pasture.
SSSI	Wendlebury Meads and Mansmoor Closes	73.2	SP562175	3700m west	Wendlebury Meads consists of traditionally-managed, unimproved neutral meadows, supporting a complex variety of plant communities. The meadows are one of the few remaining examples of calcareous clay pasture communities which were once widespread in southern England.
SSSI	Long Herdon Meadow	4.5	SP648202	4445m north-east	This site comprises an alluvial meadow adjacent to the River Ray with a botanically-rich grassland community. Winter flooding encourages wading bird to the area.
SSSI	Shabbington Woods Complex	305.6	SP615110	4800m south	This site is the largest remaining relict of the once extensive Royal Forest of Bernwood. The wood is almost entirely planted with conifer and conifer-broad-leaved mixtures with only a small area of ancient semi-natural woodland remaining. The site is important insect fauna. Also included within the site are two unimproved neutral meadows with ridge and furrow.



- 2.5.3 Table 2.4 provides details of the three non-statutory sites that are located within 1km of the site boundary. The locations of the sites are shown in Figure 2.5.
- 2.5.4 Reference to MAGIC demonstrates that the western site boundary is continuous with the Upper Thames Tributaries ESA; there are no other statutory land designations within 1km of the site boundary.

**Table 2.4 Non-statutory designated sites located within 1km of C Site boundary**

Site Type	Name	Area (ha)	NGR	Distance	Summary of interest feature
CWS (Oxon)	Meadows South of the River Ray	11.7	SP 617 186	780m north	This site comprises an area of unimproved wet pasture used for grazing. Plant species include great burnet ( <i>Sanguisorba officinalis</i> ), pepper saxifrage ( <i>Silene silaus</i> ), ragged robin, cuckoo flower ( <i>Cardamine pratensis</i> ), betony and devil's-bit scabious ( <i>Succisa pratensis</i> ). This type of wet tussocky grassland provides good habitat for birds such as snipe.
CWS (Oxon)	Arcott Wood	5.9	SP 615 169	490m east	This site comprises an area of ancient woodland with remnants of old broad-leaved woodland. The sparse canopy layer contains oak and ash with an often dense, scrubby shrub layer comprising hawthorn and blackthorn. Ground flora includes wood anemone, primrose, common spotted orchid and barren strawberry ( <i>Potentilla sterilis</i> ). Bird species recorded on-site include cuckoo and willow tit.
LWS (Bucks)	Bicester Garrison Site	21.5	SP 611 162	240m south-east	This site comprises tussocky grass fields, adjoining species-rich unimproved grassland and a pond. It supports many unusual plants in Buckinghamshire as well as other wildlife such as owl, kestrel and invertebrates, including meadow brown ( <i>Maniola jurtina</i> ), common blue ( <i>Polyommatus icarus</i> ) and migrant clouded yellow butterfly ( <i>Colias croceus</i> ).

Note: 1) CWS - County Wildlife Site (Oxon), LWS - Local Wildlife Site (Buckinghamshire).

### Other priority habitat types

- 2.5.5 The landscape within 2km of Site C comprises areas of grassland (with examples of flower-rich meadows) and arable fields, most of which are delineated by hedgerows



and standard trees. There are also four areas of ancient woodland or ancient re-planted woodland within 2km, namely Arncott Wood and associated patches, Little Wood and Piddington Wood. Smaller patches of broad-leaved and mixed woodland also occur within 1km of the site.

### Legally protected and priority species

2.5.6 The key species records for C Site are summarised below whilst tables with full details of the biological records obtained for each study area are presented in Appendix B.

#### 2.5.7 Key species records for C Site

- Brown long-eared bat: One record located approximately 1700m south of the site at Murcott in October 1996. There is a roost record near the village of Boarstall 3000m from the site boundary dated September 1996. There are six bat boxes containing brown long-eared bats 2.3km south of the site all recorded in 2002 at Whitecross Green Wood.
- Pipistrelle bat: One record of a roost from nearby Boarstall decoy (2500m from site boundary) and one record of a grounded bat found north of Piddington, approximately 3200m from the site. Both records date from July 2002.
- Bechstein's bat (*Myotis bechsteinii*): One record of a grounded bat located approximately 1500m to the east of the site boundary at Bullington prison (September 2001).
- Daubenton's bat: One record of a grounded Daubenton's bat found at the prison (located 1500m east) dating from November 1997.
- Noctule bat: One record of a grounded noctule bat, located near the prison, dating August 1997.
- Great crested newt: This record is located 100m east of the site in 'Arncott pond' and dates from November 1986.
- Common lizard: Six records from Whitecross Green Wood SSSI located approximately 1,900m south-west of the site boundary. Records date from 1996, 1997, 1998 and 2003.
- Barn owl (*Tyto alba*): One record associated with the Bicester Garrison LWS (1996).
- UK BAP priority species/Birds of Conservation Concern recorded within 2km of the site boundary include: cuckoo and curlew and willow warbler, kestrel (*Falco tinnunculus*) and green woodpecker (*Picus viridis*).
- UK BAP priority invertebrate species recorded within 2km include large nutmeg butterfly (*Apamea anceps*), rustic moth (*Hoplodrina blanda*), white admiral butterfly (*Limenitis camilla*), lackey moth (*Malacosoma neustria*), shaded broad-bar (*Scotopteryx chenopodiata*), white ermine moth (*Spilosoma lubricipeda*), oak



hook-tip (*Watsonalla binaria*), wood white (*Leptidea sinapis*), brown hairstreak and small heath butterfly. Nationally scarce or notable invertebrates include: two ground beetles (*Acupalpus exiguous* and *Bembidion gilvipes*), a rove beetle (*Sepedophilus pedicularius*) and black hairstreak butterfly (*Satyrrium pruni*).

- Other UK BAP priority species recorded within 2km include common toad and hedgehog.
- Tubular water drop-wort (*Oenathe fistulosa*): A red list vulnerable plant and a UK BAP priority species, the plant has been recorded at a distance of 600m in a field east of Arncott Meadows. SSSI.
- True fox sedge (*Carex vulpina*): A red list vulnerable plant, a UK BAP priority species and a nationally rare plant species, has been recorded at a distance of 300m from the site at Arncott Bridge Meadows SSSI. The record is dated from June 2005.

### Waterbodies within 500m of the Sites

- 2.5.8 Analysis of Ordnance Survey maps and aerial photographs revealed that there are a total of 21 waterbodies located on-site and a further 12 waterbodies located within 500m of the site boundary.

## Extended Phase 1 Habitat survey

### Description of on-site habitats

The Phase 1 habitat map for C Site is presented in Figure 2.6.

- 2.5.9 The site comprises areas of amenity grassland, young broad-leaved woodland, standard trees, drainage ditches, waterbodies, scattered and dense scrub, semi-improved grassland, buildings, warehouses, roads and hardstanding. Further details of each of the habitats present are provided below.
- 2.5.10 *Broad-leaved plantation*: There are a number of areas of even aged but young broad-leaved plantation located on-site. Frequently occurring species include ash, pedunculate oak, field maple and willow. The understorey is generally impoverished supporting mainly nettle, bramble and ivy (*Hedera helix*).
- 2.5.11 *Amenity grassland*: Extensive areas of amenity grassland are located through out the site, surrounding the industrial units and office buildings. These areas consist of Yorkshire fog, cock's-foot, fescues (*Festuca* spp.) and annual meadow grass, whilst herbs mostly comprise common bird's-foot-trefoil, self-heal, red clover and white clover, creeping buttercup, creeping cinquefoil, daisy, ribwort plantain and crane's-bills.
- 2.5.12 *Semi-improved grassland*: There is a small area of grassland which is more species-rich than the surrounding areas of amenity grassland. Instead of being dominated by common grasses, the sward supports an abundance of common bird's-foot-trefoil,





scentless mayweed (*Tripleurospermum inodorum*) and perforate St. John's-wort (see TNs 11).

- 2.5.13 *Dense/scattered scrub and tall ruderal vegetation*: There are a number of areas of dense and scattered scrub located throughout the site. These are dominated by bramble, hawthorn, elder and willow species. Tall ruderal vegetation also occurs in small pockets throughout dominated by nettle, creeping thistle, willowherb, bristly ox-tongue and teasel.
- 2.5.14 *Water tanks*: Several square concrete water tanks (approximately 10m x 10m in size, with an estimated depth >1m), with a synthetic liner are located throughout the built areas of the site. These tanks provide emergency water supplies to the area. Most of the tanks appear devoid of aquatic vegetation, but sticklebacks (*Gasterosteidae*) were noted in a number of these. Many of the tanks have wet ditches running in close proximity to them, providing connectivity to the wider landscape. In addition, there are two more natural waterbodies located in the northern section of the site. These are surrounded by dense, broad-leaved scrub and are entirely shaded, such that there is virtually no aquatic vegetation present.
- 2.5.15 *Ditches*: The site supports a network of seasonally inundated drainage ditches that are connected to ditches and drains within the wider landscape. These occur alongside roads and railway tracks. Many of the ditches are dry or contain minimal amounts of open water. However, where water is present, these support bulrush, false fox sedge, soft rush, hard rush, sharp-flowered rush and great willowherb. Watercress and clubrush (*Schoenoplectus lacustris*) also occur. The presence of a small population of fish was noted in some of these.
- 2.5.16 *Standard trees*: There are a number of mature standard trees located on-site, these mostly comprise pedunculate oak, horse chestnut, common lime, weeping willow and poplar.
- 2.5.17 *Buildings*: The majority of the buildings on-site consist of large, hangar-like warehouses with the lower walls constructed of brick and the upper walls and roof generally of corrugated alloy, with an open roof void. These building are of varying age and many of the older building are now dis-used and left open. A few flat-roofed office buildings and small storage sheds also occur across the site.
- 2.5.18 *Hardstanding*: A network of roads, car parks and railway tracks (both used and dis-used) exists across the site.

#### **Potential for legally protected/priority species**

- 2.5.19 *Badger*: See confidential badger Appendix C.
- 2.5.20 *Bats*: The site contains a large number of mature trees and a limited number of buildings that could provide potential roosting habitat for bats (see TN12). Extensive areas of suitable foraging habitat are located across the site (waterbodies, open areas of grassland and standard trees), along with a number of linear features such as ditches



and strips of scrub providing good connectivity across the site and with the wider landscape.

- 2.5.21 *Water voles*: The network of ditches that occurs across the site are intensively managed, albeit they provide a small amount of habitat that could be used by water vole. There are no records of water vole from this section of the River Ray (which at its closest point is located between 40-50m from the site boundary and between 100-250m from the closest area of works), albeit the River provides some habitat that could be used by this species for their habitat requirements.
- 2.5.22 *Otter*: The drainage ditches located on-site are too small and contain insufficient flow to provide suitable habitat that could be used by otter. There are no records of otter occurring in River Ray, albeit possible that migrating otter could periodically utilise this watercourse for their habitat requirements as they move through their territories.
- 2.5.23 *Dormice*: The dense scrub/plantation woodland located on the site has the potential to support a small population of dormice.
- 2.5.24 *GCN*: There are a number of natural and man-made ponds situated on and-off site that may provide breeding habitat for GCN. Many of these waterbodies are connected with each other and with the wider landscape by ditches and areas of suitable terrestrial habitat. In addition, a large number of water tanks are located throughout the built-up areas, some of which are known to contain GCN.
- 2.5.25 *Reptiles*: The majority of the habitat located across the site i.e. amenity grassland and hardstanding provides sub-optimal reptile habitat. This said, the dense and scattered scrub, drainage ditches and colonising vegetation in the vicinity of the railway lines, situated within less utilised/disturbed areas of the site provide excellent opportunities for reptile species such as grass snake and common lizard to forage and migrate throughout the site.
- 2.5.26 *Birds*: The grassland, dense scrub, individual scattered trees, waterbodies and buildings on the site provide potential nesting habitat for a range of bird species, both common and notable.

### Implications of the Phase 1 Survey

- 2.5.27 The Phase 1 survey of Graven Hill and C Sites has identified the presence and/or potential for presence of a number of legally protected and/or priority species on-site or within 1km of the site boundaries. Recommendations for detailed surveys for the following species/groups of species were therefore made:
- badger (including a bait marking survey at Graven Hill);
  - bats;
  - water vole;
  - dormouse;
  - great crested newt;



- reptiles;
- invertebrates; and
- birds.

2.5.28 The methods and results of these surveys are presented in the following sections.





## 3. Bats

### 3.1 Methodology

- 3.1.1 The methodology for undertaking the bat survey work followed guidance provided by Natural England [*Bat Mitigation Guidelines*, English Nature (now Natural England). 2004] and the Bat Conservation Trust (*Bat Survey s- Good Practice Guidelines*, Bat Conservation Trust. 2007). The work has comprised a combination of assessment of habitat suitability, roost assessments, emergence/re-entry surveys and activity surveys.

#### Habitat suitability

- 3.1.2 Habitat suitability for bats was initially assessed during the extended Phase 1 habitat survey (see Section 2.4.26 and 2.5.20) and then subsequently through building inspections, whilst undertaking bat activity surveys (see below) and carrying out tree roost assessments. Habitat suitability was assessed in respect of the following three criteria: features that offer potential for roosting (e.g. trees, buildings and other built structures); opportunities for commuting (e.g. provided by structural features such as hedgerow, waterways and woodland edge); and opportunities for foraging (e.g. over areas of grassland or adjacent to woodland). Characteristics that are likely to reduce the value of a feature or habitat for bats, such as high light levels, were also recorded.

#### Roost assessment

##### External assessment

- 3.1.3 External roost assessment surveys of the development sites were carried out on 02 and 03 August 2010, 16 February 2011 and 11 July 2011 by a Natural England licensed bat ecologist (Sue Field MIEEM, NE scientific licence no.20113313). Any trees, buildings or other structures thought to have some potential to support bat roosts were mapped, and detailed notes on them were made. Trees were graded for their potential to support roosts based on the likely number and suitability of roost spaces present, and proximity to good commuting and foraging habitat. Factors affecting the likelihood of potential roost sites being used by bats, such as high levels of illumination from street lamps and security lighting, were also included in the assessment (as far as is possible during a daytime survey).

##### Internal assessment

- 3.1.4 All trees identified from the external assessment as having some potential to support roosting bats were climbed and inspected by Mike Freeman (Licensed bat ecologist: 20104247) between 14-16 March and the 04-08 April 2011 inclusive. The trees were examined using a combination of hand held bright torches (0.5-2M candlepower),



high power mini torches and a 90cm long 5mm diameter fibre-optic endoscope. For each tree the species, trunk diameter and location grid reference was recorded. The results of this survey are presented in Appendix C.

- 3.1.5 The trees and their features were then categorised into a risk matrix that placed each tree or feature into a category depending on its likelihood to support roosting bats. This could only be determined following the internal tree inspections. The trees and the individual features were categorised as:
- Zero/Low - no potential to house day roosting bats or unlikely to be used by bats as the features are shallow, wet or light;
  - Medium - possibly used by small numbers of bats;
  - High - ideal features that could be used by bats; and
  - Confirmed use of feature by bats by presence of bats or signs i.e. droppings.
- 3.1.6 Following the tree climbing inspection, some of the features assessed from ground level as being likely to have medium to high potential to support bat roosts were found to be in the low category. The results section lists those trees that the internal inspection confirmed as having some potential to support roosts and confirmed roosts.

### **Winter building inspections**

- 3.1.7 A hibernation survey comprising detailed external and internal inspections (where access was possible) was undertaken for each of the buildings identified as having potential to support hibernating bats. Air raid shelters at sites Graven Hill and C site were surveyed on 16 February 2011.
- 3.1.8 Close-focusing binoculars were used to inspect the buildings' exteriors for potential entry points for bats and a high-power focused-beam lamp was used to inspect the building interiors for bats or signs of bats, such as droppings, feeding remains, urine staining, or absence of cob-webbing from potential roost crevices.
- 3.1.9 The temperature and humidity inside each building was also measured using a digital thermohygrometer (Precision Gold). The readings were compared with those from outside, in order to help assess the suitability of the buildings as hibernation sites (the ideal hibernaculum has a stable, cool temperature maintained above freezing, with a relative humidity close to 100%). The optimum period to survey for hibernating bats is December-February, although bats will move between sites during this period and different species leave and enter hibernacula at different times; the absence of hibernating bats during a single survey cannot therefore be taken as proof that the structure is not used as a hibernaculum, or by bats during other times of the year.

### **Summer building inspection**

- 3.1.10 The winter building inspections identified the presence of bat dropping and some potential feeding remains within the air raid shelters. As a result a brief summer



inspection of these air raid shelters was carried out on July 11 2011 to confirm whether there was evidence of summer roosting activity.

### **Emergence/re-entry survey**

- 3.1.11 Dusk emergence and dawn re-entry surveys were carried out between May and August 2011 inclusive. During the emergence/re-entry surveys each surveyor was stationed at a different location near to buildings/structures/trees that had been identified (from the external roost assessment) as having potential to support roosts and/or adjacent to linear features, which were considered likely to be affected by the development proposals (see **Figures 3.1 to 3.3** for static survey locations). Two surveys were undertaken per structure/tree, albeit, an additional dusk survey was also carried out at E15A Appendix due to the presence of a maternity roost. These mostly comprised one dusk and one dawn survey, albeit in some cases due to the nature of the building/tree it was more appropriate to undertake two dusk or two dawn surveys to increase the likelihood of a potential roost being detected.
- 3.1.12 Emergence surveys commenced approximately 15 minutes before sunset and finished approximately 90-120 minutes after sunset. Re-entry surveys commenced approximately 120 minutes before sunrise and concluded at or just after sunrise. A summary of each survey date, survey location, weather conditions and sunset/sunrise times is shown in Appendix E. Sunset and sunrise times for all the surveys were taken from the Metcheck website.

### **Activity survey**

- 3.1.13 Surveys to investigate bat activity across the site were undertaken during May to July 2011 inclusive. A total of seven activity surveys were completed for Graven Hill Site and five for C site. These focused on sampling suitable foraging and commuting habitats present. During each survey event, up to three separate transect routes were walked. Transect routes are shown in Figure 3.4-3.8.
- 3.1.14 Activity surveys commenced 15 minutes before sunset and finished approximately 150-180 minutes hours after sunset. These timings coincide with the time when bats are most active in the evening and are widely recognised as an optimal time to survey for bat activity (BCT, 2007).

### **Data recording and analysis**

- 3.1.15 During all the surveys, bat calls were recorded using frequency division bat detectors (a Batbox duet) and recording devices (an Edirol R09), which were subsequently analysed using BatSound. The likely bat species, the location of the registration and other detail (where discernable) such as direction of flight, activity (e.g. foraging or commuting), number of passes and number of bats were also recorded during the bat survey.



## 3.2 Summary of desk study results (see Section 2.4)

### Graven Hill

- 3.2.1 The desk study that was undertaken as part of the extended Phase 1 habitat survey identified the presence of brown long-eared bat, pipistrelle bat, Leisler's bats and Natterer's bats as occurring within 2km of the site boundary. Additionally there are records of roosts for both common pipistrelle bat and Natterer's bat within 5km of the site boundary.

### C Site

- 3.2.2 The desk study that was undertaken as part of the extended Phase 1 habitat survey identified the presence of brown long-eared bat, pipistrelle bat, Leisler's bats, Daubenton's bats and noctule bats occurring within 2km of the site boundary. Additionally there are records of roosts for both common pipistrelle bat and brown long-eared bat within 5km of the site boundary.

## 3.3 Field survey results

### Graven Hill

#### Scoping surveys (summer 2010)

- 3.3.1 The scoping surveys identified that the following buildings and trees provide sufficient roosting habitat that emergence surveys were recommended:
- Buildings: E25, E5, E2A, E14, E15A, E15 Appendix, Theatre, Rodney House Complex, DSDA building, D10, D12 and the air raid shelters (see Figure 3.1 and 3.2); and
  - Trees: ET1, ET8, ET12, ET13, ET 14, ET19, ET21, ET23, ET24 and ET28 (albeit trees ET13 and ET28 will not be affected by the works so have been omitted from further consideration) (see Figure 3.2).
- 3.3.2 Although surveys at trees ET8 and ET19 were initiated, these were called off, as stampeding cattle were considered to be a health and safety risk to surveyors.

#### Building inspections

- 3.3.3 The 2010 scoping survey identified the structures described below as requiring further internal inspection during the winter months. These were also subject to a search during July 2011 for any evidence of summer roosting activity. The results of these inspections are detailed below.





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#### *Air raid shelters within D site at Graven Hill*

- 3.3.4 The air raid shelters have low-moderate potential to support hibernating bats. This is because the air raid shelters contain few cracks which could be used for roosting and have no insulation. This means that the temperature inside the structure will fluctuate with the weather which provides less suitable habitat for hibernating bats. During the winter hibernation inspection two bat droppings were found in one of the air raid shelters and two air raid shelters contained a single butterfly wing (which can sometimes indicate that bats are using the site as a feeding perch). A further inspection was undertaken during the summer to determine whether the shelters were being used as a feeding perch or by individual roosting bats, or whether the evidence was as a result of bat activity rather than being indicative of a roost. No evidence of bats was found. The single wings are most likely due to spiders.

#### *Substation*

- 3.3.5 The substation structure has low potential to support hibernating bats. This is because the substation contains few cracks which could be used for roosting and it has no insulation. This means that the temperature inside the structure will fluctuate with the weather which provides less suitable habitat for hibernating bats. During the winter hibernation a single old bat dropping and a small number of butterfly wings were found. As a result a further summer inspection was undertaken to determine whether the structure is used by roosting bats. No bat droppings were found suggesting that the evidence was from bat activity rather than roosting bats. There were also a number of spider webs which would explain the small number of butterfly wings that were found. There was no evidence to suggest this structure was being used as a feeding perch.

#### *Pumping House*

- 3.3.6 This building has low potential to support hibernating bats. The structure was fully inspected inside. The cobwebs were fully intact showing no signs of use and there was no other evidence of bat use. Furthermore, there are few access points which could permit bats to enter the building. The summer inspection found no evidence of bats.

#### *Theatre*

- 3.3.7 The theatre has been assessed as having moderate potential as a maternity roost as there are a number of cracks within the brickwork, under tiles and possibly through louvers within top of the roof that provide access into the main loft space. As such emergence/re-entry surveys were recommended to be carried out during the summer months. It has been confirmed that there are no underground plant rooms or service ducts within this building (which if present may have provided habitat for hibernating bats).

#### **Activity surveys**

- 3.3.8 The survey work confirmed the presence of eight species of bat foraging or commuting over the site (Figure 3.4, 3.5 and 3.8). Of these species, the most



frequently recorded bats were common pipistrelle and soprano pipistrelle, albeit noctule bats were also recorded frequently. Less frequently recorded bat species were *Myotis* sp., serotine and Leisler's. Long-eared and Daubenton's bats were only recorded on a couple of occasions and are unlikely to use the site on a regular basis.

- 3.3.9 The site contains an abundance of suitable foraging habitat for bats. Activity was mainly focused along the boundary features including the hedgerows, woodland/plantation margins, the semi-improved grassland field boundaries and with a limited amount of activity along the tree lined avenues of the garrison. For security reasons, much of the garrison is very well lit, a factor that reduces the suitability of foraging within the main garrison site.
- 3.3.10 Common pipistrelle is the most common and widespread bat species in the UK (estimated population size 2,430,000<sup>3</sup>). It frequently uses urban habitats for roosting and foraging. Soprano pipistrelle, is the next most common and widespread UK bat species (estimated UK population size 1,300,000) and also regularly occurs in urban habitats. Noctule is classified as an 'uncommon' bat species (as determined by the Bat Conservation Trust) (estimated population size 50,000). A decline in the national populations of all three species over the last thirty years has meant that these species are all now UK BAP priority species.
- 3.3.11 Of the other species of bats recorded on-site, Daubenton's is the most commonly occurring bat in the UK with an estimated UK population of approximately 560,000 individuals. This species prefers to forage close to the surface of waterbodies and woodland. The next most common species that occurs on-site is long-eared bat (most likely brown long-eared bats albeit not possible to distinguish this from the recordings) with an estimated UK population of 245,000 individuals. This species prefers to utilise woodland habitat for its foraging requirements. Serotine bats have an estimated UK population of 15,000, albeit this species is predominantly restricted to the more southerly regions of England. Serotine bats forage in a range of habitats, although they are more common than noctule bats in suburban areas. Of the bats recorded on-site, Leisler's bat is the scarcest species, with an estimated UK population of just 10,000 individuals. This species also prefers woodland for its foraging requirements. All species of British bats are protected under the *Habitats Regulations 2010*.

### Emergence surveys

- 3.3.12 The survey work confirmed the presence of four bat roosts on-site. The most important of these is a maternity roost located in building E15 A Appendix (Figure 3.2). This roost is used by three different species of bat common pipistrelle, soprano pipistrelle and noctule bats. Noctule bats do not often roost in buildings and although some usage of buildings is recorded in the UK, invariably buildings are not the most important type of maternity roosting site for this species of bat. A maximum count of

<sup>3</sup> All population estimates from: National Bat Monitoring Programme (2006). The State of the UK's Bats. Bat Conservation Trust, London.



98 bats was recorded emerging from the building on any one occasion. The majority of these were common pipistrelle bats.

- 3.3.13 Additionally, a single common pipistrelle bat was recorded emerging from both building E5 and the theatre (Figure 3.2). A single pipistrelle bat was also recorded emerging from E15A, albeit the recording was very faint and it was not possible to determine whether this was a common or soprano pipistrelle. These roosts are best described as summer roosts and are likely to support only a few individuals, most likely non-breeding females or males.

## C Site

### Scoping survey (summer 2010)

- 3.3.14 The scoping survey identified that the following buildings and trees provide sufficient roosting habitat that emergence surveys were recommended:
- Buildings: C8A, boiler house, air raid shelters (Blocks A, B and C); and
  - Trees: CT5, CT10 and CT11 (albeit CT5 will not be affected by the proposed development and as such has been omitted from further consideration) (see Figure 3.3 for locations).

### Winter inspection (winter 2010)

- 3.3.15 The air raid shelters could not be accessed in order to determine their use as hibernacula as the doorways had been breeze-blocked up and there would be a high level of disturbance needed in order to gain access. Anabat (static detector) surveys were undertaken during late February-March 2011 which confirmed *Myotis* and possibly long-eared bats use this area, albeit not possible to confirm whether these bats emerged from the air raid shelters.

### Activity surveys

- 3.3.16 The survey work confirmed the presence of seven species of bat foraging or commuting over the site (Figures 3.6 and 3.7). Of these species, the most frequently records bats were common pipistrelle and soprano pipistrelle, albeit noctule bats were also recorded frequently. Less frequently recorded bat species were *Myotis* sp. and serotine. Long-eared and Leisler's bats were only recorded on a few occasions and are unlikely to use the site on a regular basis. The status of these bats has already been discussed in the biodiversity chapter of the ES.
- 3.3.17 The site contains some suitable foraging habitat mostly comprising the broad-leaved plantation, waterbodies, drainage ditches and mature standard trees situated within the amenity grassland. Activity was mainly focused along the boundary features including the woody/scrub margins, around the waterbodies but with a limited amount of activity along the tree lined avenues of the main site. For security reasons, much of the site is very well lit, a factor that reduces site's suitability for foraging.



**Emergence surveys**

- 3.3.18 The AMEC surveys confirmed the presence of two small common pipistrelle summer roosts on the site. Only one bat was recorded emerging out of each of these roosts. The first of the roosts is located within in a weeping willow (*Salix babylonica*) tree CT10 whilst the other occupies part of building C8A. These roosts are best described as summer roosts and are likely to support only a few individuals, most likely non-breeding females or males.



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## 4. Water vole

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### 4.1 Methodology

4.1.1 Each watercourse and waterbody within or adjacent to the proposed development areas were assessed for their potential to support water vole. Those which provided some suitable habitat (Figure 4.1-4.3) were surveyed for evidence of water voles, in May 2011, following guidance provided in the *Water Vole Conservation Handbook* (Strachan & Moorhouse 2006). This included searching for the following:

- latrines - comprising a concentration of droppings in discrete locations, often near nest sites, at range boundaries or at places used to enter and exit the water;
- feeding stations - comprising neat piles of chewed lengths of vegetation, usually up to 10cm in length, on pathways or haul-out locations;
- burrows - these are typically found along the waters edge and on top of the bank (up to 5m from the waters edge) and are 4-8cm in diameter. Holes on top of the banks often have 'lawns' around them (areas of grazed vegetation); and
- footprints - located in soft mud or silt.

4.1.2 All results were recorded in the field on the water vole survey pro-forma provided within the *Water Vole Conservation Handbook*.

### 4.2 Summary of desk study results

#### Graven Hill

4.2.1 There are no records of water vole occurring within 2km of the site boundary.

#### C Site

4.2.2 The closest record of water vole is located 2km from the site boundary within Boarstall Duck Decoy LWS. This is an old record dating from 1980.

### 4.3 Field survey results

#### Graven Hill and C Site

4.3.1 Table G1 in Appendix G provides a breakdown of the survey findings. All of the watercourses/waterbodies located on both of the sites provided only a small amount of



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habitat that could support a population of water voles. The majority of the watercourses are drainage ditches rather than streams, and as such are subject to fluctuating water levels. Furthermore, in Spring 2011, the majority of drainage ditches were dry, intensively managed by a cutting regime, or were subject to high levels of human disturbance, meaning that they were considered to be largely unsuitable to support a population of this species.

- 4.3.2 There is a drainage ditch located in the semi-improved grassland fields in the north-eastern section of the Graven Hill Site, albeit this is also considered to be largely unsuitable for water vole, owing to the shading of the channel by the scrub and poaching of the banks by cattle.
- 4.3.3 Additionally Langford Brook and the River Ray flow in the vicinity of Graven Hill and C sites. At their closest points, both of these watercourses flow within 40-50m of the site boundaries, albeit for the most part, they are located in excess of 100-250m away from the closest area of works. Although no evidence of water vole was recorded, it is possible that this species occurs in upstream and downstream sections.
- 4.3.4 The survey did not identify any evidence to suggest the presence of water vole in any of the on-site drainage ditches/watercourses/waterbodies.



## 5. Dormice

### 5.1 Methodology

- 5.1.1 Dormice construct nests during both the summer and winter, with summer nests usually made out of woven fibrous vegetation of various kinds constructed within dense vegetation, such as a dense hedge or woodland, but are usually off the ground. Winter nests are usually closer to or at ground level. This habit of nest building can be used to survey for the presence of dormouse. This is achieved by providing suitable places to for dormice to build their nests in the form of wooden boxes and/or plastic tubes, which are then checked at regular intervals. The wooden nest boxes are generally used for long-term monitoring as they are more durable but it usually takes longer for dormouse to use them. Tubes are best used to determine presence/absence over a relatively short period of time as they are readily used by dormouse and easy to set out at a site. Tubes were used for these surveys.
- 5.1.2 Surveys were undertaken by surveyors licensed to survey for dormice. In order to effectively check each tube, a quiet and careful approach was made before the entrance was sealed with a cloth. The inside of the tube was then carefully inspected for the presence of nests or animals. Species other than dormouse, such as wood mouse (*Apodemus sylvaticus*), yellow-necked mouse (*Apodemus flavicollis*) and even birds, often use tubes. However, dormouse nests have characteristic features<sup>4</sup> and can be relatively easy to identify. Occasionally the dormice themselves are found within tubes also.
- 5.1.3 The survey methodology followed guidance given in The Mammal Society's "Dormouse Nest Tubes" leaflet (no date), as well as general advice given the *Dormouse Conservation Handbook* (English Nature, 2006), *Dormice* (The Mammal Society, 1992) and *A Practical Guide to Dormouse Conservation* (The Mammal Society, 1989).

#### Graven Hill

- 5.1.4 A total of 173 tubes at Site E and 175 tubes at D Site (within Graven Hill) were placed in scrub, hedgerows and woodland at the start of July 2010 and were checked monthly until November 2010 with further checks in May 2011. The locations of the dormouse nest tubes used at this site are shown in Figures 5.1 (E Site and Graven Hill Hiltop) and 5.2 (D Site). These were placed in order to sample all suitable dormouse habitats across the site. A total of 182 dormice tubes were placed in the woodland

<sup>4</sup> They generally have a definite woven structure, a closed, domed roof even with a tube and an entrance left by a departing dormouse.



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margins that flank the rides of Graven Hill Wood (see Figure 5.1), as well as along the hedgerows leading from Graven Hill Wood. Surveys at Graven Hill Hilltop were carried out between April-September 2011.

- 5.1.5 Using the guidance provided by English Nature (2006), which provides an index of probability for finding dormice in tubes in each month between April and November, and based on the level of survey effort carried out, a survey effort score of 23 was achieved by the end of May 2011 for D and E Sites and 21 for Graven Hill Hilltop. The guidance states that the minimum score to be able to ascertain the likely absence of dormice from a site is 20. The surveys have therefore exceeded this minimum requirement.
- 5.1.6 The date of each survey at E Site is listed below:
- 27 August 2010;
  - 27 September 2010;
  - 4 November 2010;
  - 25 November 2010;
  - 12 May 2011; and
  - 26 May 2011.
- 5.1.7 The date of each survey at D Site is listed below:
- 20 August 2010;
  - 23 September 2010;
  - 3 November 2010;
  - 26 November 2010;
  - 12 May 2011; and
  - 25 May 2011.
- 5.1.8 The date of each survey at Graven Hill Hilltop is listed below:
- 19 May 2011;
  - 31 May 2011;
  - 5 July 2011;
  - 17 August 2011;
  - 12 September 2011; and
  - 23 September 2011.





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## C Site

- 5.1.9 A total of 151 tubes were placed in scrub, hedgerows and woodland at the start of July 2010 and were checked monthly between then and November 2010 with further checks in May 2011. The locations of the dormouse nest tubes used at this site are shown in Figure 5.3. These were all placed in order to sample all suitable dormouse habitats across the site.
- 5.1.10 A survey effort score of 23 was achieved by the end of May 2011.
- 5.1.11 Surveys were undertaken on the following dates:
- 19 August 2010;
  - 22 September 2010;
  - 26 October 2010;
  - 29 November 2010;
  - 4 May 2011; and
  - 27 May 2011.

## Constraints

- 5.1.12 Separating dormouse nests from nests constructed by other rodents can be difficult, especially in the case of incomplete nests or nests which were damaged subsequently by another species. Any nests found on site which looked likely to have been constructed by dormouse were photographed and a consensus of opinion from a number of suitably experienced ecologists within AMEC was reached.

## 5.2 Summary of desk study results

- 5.2.1 There are no records of dormice occurring on either site or within 2km of either of the site boundaries.

## 5.3 Field survey results

### Graven Hill

- 5.3.1 No nests built by dormice were found within the nest-tubes installed on D and E Sites. Although several areas of habitat on site are deemed suitable to support this species, it seems unlikely that dormice are present.
- 5.3.2 A single dormouse nest was found in one of the nesting tubes in September 2011 (See figure 5.1). This was located on the northern edge of Graven Hill Wood. No other evidence of dormouse was recorded during any of the other surveys.



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## C Site

- 5.3.3 A nest (Nest A) was found in tube 41, during the November 2010 check, which showed features suggesting it had been constructed by dormice. Analysis by several ecologists within AMEC of the photographs taken determined that it is a dormouse nest. This tube was located in one of the small woodland plots approximately at the centre of the site. These are not extensive and not well connected to other plots on site, being isolated from the linear woodland and scrub area, which runs along the western site boundary, by rail tracks and sidings.
- 5.3.4 A second nest (Nest B) which is also likely to have been constructed by dormouse was found on 4 May 2011 in tube 142. A further nest (Nest C) which is of less certain origin but shows some signs of having been built by dormouse was found on the same day in tube 25. The former is located within the strip of woodland adjacent to the eastern boundary on the site. The latter is in the vicinity of Nest A, but within the largest of the group of woodland plots. The locations of these nests are shown in Figure 5.3.



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## 6. Great crested newts

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### 6.1 Methodology

#### Desk-based review of available breeding habitat

- 6.1.1 A desk-based review was undertaken to identify all waterbodies within 500m of both sites, as 500m is the maximum distance that great crested newt (GCN) are generally considered to travel from their breeding sites to utilise terrestrial habitats (English Nature, 2001). To achieve this, the Ordnance Survey 1:25,000 scale map and aerial photographs of the sites and their surroundings were reviewed to identify waterbodies located within 500m of the site boundary. The results of the extended Phase 1 habitat surveys from 2008 were also used to locate waterbodies.

#### Screening survey

- 6.1.2 Each water body that was identified on-site or within 500m of the development sites (where access could be agreed) was visited at the beginning of April 2011 to assess its suitability to support breeding GCN. This assessment followed the methodology set out in the Habitat Suitability Index (HSI) Guidelines, produced by the *National Amphibian and Reptile Recording Scheme* (NARRS, 2008)<sup>5</sup>, which uses information on measurable habitat features to determine the quality of a waterbody for GCNs. At each water body, ten key habitat features<sup>6</sup> were assessed, converted into Suitability Index scores, and then put through a simple calculation to generate an overall numerical HSI score of between 0 and 1. This overall HSI score is then used to classify the suitability of the water body for breeding GCNs into one of five categories (as set out in **Table 6.1**).

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<sup>5</sup> The great crested newt HSI methodology was originally presented in a paper by Oldham *et al.* (2000).

<sup>6</sup> Geographic location; pond area; pond permanence; water quality; pond shading; number of waterfowl; occurrence of fish; pond density; terrestrial habitat; and macrophyte cover.



**Table 6.1 HSI score categories**

HSI	Pond suitability
<0.5	Poor
0.5-0.59	Below Average
0.6-0.69	Average
0.7-0.79	Good
>0.8	Excellent

6.1.3 In addition to the HSI classification, the following factors were also assessed in the screening assessment, given that they could either significantly affect the suitability of the water body to support GCNs or prevent any animals present from accessing the development site from the water body in question:

- receiving discharge of pollutants at excessive levels or containing anoxic waters;
- insufficient aquatic vegetation or other material that could be used for egg laying;
- evidence of extreme levels of fish activity (e.g. an intensively managed fishing lake) or waterfowl activity (where the number of waterfowl present exceeds 10 per 1,000m<sup>2</sup> [Oldham et al 2000]);
- links to fast flowing streams, or the presence of an extreme management regime; and
- habitat connectivity - e.g. the presence/absence of: suitable connecting features (such as mature hedgerows, ditches or woodland) between the pond and the site; or of significant barriers to movement between the pond and the development area.

6.1.4 The screening assessment, as described above, enabled a screening decision to be made. If a water body was found to provide suitable habitat for GCNs and it was determined that, if present, GCNs could access the development site, then the water body would be 'screened in' to the presence/absence survey.

### **Presence/absence and population surveys**

6.1.5 Presence/absence surveys were carried out in 2011 at the 67 'screened-in' waterbodies across the two sites. To determine the presence/absence of GCN, each water body was visited four times (see Table H1 in **Appendix H** for survey dates) in suitable



weather conditions<sup>7</sup> within the optimum survey period<sup>8</sup>. During each survey the most appropriate of the following survey methods were employed:

- Bottle-trapping - bottle traps constructed from two litre plastic bottles were set at regular intervals around the margins of each water body. They were revisited early the next morning to record and then release any newts that had been trapped.
- Torch-light surveying - each water body was illuminated with a powerful torch, after dusk, in order to reveal the presence of any newts in the water.
- Egg search - marginal aquatic macrophytes were inspected for the presence of great crested newt (and other amphibian) eggs.
- Artificial egg substrate search: Artificial egg substrates were placed in the waterbodies and given time to settle. On return visits these were searched for GCN (and other amphibian) eggs.
- Terrestrial searching - suitable refuge material that was found in the vicinity of the pond was searched for resting animals. Such refugia included bark, logs and stones.

6.1.6 Those waterbodies that were found to support GCNs within the first four survey events were surveyed a further two times to complete the six visits that are required to inform a population size class assessment.

### Population size class assessment

6.1.7 Once six survey visits had been completed to a water body that supports GCN, a population size class estimate is made using the maximum count of adult GCNs recorded by either bottle trapping or torch surveying during a single survey visit.

6.1.8 As set out in the *Great crested newt mitigation guidelines* (English Nature, 2001), populations can be classed as:

- ‘small’ for maximum counts up to 10;
- ‘medium’ for maximum counts between 11 and 100; and
- ‘large’ for maximum counts over 100.

<sup>7</sup> As defined in the *Great Crested Newt Mitigation Guidelines* (English Nature, 2001).

<sup>8</sup> All visits were undertaken between April and end of May (as per the Great Crested Newt Mitigation Guidelines [English Nature, 2001]), with at least half the visits undertaken in the period mid-April to mid-May.



## 6.2 Summary of desk study results

### Graven Hill

- 6.2.1 There is one record of GCN recorded within 2km of the site boundary. This is located 940m south of the site.

### C Site

- 6.2.2 There is one record of GCN occurring adjacent to the site boundary at Arncott Pond.

## 6.3 Field survey results

### Graven Hill and C Site

- 6.3.1 The HSI scores for each of the waterbodies are detailed in Table H2 in Appendix H1. A total of 46 waterbodies were both accessible and of sufficient quality that survey work was recommended.

### Graven Hill

- 6.3.2 Table 6.2 details the waterbodies in which GCN have been confirmed and the relative population size class. Full details of all the survey results are provided in Table H3 Appendix H. Figure 6.1 indicates the locations of ponds around the site and those which were surveyed.
- 6.3.3 Graven Hill supports one large metapopulation of GCN, 2 small metapopulations of GCN and 3 small populations of GCN. The maximum count for the large population of GCN was 122 GCN individuals. This was within water body 11. Ponds supporting GCN and the sizes of the populations are indicated on Figure 6.3.

**Table 6.2 Summary of GCN survey results at Graven Hill**

Water body number	GCN population estimate	Comments (metapopulation)
<b>On-site waterbodies</b>		
11	large	Metapopulation with 8b
12	small	Metapopulation with E11
17	small	
18	small	
E3	small	



Water body number	GCN population estimate	Comments (metapopulation)
E11	small	Metapopulation with 12
E15a	small	Metapopulation with E15b, 25b and 26b
E15b	small	Metapopulation with E15a, 25b and 26b
<b>Off-site waterbodies</b>		
8b	small	Part of a large metapopulation with 11
25b	small	Metapopulation with E15a, E15b and 26b
26b	small	Metapopulation with E15a, E15b and 26a

### C Site

6.3.4 Table 6.3 details the waterbodies in which GCN have been confirmed at C Site and the relative population size class. Full details of all the survey results are provided in Table H2 in Appendix H. Figure 6.2 indicates the locations of ponds around the site, those which were surveyed and those where GCN were present.

6.3.5 C site supports four small populations and one medium of GCN. None of these individual populations formed part of a larger metapopulation.

**Table 6.3 Summary of GCN survey results at C site**

Water body number	GCN population estimate	Comments (metapopulation)
<b>On-site waterbodies</b>		
1	Small	None
E5	Medium	None
E8	Small	None
D17	Small	None
<b>Off-site waterbodies</b>		
60a	Small	None



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**Provision of foraging habitat at Graven Hill and C site**

- 6.3.6 Where GCN have been confirmed on Graven Hill and C Site, much of the terrestrial habitat that immediately surrounds the waterbodies (to a distance of 50m), comprises amenity grassland and standard trees. This provides only sub-optimal terrestrial for GCN. There are however small areas of scrub, hedgerow and in some cases plantation woodland, within 250m of the breeding waterbodies which provide more optimal areas for foraging and hibernacula.
- 6.3.7 Where GCN have been recorded in off-site ponds (i.e. 8b, 25b, 26b and 60a), these are immediately surrounded by better quality terrestrial habitat (i.e. semi-improved grassland, hedgerows and scrub).





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## 7. Reptiles

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### 7.1 Methodology

#### Presence/absence and population survey

- 7.1.1 The methodology for the reptile survey followed guidance provided in Froglife's Advice Sheet 10 - *Reptile Survey, an introduction to planning, conducting and interpreting surveys for snake and lizard conservation* (Froglife, 1999) and took into account additional guidance provided by the *Herpetofauna Workers' Manual* (JNCC, 1998) and *Reptiles: guidelines for developers* (EN, 2004).
- 7.1.2 The Froglife Advice Sheet (1999) recommends placing between 5 and 10 artificial refugia per hectare (ha) and this guidance was adopted, or exceeded, for all suitable reptile habitats on site. The Graven Hill site is, in total, approximately 207ha in size, whilst C site is 83ha in size, but not all of the habitats within the sites provide suitable habitat for reptiles (for instance, the centre of a heavily grazed field, which does not provide shelter/cover for reptiles, is very unlikely to represent an attractive basking or foraging area). In total, 373 artificial refugia (comprising tiles of roofing felt, minimum size of 0.5m x 0.5m) were set out on 7 June 2010 (for Sites D&E) and 12 May and 13 May 2011 (for Graven Hill Hilltop) in all the habitats assessed as having the potential to support reptiles within the site, namely the hedgerows and field margins, areas of scrub and ruderal vegetation (see **Figure 7.1**). The total area of reptile habitat on Graven Hill is approximately 20ha. The tile density is therefore 18 tiles per hectare of potentially suitable reptile habitat. Fields containing cattle were visually surveyed by the ecologist.
- 7.1.3 At C site, the total area of suitable reptile habitat was 5.95ha. 65 tiles were laid out on 7 June 2010 as such a tile density of 10.9 tiles per hectare was achieved (see **Figure 7.2**).
- 7.1.4 Once the artificial refugia had been allowed to 'bed-in' for a period of one week, seven survey visits (Froglife, 1999) were then undertaken at C, D and E Sites, between May and early October 2010 (Tables I1 and I2 in Appendix I). On each visit, the surveyors utilised two complementary reptile survey techniques, namely checking each of the artificial refugia and any other existing refugia (e.g. discarded metal or plastic sheeting, piles of wood) and 'direct observation' of animals basking/sheltering elsewhere. Where reptiles were found to be present, a further 13 surveys were undertaken to inform a population estimate. Additionally it should be noted that Graven Hill Hilltop was included in the surveys in May 2011 and as such a further 20 surveys needed to be completed. Consequently, 40 surveys in total were undertaken at Graven Hill (covering D Sites, E Site and Graven Hill Hilltop). Due to weather



conditions it was not possible to complete two of the surveys, hence the reason why 42 survey visits are listed in Appendix I.

## 7.2 Summary of desk study

### Graven Hill

- 7.2.1 There is one historic record of reptiles occurring within 2km of the site boundary. This relates to a single record of grass snake, dating from 1987.

### C Site

- 7.2.2 There are six records of reptiles occurring within 2km of the site boundary. These relate to records of common lizard, the most recent of which dates from 2003.

## 7.3 Field survey results

### Population size class assessment

- 7.3.1 The Froglife Advice Sheet (1999) sets out a method for obtaining a relative population class size for reptile species, which is based on the maximum number of adults recorded on any single survey visit during a 20 visit population survey (**Table 7.1**).

**Table 7.1 Reptile population size classes**

Species	Low Population	Good Population	Exceptional Population
Adder	< 5	5 – 10	> 10
Grass snake	< 5	5 – 10	> 10
Common lizard	< 5	5 – 20	> 20
Slow worm	< 5	5 – 20	> 20

### Graven Hill

- 7.3.2 The surveys have identified that a ‘good population’ of common lizard occurs on Graven Hill site with a maximum count of six individuals recorded during any one survey. A ‘low population’ of grass snake also occurs on-site. No other reptile species were recorded during the survey. The locations of the reptiles recorded are shown in **Figure 7.1**. Further details of these survey findings are provided in Table I3.

### C Site

- 7.3.3 No reptiles were recorded during any of the surveys at C site (Table I4), albeit the areas of potential reptile habitat are shown in **Figure 7.2**.



## 8. Invertebrates

### 8.1 Methodology

#### Field survey

- 8.1.1 All survey work was completed over nine days. Sites D and E within Graven Hill and C Site were surveyed between 03-06 August 2010. Graven Hill Hilltop was surveyed between 07-10 July 2011. Furthermore, D and E Sites within Graven Hill and C site were surveyed for black and brown hairstreaks during July 2011. All surveys took place in generally good weather conditions, details of these are provided in Table 8.1. Survey locations are provided on Figures 8.2 and 8.3 for Graven Hill and C Site respectively. A list of species recorded is provided in Appendix J.

#### Terrestrial invertebrates

- 8.1.2 The main survey methods for terrestrial invertebrates were sweep-netting and active searching. The former involved using a 40cm diameter net mounted on a metre long angling pole. The net was passed over bare ground and through low vegetation. Material was removed selectively with a pooter (aspirator). Direct searching included searching under stones and other debris, searching flower-heads, recording butterflies and other obvious insects in flight and recording plant galls and leaf-mines.
- 8.1.3 Target groups were identified which were considered by the surveyor to be good habitat indicators. These include Orthoptera (grasshoppers and allies), Odonata (damselflies and dragonflies), shieldbugs and grassbugs, selected Coleoptera (beetles), butterflies, day-flying moths, selected Diptera and selected aculeate Hymenoptera (ants, bees and wasps).
- 8.1.4 A specific survey for the adults of black hairstreak (*Satyrrium pruni*) and to record the locations of blackthorn bushes which is the foodplant of the black and brown hairstreak (*Thecla betulae*) was also carried out. Both species are partially protected under Schedule 5 of the *Wildlife & Countryside Act 1981* (in respect of sale only) and the brown hairstreak is a UK BAP species. The black hairstreak is a rare, sedentary butterfly which is restricted to about 45 sites in the south and east Midlands and is known to occur in the immediate area outside the MOD sites (Butterfly Conservation: Upper Thames Branch 2010). It has a short flight period from mid June to mid-July and is probably the most elusive native butterfly in Britain because it spends most of its adult life in the canopies of woodland trees. Unfortunately, there are no standard survey methods for recording this species. The brown hairstreak has similar habitats and feeds on the same foodplant, blackthorn. Like, the black hairstreak, it also spends most of its adult life high in the canopy, basking and feeding on aphid honeydew. Only on warm sunny days, after mating, does the female descend to oviposit and this



is the best opportunity to see the species (males rarely descend). Brown hairstreaks occur in south-west England, south and west Midlands, southern England (except the south-east), Lincolnshire and south-west Wales. The 2011 survey was too early for the flight period of this species but the best way to record brown hairstreak is to search for the eggs which are laid on the underside of blackthorn twigs where new growth meets old growth. This needs to be undertaken in the winter months.

- 8.1.5 The locations of blackthorn bushes at both sites were noted in case winter searches of the eggs of brown hairstreak are to be undertaken. Binoculars were used to determine whether hairstreaks were present in the tree canopy at or near blackthorn bushes but no convincing sightings of black hairstreak were made.

### Aquatic invertebrates

- 8.1.6 The sample methodology used for sampling aquatic invertebrates was 3 minute kick sampling using a standard 1mm mesh hand net followed by 1 minute of hand searching. The sorting procedure involved washing the sample by placing the sample in a coarse sieve (1cm) with a finer sieve (500 microns) placed beneath and pouring water over these until the water in order to wash out mud and silt. The material caught in the coarse sieve was sorted and checked in the field for large aquatic invertebrates (i.e. large molluscs, large water beetles, mature dragonfly nymphs, etc). The washed and sieved samples were then placed into a sample container, 10% formalin was added and the samples were later sorted in the laboratory. Abundances were counted during sorting.
- 8.1.7 All aquatic macro-invertebrates have been identified to species except for the difficult taxa which include oligochaetes, water beetle larvae, chironomid larvae, etc.

## 8.2 Summary of desk study results

### Graven Hill

- 8.2.1 There are four records of UK BAP priority and nationally scarce invertebrate species occurring on-site (within Graven Hill Wood) or within 250m of the site boundary. The first of these relates to a ground beetle *Bembidion gilvipes* which was recorded in the Bicester Sewage Treatment works, a rove beetle *Philonthus fumarius*, a wall butterfly and a grizzled skipper butterfly (*Pyrgus malvae*).

### C Site

- 8.2.2 UK BAP priority invertebrate species recorded within 2km of C site are large nutmeg butterfly, rustic moth, white admiral butterfly, lackey moth, shaded broad-bar, white ermine moth, oak hook-tip, brown hairstreak and small heath butterfly. Nationally scarce or notable invertebrates include: two ground beetles *Acupalpus exiguus* and *Bembidion gilvipes* and a rove beetle *Sepedophilus pedicularius* and black hairstreak butterfly.



## 8.3 Field survey results

- 8.3.1 Details of the survey dates and weather conditions at the time of survey are provided in Table 8.1.

**Table 8.1 Survey dates and weather conditions**

Date	Weather conditions
3/8/2010	85% cloud at start of survey with cool breeze. Sunny and warm later.
4/8/2010	95% cloud at start of survey, dry and breezy at times. Heavy rain and thunder during day.
5/8/2010	85% cloud at start, breeze present, warm.
6/8/2010	100% cloud at start of survey, cool breeze, mild
7/7/2011	Sunny throughout most of day.
9/7/2011	Sunny but breezy.
10/7/2011	Sunny and hot with no breeze.

### Description of findings at Graven Hill and C Site

- 8.3.2 A total of 384 species of terrestrial invertebrate and 41 species of aquatic invertebrate species were recorded at Graven Hill. Of these four UK BAP, one Oxfordshire BAP, one Extinct, three Red Data Book, one Near Threatened and eleven Nationally Scarce (or equivalent) species and one species referred to as being 'new to Britain' were recorded at Graven Hill and these are listed and briefly discussed below. The species that are newly described to science and/or added to the British list were recorded as some of these may prove in due course to be rare or uncommon. The definitions of rarity are detailed in Appendix J.
- 8.3.3 118 species of terrestrial invertebrate and 38 species of aquatic invertebrates were recorded at C Site. Of these, two Nationally Scarce, one Near threatened and two species new to Science and Britain were recorded.
- 8.3.4 A summary of priority invertebrate species recorded at each site and details of the conservation status of each species are provided in Tables 8.2 and 8.3.



**Table 8.2 Summary of invertebrate species of high nature conservation value, recorded at Graven Hill**

Species	Level of conservation interest	Location of recording
<i>Coenonympha pamphilus</i>	UK BAP priority	E3, E10
<i>Scotopteryx chenopodiata</i>	UK BAP priority	Graven Hill central area Site 4
<i>Tyria jacobaeae</i>	UK BAP priority	D3, E3, E4, Graven Hill central area Site 2
<i>Bombus humilis</i>	UK BAP and Oxfordshire BAP	E10
<i>Stictopleurus abutilon</i>	Extinct	D3, D6
<i>Campiglossa malaris</i>	Red data book 1	D1, D3, D6, E3, Graven Hill central area Site 1
<i>Cnemacantha muscaria</i>	Red data book 3	Graven Hill central area Site 4
<i>Symmorphus connexus</i>	Red data book 3	Graven Hill central area Site 1
<i>Conocephalus discolor</i>	Nationally scarce	D4
<i>Hippodamia variegata</i>	Nationally scarce	E10
<i>Stratiomys singularior</i>	Nationally scarce	D2
<i>Pipizella virens</i>	Nationally scarce	Graven Hill central area Site 1
<i>Ictericia westermanni</i>	Nationally scarce	D1, D3, E3, E4
<i>Colobaea bifasciella</i>	Nationally scarce	E8
<i>Trachysiphonella scutellata</i>	Nationally scarce	E3
<i>Meonura minutissima</i>	Nationally scarce	Graven Hill central area Site 3
<i>Mintho rufiventris</i>	Nationally scarce	D1
<i>Oxybelus argentatus</i>	Nationally scarce	E4
<i>Nomada fucata</i>	Nationally scarce	Graven Hill central area Site 3
<i>Phasia barbifrons</i>	New to Britain in 1999	E9



**Table 8.3 Summary of invertebrate species of high nature conservation value that were recorded at C site**

Species	Level of conservation interest	Location of recording
<i>Enochrus nigrinus</i>	Near threatened	C6
<i>Homoneura thalhammeri</i>	Nationally scarce	C4
<i>Tetanocera punctifrons</i>	Nationally scarce	C5
<i>Palloptera anderssoni</i>	New to science and Britain recorded in 1988	C4
<i>Leiomyza birkheadi</i>	New to science and Britain recorded in 2006	C4

- 8.3.5 All three of the UK BAP Lepidoptera recorded at Graven Hill (small heath (*Coenonympha pamphilus*), shaded broad-bar (*Scotopteryx chenopodiata*) and cinnabar (*Tyria jacobaeae*)) are still widespread and common throughout Britain although Butterfly Conservation has evidence that all are declining. The brown-banded carder bee (*Bombus humilis*) is a genuinely scarcer insect and has suffered a more dramatic decline in its range and abundance, in line with several other bumblebee species. These declining bumblebees appear to have a requirement for large tracts of open flower-rich grassland which may be most frequent along the coast or in restricted areas such as other MOD sites (e.g. Salisbury Plain supports several rare and declining aculeate species).
- 8.3.6 The rhopalid bug *Stictopleurus abutilon* was considered to be extinct in Britain since there appeared to be no records after 1948. However, in the mid-1990's this species appeared to re-colonise southern England and since then it has occurred annually and appears to have re-established itself. This species likes, dry, open spaces, such as waste ground, pioneer grassland, etc.
- 8.3.7 The RDB1 picture-winged fly *Campiglossa malaris* was first recorded in Britain in 1974 from Kent and up to the early 1990s was still only known from two Kent sites. More recently, it has been recorded throughout Kent and elsewhere and is clearly spreading, possibly as a result of climate change or global warming (this is the case with several rare and uncommon species recorded from the survey site). This species should be downgraded from RDB1 status to reflect its increase in range and abundance.
- 8.3.8 The RDB3 lauxanid fly is mainly known from northern and western Britain and it is somewhat surprising to record it from Oxfordshire (the male genitalia of the Bicester specimen has been checked to confirm that it is this species). This is a poorly known species. The larvae of this family are generally believed to develop in decaying plant matter. The RDB3 eumenid wasp *Symmorphus connexus* is mainly known from south east England extending as far as Oxfordshire (there are odd outlying records further



north and west). This species has been recorded provisioning its burrows with the larvae of a specific leaf beetle and micro-moth.

- 8.3.9 The Near Threatened water beetle *Enochrus nigrinus* is confined to southern and eastern England where it has been recorded from mesotrophic and base-rich fens in lowlands. Foster (2010) gives a definition of the 'Near Threatened' IUCN status.
- 8.3.10 A total of thirteen Nationally Scarce species were recorded. Some of these are species that were formerly rare but have since expanded their ranges such as the long-winged conehead (*Conocephalus discolor*) and the adonis ladybird (*Hippodamia variegata*). The larva of what appears to be the soldier-fly *Stratiomys singularior* was recorded in one of the aquatic samples (larvae of this species and *S. longicornis* are difficult to differentiate but the latter is extremely unlikely to occur in Oxfordshire). The hoverfly (*Pipizella virens*) is a small species restricted mainly to south-eastern England and whose larvae may be associated with aphids on the roots of white umbels. The distinctive picture-winged fly *Ictericia westermanni* may also have spread in recent years and this species is also associated with hoary ragwort (*Senecio erucifolius*) like the RDB1 *Campiglossa malaris*. The lauxaniid *Homoneura thalhammeri* is associated with woody scrub such as (*Salix caprea*) and other *Salix* species often in damp conditions. Two infrequent snail-killing flies were recorded namely, *Colobaea bifasciella* and *Tetanocera punctifrons*; both are associated with aquatic snails in lush marginal vegetation around ponds, ditches and lakes. The minute chloropid (*Trachysiphonella scutellata*) was given Notable status by Falk (1991) but was relegated in the recent unpublished review by Falk and Ismay (in prep.). *Trachysiphonella* species are often associated with basic grasslands and may be associated with ants. The minute carnid *Meonura minutissima* in the larval stage may be associated with bird's nests, carrion, and/or dung whilst the adult has been recorded from chalk downland, moorland and woodland. The distinctive parasite fly *Mintho rufiventris* has mainly been recorded from grassland and woodland; the larvae is a parasite on the caterpillars of a pyralid moth. The solitary wasp *Oxybelus argentatus* has mainly been recorded from coastal grasslands but occurs sparingly inland in southern England. The female wasp provisions her nests with flies, which are carried to the burrow, impaled on the sting. The nomad bee *Nomada fucata* is widely distributed throughout southern England and South Wales. It parasitizes the nests of the mining bee *Andrena flavipes* and both the parasite and the host are found in open countryside.
- 8.3.11 Amongst the species new to Britain in recent years, the harlequin ladybird (*Harmonia axyridis*) and the horse chestnut leafminer (*Cameraria ohridella*), have spread rapidly since arriving and are both considered pest species. The tachinid *Phasia barbifrons* appears to be relatively widespread and frequent in grasslands, heathland and on waste ground sites (this species was added to the British list by Clemons 2001). *Palloptera anderssoni* is externally identical to the common *P. ustulata* and until more records are forthcoming, the status of this species is unclear (this species was described by Rotheray and MacGowan 1998). The same may also be true of the minute *Leiomyza birkheadi* which is externally identical to *L. laevigata*: the only records of this species are those published by Gibbs and Papp (2006). The bumblebee *Bombus hypnorum*





was added to the British list in 2000 and has quickly spread and become relatively frequent throughout England.

## 8.4 Description of habitats in which invertebrates occur at Graven Hill and C site

### Woodland and woody scrub

- 8.4.1 The woodland at the centre of Graven Hill is an area of ancient woodland and is the most valuable habitat for invertebrates that occurs on either of the sites. The number of rare and uncommon invertebrate species may not reflect this, but the presence of many features of invertebrate value (such as the size of the woodland, its semi-natural nature, presence of dead and decaying wood, good plant species richness and structure, extensive woodland edges, frequent clearings, rides and paths, damp nature of the soil, etc.) indicates it should be of high invertebrate nature conservation value. The other areas of woodland and woody scrub also provide valued areas of habitat for invertebrates.
- 8.4.2 Several species of interest were recorded from the woodlands. The Nationally Scarce carnid *Meonura minutissima* and nomad bee *Nomada fucata* were recorded from the central woodland at Graven Hill. The cinnabar moth was also recorded here although in the cleared area near the water tank. *Palloptera anderssoni* and *Leiomyza birkheadi*, which were described as new to science in 1998 and 2006 respectively, partly from British material, may be genuinely rare species but more records are probably required to establish this. *Palloptera anderssoni* has been found in England since its description but the author is aware of no additional records of *Leiomyza birkheadi* since it was described. The former has been bred from under the bark of birch, lime and sycamore whilst the latter has been collected from fungi in woodland, parkland and an old hedgerow. The anomalid ichneumon *Gravenhorstia cerinops* is uncommon in woodlands according to Gauld and Mitchell (1977). The holly blue is a local butterfly which can disappear in some years, only to be frequent in others.
- 8.4.3 *Homoneura thalhammeri* is associated with wet woody scrub particularly willow and other willows and was the only definite uncommon scrub associated insects recorded on the survey. Woody scrub was frequent on the site but usually fringed mixed woodland and seldom formed discrete stands of woody scrub. Isolated woody scrub can be valuable for invertebrates, for example along watercourses.

### Grassland

- 8.4.4 The vast majority of the rare and uncommon insects recorded are associated to a greater or lesser degree with unimproved or species-rich semi-improved grassland. These include the three UK BAP species, the small heath, cinnabar and brown-banded carder bee, the long-winged conehead *Conocephalus discolor*, the adonis ladybird *Hippodamia variegata* and the chloropid *Trachysiphonella scutellata*. The picture-winged flies *Campiglossa malaris* and *Ictericia westermanni* whose larvae feed on



ragworts are usually found in ruderal stands within grassland. The grassland at Graven Hill appears to be relatively species-rich for invertebrates. It also appears to be relatively species-rich for plants which might be taken as a good indicator of their potential invertebrate conservation value. The presence of dry banks of varying aspects, slopes, frequent bare ground, and the apparent lack of high inputs of herbicides, insecticides and fertilisers are factors which might explain why they are of value to native invertebrates.

### Waste ground

- 8.4.5 Waste ground is often the characteristic habitat of the 'Extinct' rhopalid bug *Stictopleurus abutilon*. Several of the 'grassland' species mentioned above also regularly occur in this habitat including the small heath, cinnabar, long-winged conehead, adonis ladybird and *Icterica westermanni*. Waste ground was restricted to small areas of Graven Hill site and cannot be considered an important habitat on the sites.

### Hedgerows

- 8.4.6 No rare or uncommon species specific to hedgerows were recorded on the survey but these can be important for insects in region, for example, hairstreak butterflies may utilise hedgerow trees or bushes.

### Ditches and ponds

- 8.4.7 The Near Threatened water beetle *Enochrus nigrinus*, the Nationally Scarce soldier-fly *Stratiomys singularior* and the snail killing fly *Colobaea bifasciella* are associated with lowland fens, marshes, ponds and ditches to a greater or lesser degree. *Stratiomys singularior* is more frequent in coastal brackish ditches and *Colobaea bifasciella* may have a requirement for ponds and ditches to dry out (or for snails to get stranded on receding drawdown zones).
- 8.4.8 *Tetanocera punctifrons* is also strongly associated with wetlands but these include damp woodland and riverside locations.
- 8.4.9 The ditches appear not to be outstanding for invertebrate conservation. All the natural ponds examined on both the sites were dry and consequently could not be sampled for aquatic invertebrates. Seasonal ponds can be important for invertebrates but those in Oxfordshire are not known to support particularly significant species (such as the fairy shrimp *Cheirocephalus diaphanous* or tadpole shrimp *Triops cancriformis*) are consequently they are not likely to be more than local (or district) significance for invertebrates.

## 8.5 Areas of habitat important for invertebrates

- 8.5.1 The invertebrate habitat assessment concluded that of the habitats present on-site, that the central woodland at Graven Hill is the most important invertebrate habitat on



either of the two sites. The semi-improved grassland fields at Graven Hill appear to represent the second most valuable invertebrate habitat with the majority of the rare and uncommon species associated with this habitat. Overall, there is a useful mosaic of habitats present on both sites which provide a range of conditions for a wide variety of invertebrate species.





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## 9. Birds

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### 9.1 Methodology

- 9.1.1 A generic breeding bird survey was carried out following a method based on the British Trust for Ornithology's Common Bird Census (CBC) methodology<sup>9</sup> (Gilbert *et al.*, 1998). The survey area comprised all habitats within the site boundary and any surrounding areas which could be surveyed from within the site boundary<sup>10</sup>. A total of 3 survey visits per site were carried out during the 2011 breeding season. As the Graven Hill site was initially treated as three separate sites (E Site, D Site and Graven Hill), each survey visit was undertaken over three mornings. The dates and weather conditions of the respective days are given below.

#### Graven Hill

##### April

- Site E: 4 April 2011. Cloud cover: 1/8. Wind: SW 0-1.
- Site D: 8 April 2011. Cloud cover 0/8. Wind: 0.
- Graven Hill: 12 April 2011. Cloud cover: 1/8. Wind: NE 2-3.

##### May

- Site E: 20 May 2011. Cloud cover: 2/8. Wind: 0.
- Graven Hill: 19 May 2011. Cloud cover: 0/8. Wind: 0.
- Site D: 23 May 2011. Cloud cover: 3/8. Wind: N 3-4.

##### June

- Site E: 7 June 2011. Cloud cover: 1/8. Wind: SW 2.
- Graven Hill: 17 June 2011. Cloud cover: 2-8/8. Wind: SW 1-3.

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<sup>9</sup> While eight to ten visits are the norm for CBC sites being monitored over the long-term, where territory mapping is being used for the purpose of assessing potential environmental impacts it is generally accepted that three visits are sufficient to determine the numbers and densities of breeding birds with reasonable accuracy.

<sup>10</sup> Not all birds noted outside the site boundary will necessarily occur within the site boundary, but as a precaution, these were included within the assessment, as as part of the territories they hold may overlap the site. The areas outside the site boundary where not accessed due to restrictions.



- Site D: 8 June 2011. Cloud cover: 7/8. Wind: SW 1.

### C Site

- 7 April 2011. Cloud cover: 1/8. Wind: SW 0-1.
- 20 May 2011. Cloud cover 2/8. Wind: 0.
- 7 June 2011. Cloud cover: 1/8. Wind: SW 2.

- 9.1.2 All habitats within the survey area were exhaustively surveyed during all three visits. The location and activity of each bird detected (visually and/or aurally) was recorded. Birds were considered to be demonstrating breeding behaviour if they were singing, displaying, alarm calling, carrying food, undertaking distraction displays or if eggs or chicks were found. All birds engaged in other forms of behaviour were considered to be feeding, loafing or passing through. They were not, therefore, considered to be breeding in the location of observation. The location of each bird was mapped using standard two-letter BTO Codes, and bird activity was recorded using BTO behaviour codes.
- 9.1.3 The field maps from the various visits were analysed and combined to produce the final territory location map which was used to estimate the breeding densities of each species. As territory locations are derived from a combination of each visit map (as per the CBC methodology), it should be noted that these do not generally represent specific nest locations (this is not the aim of this survey method which was designed to estimate population sizes).

## 9.2 Summary of desk study results

### Graven Hill

- 9.2.1 The desk study identified the following *Wildlife & Countryside Act*, Schedule 1 bird species to occur within 2km of the site boundary: Pintail, bittern (*Botaurus stellaris*), merlin (*Falco columbarius*), hobby (*Falco subbutteo*), peregrine, little ringed plover (*Charadrius dubius*), black-tailed godwit (*Limosa limosa*), green sandpiper (*Tringa ochropus*), greenshank (*Tringa nebularia*), barn owl and kingfisher (*Alcedo atthis*). These records were all registered between 2000 and 2004;
- 9.2.2 UK BAP priority bird species identified within 2km are: Lapwing (*Vanellus vanellus*), curlew (*Numenius arquata*), cuckoo (*Cuculus canorus*), yellow wagtail (*Motacilla flava*), grasshopper warbler, marsh tit (*Parus palustris*), willow tit (*Parus montanus*), linnet (*Acanthis cannabina*), twite (*Carduelis flavirostris*), yellowhammer (*Emberiza citrinella*) and reed bunting (*Emberiza schoeniclus*). These records were all registered between 2000 and 2004.



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### C Site

- 9.2.3 The desk study identified that the only *Wildlife & Countryside Act*, Schedule 1 bird species that has been recorded within 2km of C Site is Barn owl (*Tyto alba*). This record is associated with Bicester Garrison LWS.
- 9.2.4 UK BAP priority species recorded within 2km of the site boundary include: cuckoo and curlew, willow warbler, kestrel (*Falco tinnunculus*) and green woodpecker (*Picus viridis*).

## 9.3 Field survey results

### Graven Hill

- 9.3.1 During the survey programme 46 species were recorded holding territory within the survey area. The indicative territory locations of the species recorded are shown in Figure 9.1. The number of territories of each species within the survey area is given in Table 9.1. This table also summarises the conservation status for all 46 species.



**Table 9.1** Number of territories and conservation status of species recorded in the survey area

Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>11</sup> / UK BAP Priority Species <sup>12</sup>	Birds of Conservation Concern Red List <sup>13</sup>	Birds of Conservation Concern Amber List
Pheasant	PH	2				
Red kite	KT	1	√			√
Sparrowhawk	SH	1				
Buzzard	BZ	3				
Kestrel	K	2				√
Feral pigeon	FP	5 <sup>14</sup>				
Stock dove	SD	9				√
Woodpigeon	WP	41				
Collared dove	CD	6				
Barn owl	BO	1	√			√
Green woodpecker	G	14				√
Great spotted woodpecker	GS	13				

<sup>11</sup> The Secretary of State for Environment, Food and Rural Affairs was required under Section 41(1) of the Natural Environment and Rural Communities Act (NERC) 2006 to prepare a list of the species and habitats considered to be of principal importance for the purpose of conserving biodiversity in England. Under Section 41 of the act, consultation was required with Natural England in determining the species and habitats to appear on the list and also to take steps (where they are reasonably practicable), and promote the taking of steps by others, to further the conservation of the habitats and species on the list. The Section 41 list replaces the list published by Defra in 2002 under Section 74 of the Countryside and Rights of Way (CRoW) Act 2000.

<sup>12</sup> The Oxfordshire BAP lists which species of the UKBAP are found in Oxfordshire. No separate list of Priority Species exists for this County.

<sup>13</sup> The background to the establishment of a 'traffic light system' of conservation concern for UK birds is discussed in Gregory *et al.* (2002). The updated criteria and lists are detailed in Eaton *et al.* (2009). Broadly, 'Red-listed' species include those that are globally threatened, have suffered a historical population decline in the UK (between 1800 and 1995) or which have experienced rapid declines in their UK breeding population or contractions in their UK range of more than 50% over the past twenty-five years.

<sup>14</sup> These 5 pairs are concentrated in the southern end of Site E, represented by a single territory on Figure 9.1.





Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>11</sup> / UK BAP Priority Species <sup>12</sup>	Birds of Conservation Concern Red List <sup>13</sup>	Birds of Conservation Concern Amber List
Skylark	S	3		√	√	
Swallow	SL	3				√
Pied wagtail	PW	3				
Wren	WR	125				
Dunnock	D	46		√		√
Robin	R	113				
Blackbird	B	45				
Song thrush	ST	15		√	√	
Mistle thrush	M	6				√
Blackcap	BC	67				
Garden warbler	GW	8				
Lesser whitethroat	LW	8				
Whitethroat	WH	27				√
Chiffchaff	CC	53				
Willow warbler	WW	16				√
Goldcrest	GC	21				
Long-tailed tit	LT	18				
Blue tit	BT	102				
Great tit	GT	74				
Coal tit	CT	12				
Marsh tit	MT	7		√		
Nuthatch	NH	5				
Treecreeper	TC	10				
Jay	J	6				
Magpie	MG	19				
Jackdaw	JD	2				
Rook	RO	15 <sup>15</sup>				

<sup>15</sup> This rookery is located near the main entrance to Site E and shown as a single territory on Figure 9.1.



Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>11</sup> / UK BAP Priority Species <sup>12</sup>	Birds of Conservation Concern Red List <sup>13</sup>	Birds of Conservation Concern Amber List
Carrion crow	C	18				
Starling	SG	3		√	√	
Chaffinch	CH	56				
Greenfinch	GR	24				
Goldfinch	GO	13				
Linnet	LI	12		√	√	
Bullfinch	BF	13		√	√	

- 9.3.2 A total of five species listed under Section 41 and the BoCC Red list were recorded breeding in the survey area: skylark, song thrush, starling, linnet and bullfinch. Two BoCC Amber-listed species which are also listed in Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) were recorded: red kite and barn owl. Dunnock, which is listed under Section 41 and the BoCC Amber list, was also recorded breeding here, as was marsh tit which is listed under Section 41 only. A further seven BoCC Amber-listed species were recorded breeding: kestrel, stock dove, green woodpecker, swallow, mistle thrush, whitethroat and willow warbler. The bird population as a whole was found to consist of a fairly typical mix of woodland and open countryside species.
- 9.3.3 A possible pair of red kite was found to be holding territory at Graven Hill and a disused nest was located in the eastern section of the main woodland. This was deemed to have been used until fairly recently, as scraps of cloth and other debris were located beneath the nest and in limbs surrounding it, but the main body of the nest had partly collapsed and was no longer usable. Adult birds were seen however in the immediate vicinity of this nest on a number of occasions, both during the breeding bird surveys and other protected species surveys carried out in the spring of 2011.
- 9.3.4 Similarly, a probable male barn owl was recorded on several occasions at the southern end of Site D using an old barn owl nest box as a day-roost. No evidence of breeding was detected at this box<sup>16</sup>, however it is possible that this bird is part of a pair breeding in the vicinity.

<sup>16</sup> It should be noted that no internal inspection was carried out due to the unstable nature of the nest box, however, no chicks were heard vocalising within the box during any visit, suggesting that the nest is located elsewhere.



- 9.3.5 An additional nine species were also recorded for which breeding was not determined: mallard, Canada goose, lesser black-backed gull, herring gull, little owl, swift, house martin, lesser redpoll and redstart. The latter species was recorded in April and was therefore likely to be on passage only and the lesser redpoll is likely to be a late-departing wintering bird in this area. The remaining species may breed within the general area, though evidence of a territory being held was not noted.

## C Site

- 9.3.6 During the survey programme 36 species were recorded holding territory within the survey area. The indicative territory locations of the species recorded are shown in Figure 9.2. The number of territories of each species within the survey area is given in Table 9.1. This table also summarises the conservation status for all 36 species.

**Table 9.2 Number of territories and conservation status of species recorded in the survey area**

Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>17</sup> / UK BAP Priority Species <sup>18</sup>	Birds of Conservation Concern Red List <sup>19</sup>	Birds of Conservation Concern Amber List
Kestrel	K	1				√
Stock dove	SD	5				√
Woodpigeon	WP	15				
Collared dove	CD	2				

<sup>17</sup> The Secretary of State for Environment, Food and Rural Affairs was required under Section 41(1) of the Natural Environment and Rural Communities Act (NERC) 2006 to prepare a list of the species and habitats considered to be of principal importance for the purpose of conserving biodiversity in England. Under Section 41 of the act, consultation was required with Natural England in determining the species and habitats to appear on the list and also to take steps (where they are reasonably practicable), and promote the taking of steps by others, to further the conservation of the habitats and species on the list. The Section 41 list replaces the list published by Defra in 2002 under Section 74 of the Countryside and Rights of Way (CROW) Act 2000.

<sup>18</sup> The Oxfordshire BAP lists which species of the UKBAP are found in Oxfordshire. No separate list of Priority Species exists for this County.

<sup>19</sup> The background to the establishment of a 'traffic light system' of conservation concern for UK birds is discussed in Gregory *et al.* (2002). The updated criteria and lists are detailed in Eaton *et al.* (2009). Broadly, 'Red-listed' species include those that are globally threatened, have suffered a historical population decline in the UK (between 1800 and 1995) or which have experienced rapid declines in their UK breeding population or contractions in their UK range of more than 50% over the past twenty-five years.



Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>17</sup> / UK BAP Priority Species <sup>18</sup>	Birds of Conservation Concern Red List <sup>19</sup>	Birds of Conservation Concern Amber List
Barn owl	BO	1	√			√
Green woodpecker	G	2				√
Great spotted woodpecker	GS	3				
Skylark	S	4		√	√	
Swallow	SL	6				√
House martin	HM	2				√
Pied wagtail	PW	3				
Wren	WR	26				
Dunnock	D	14		√		√
Robin	R	32				
Blackbird	B	22				
Song thrush	ST	6		√	√	
Mistle thrush	M	3				√
Blackcap	BC	21				
Garden warbler	GW	1				
Whitethroat	WH	6				√
Chiffchaff	CC	28				
Willow warbler	WW	7				√
Goldcrest	GC	2				
Long-tailed tit	LT	1				
Blue tit	BT	35				
Great tit	GT	20				
Magpie	MG	7				
Jackdaw	JD	3				
Carriion crow	C	6				
Starling	SG	8		√	√	
Chaffinch	CH	26				
House sparrow	HS	1		√	√	
Greenfinch	GR	13				



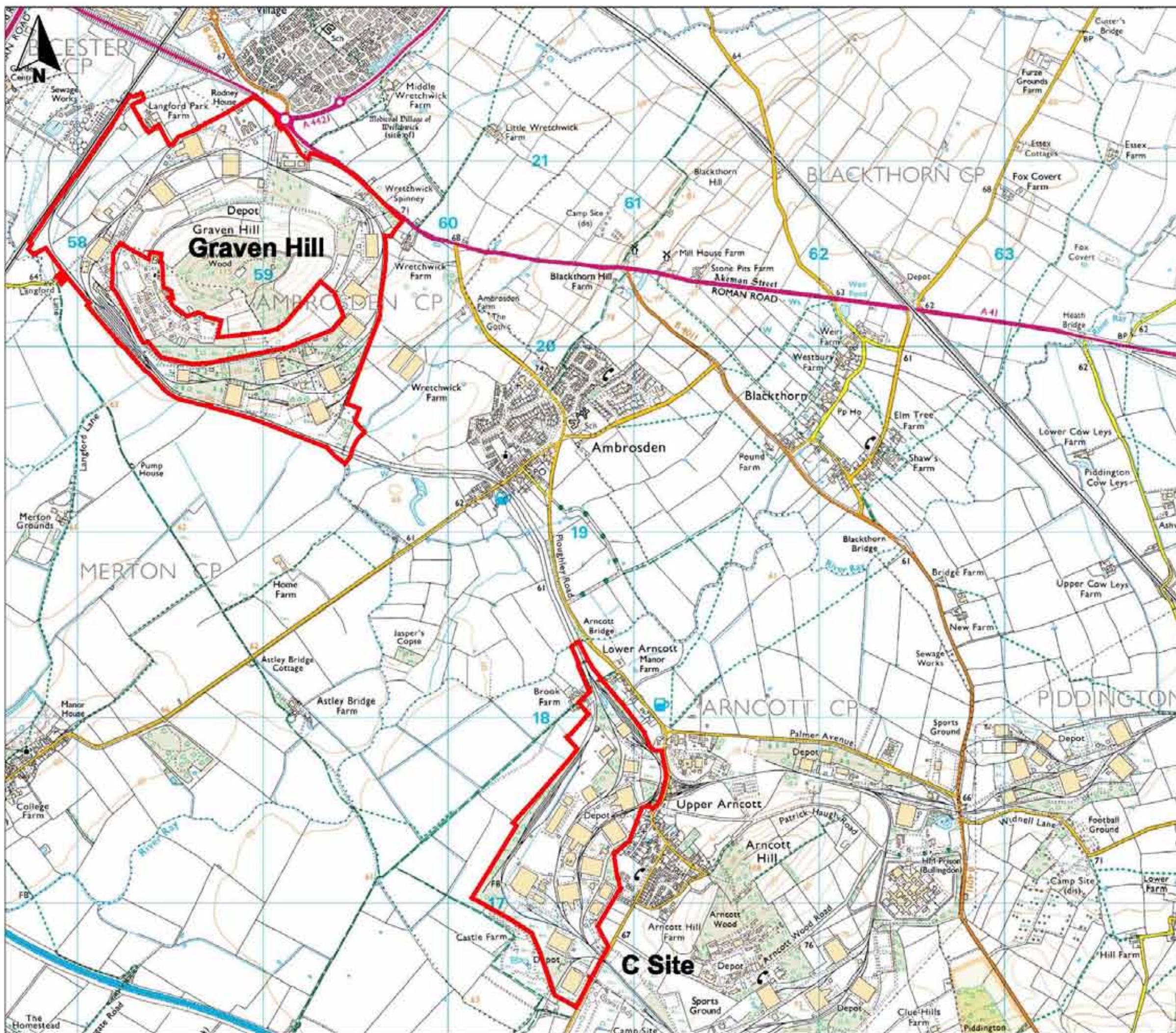
Species	BTO code	Number of territories recorded	Wildlife and Countryside Act 1981 (as amended) Schedule 1 Species	Section 41 <sup>17</sup> / UK BAP Priority Species <sup>18</sup>	Birds of Conservation Concern Red List <sup>19</sup>	Birds of Conservation Concern Amber List
Goldfinch	GO	8				
Linnet	LI	1		√	√	
Bullfinch	BF	8		√	√	

- 9.3.7 A total of six species listed under Section 41 and the BoCC Red list were recorded breeding in the survey area: skylark, song thrush, starling, house sparrow, linnet and bullfinch. One BoCC Amber-listed species which is also listed under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) was recorded: barn owl. Dunnock, which is listed under Section 41 and the BoCC Amber list, was also recorded breeding here, as were a further eight BoCC Amber-listed species: kestrel, stock dove, green woodpecker, swallow, house martin, mistle thrush, whitethroat and willow warbler. The bird population as a whole was found to consist of a fairly typical mix of woodland, open countryside and parkland species.
- 9.3.8 Evidence of barn owl within Site C was plentiful, though no active nest was noted during the 2011 surveys. Several artificial nest sites are present with the site, as are a number of small disused buildings. The majority of the evidence of barn owl presence was found around and within an artificial nest box at the southern end of the site. The back panel of this box had been recently removed or had fallen away, revealing extensive pellets deposited over a number of breeding seasons, as well as several old egg shells, suggesting this was a regularly used nest until very recently. One single storey, brick shed located on the western side of the site also featured two permanent entrances and two purposefully installed tea-chests for barn owl. However, this building has been recently opened and the door damaged, leaving the space inside exposed. The chests were not used by barn owls during the surveys and no evidence to suggest previous use by this species was recorded. A single, fresh pellet was however found outside this building in April. The evidence suggests that barn owl has bred in the area in the past and still occurs on site.
- 9.3.9 An additional nine species were also recorded for which breeding was not determined: buzzard, sparrowhawk, red kite, lesser black-backed gull, black-headed gull, heron, swift and lapwing. All these species may have bred in the wider area surrounding the site.









**Key**

Site boundary

0 m 1000 m  
Scale 1:20,000 @ A3



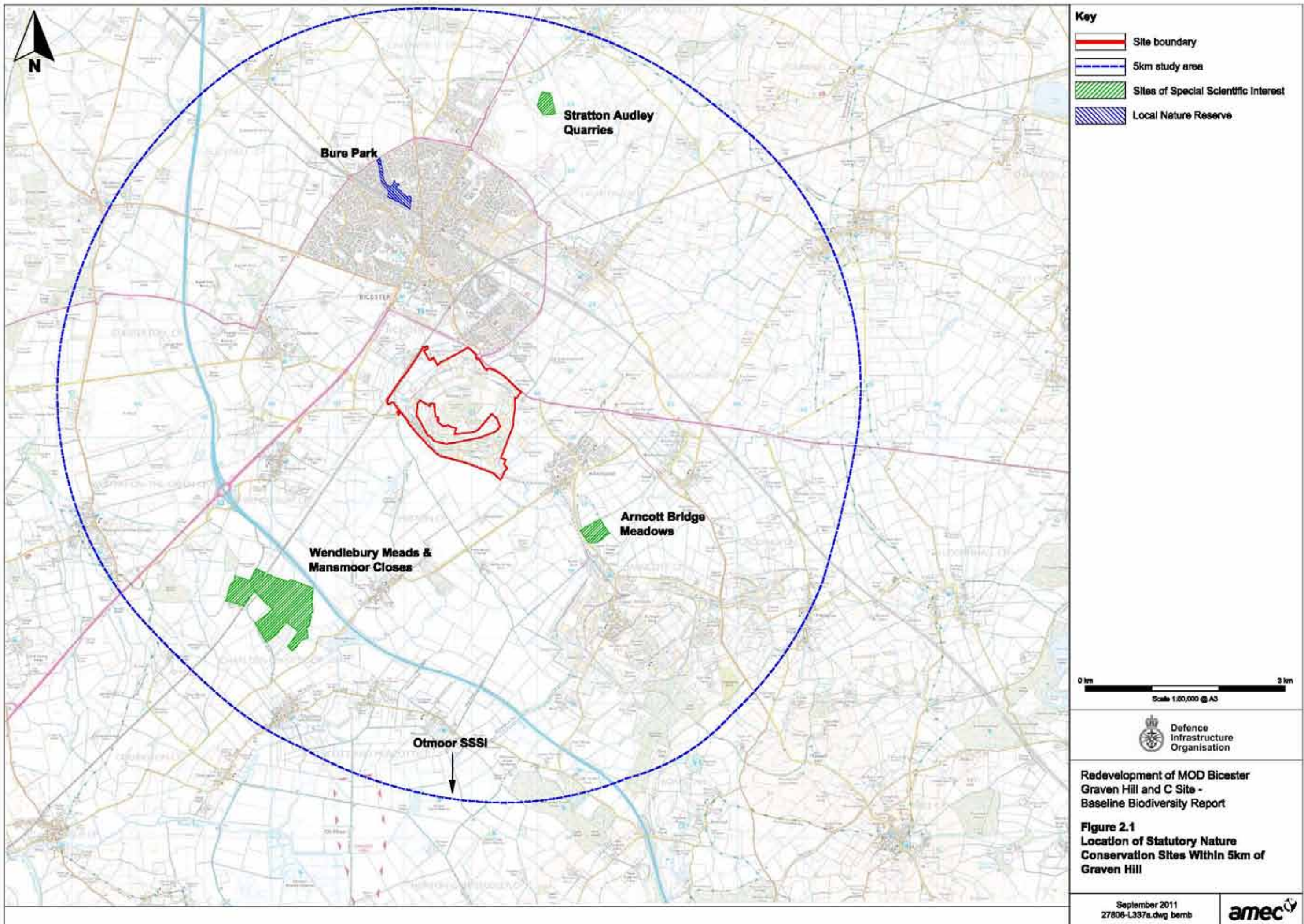
**Redevelopment of MOD Bicester  
Graven Hill and C Site -  
Baseline Biodiversity Report**

**Figure 1.1  
Locations of Graven Hill and C Site**

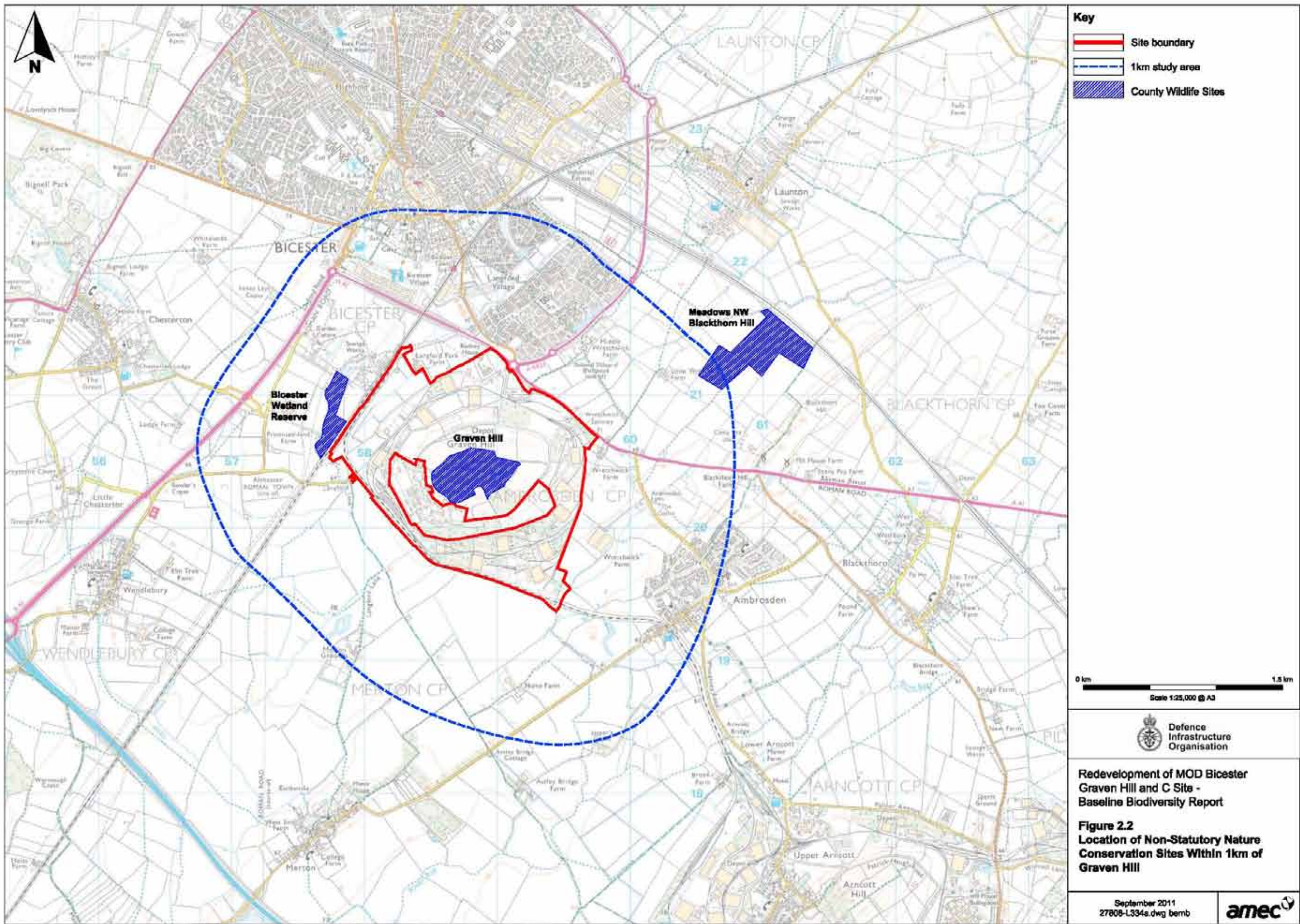
August 2011  
27808-L364.dwg bomb

**amec**

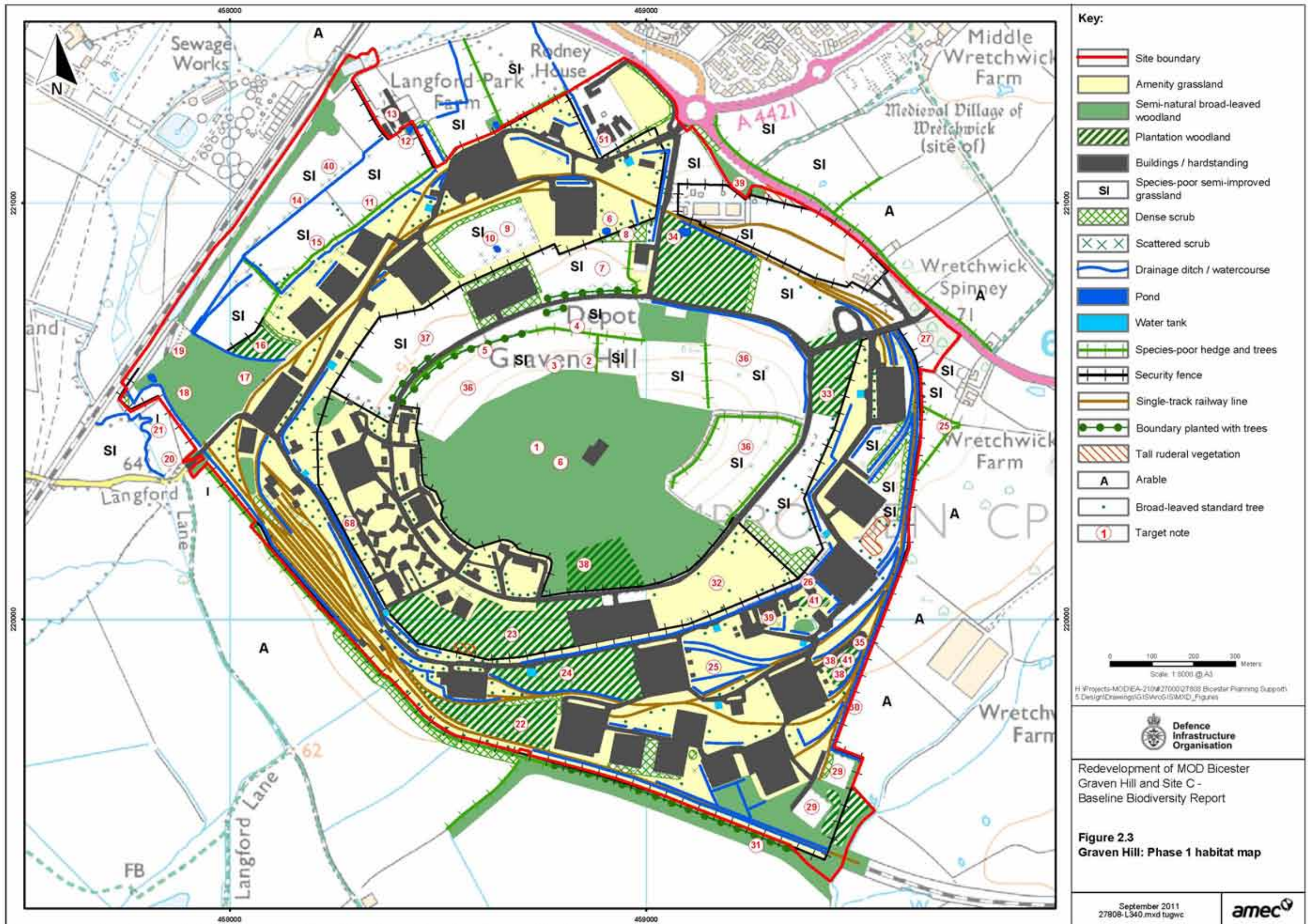




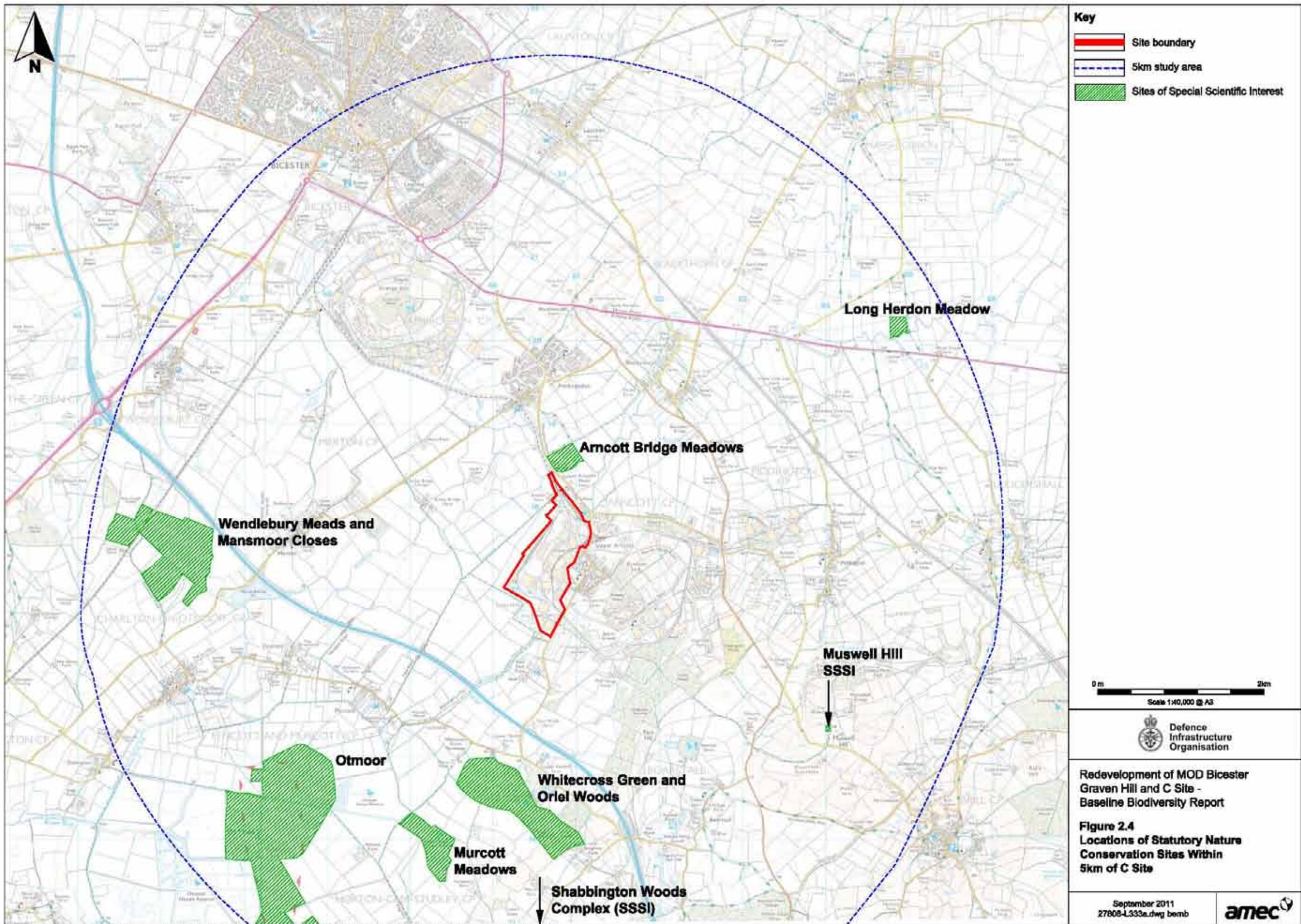




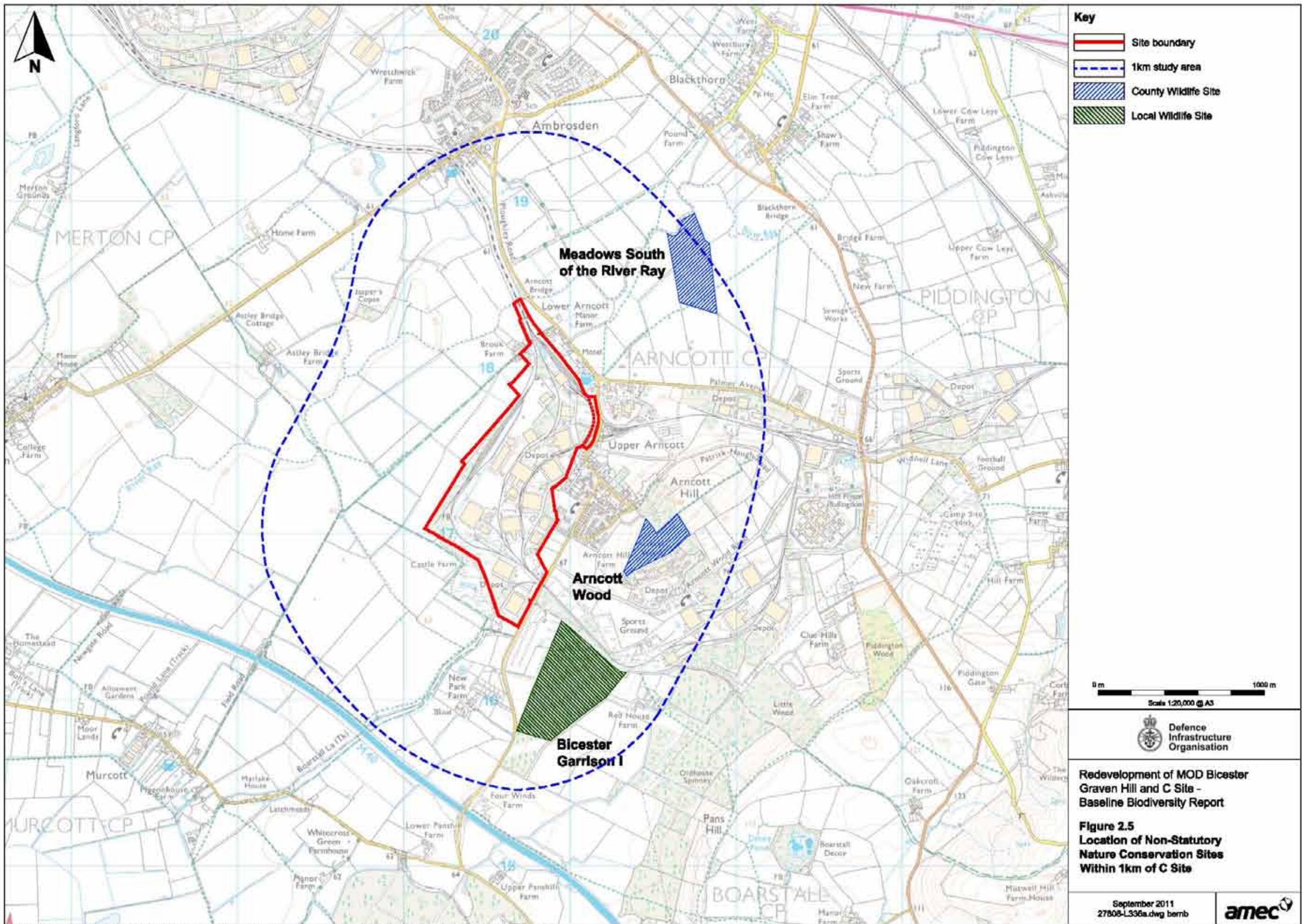




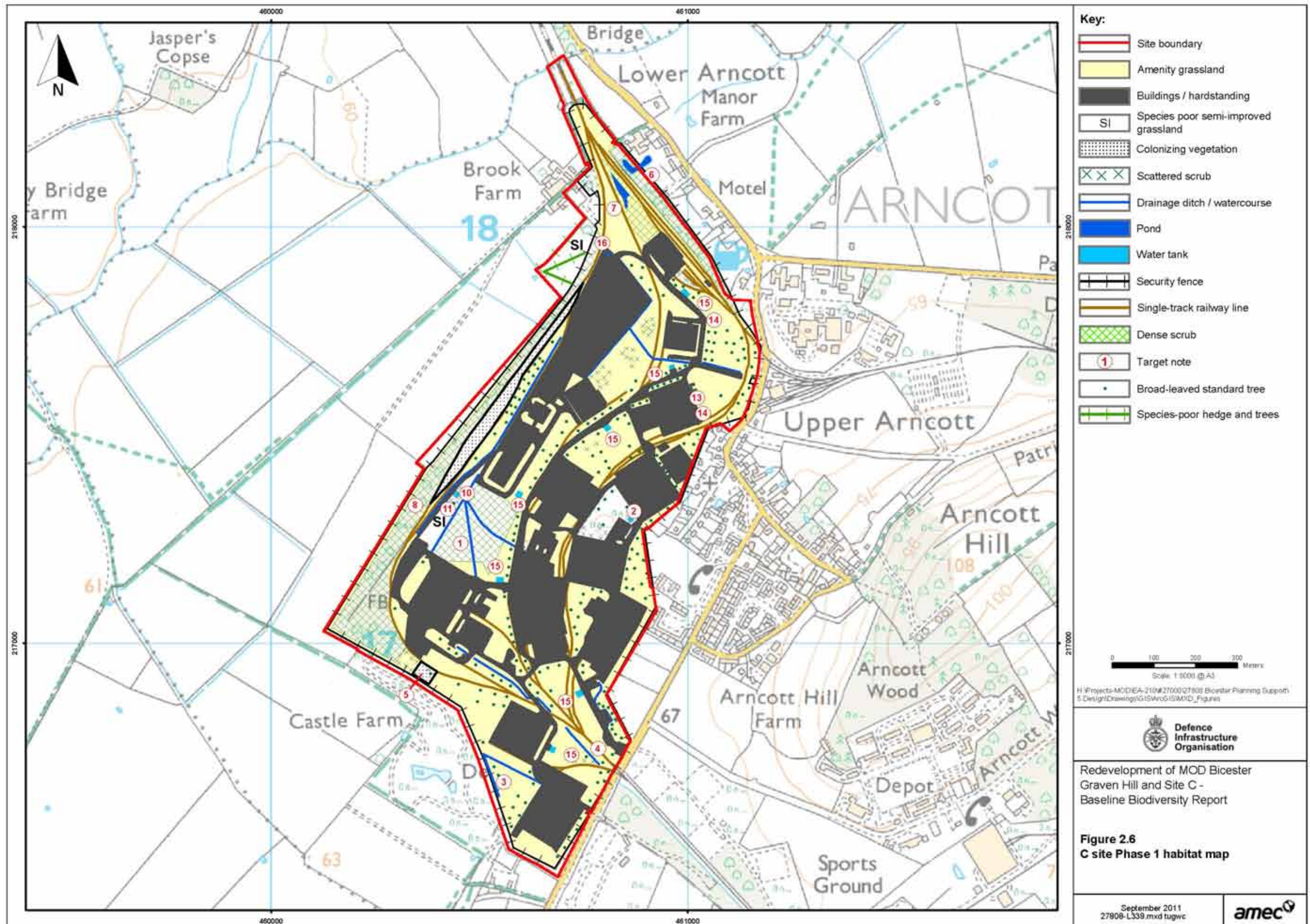




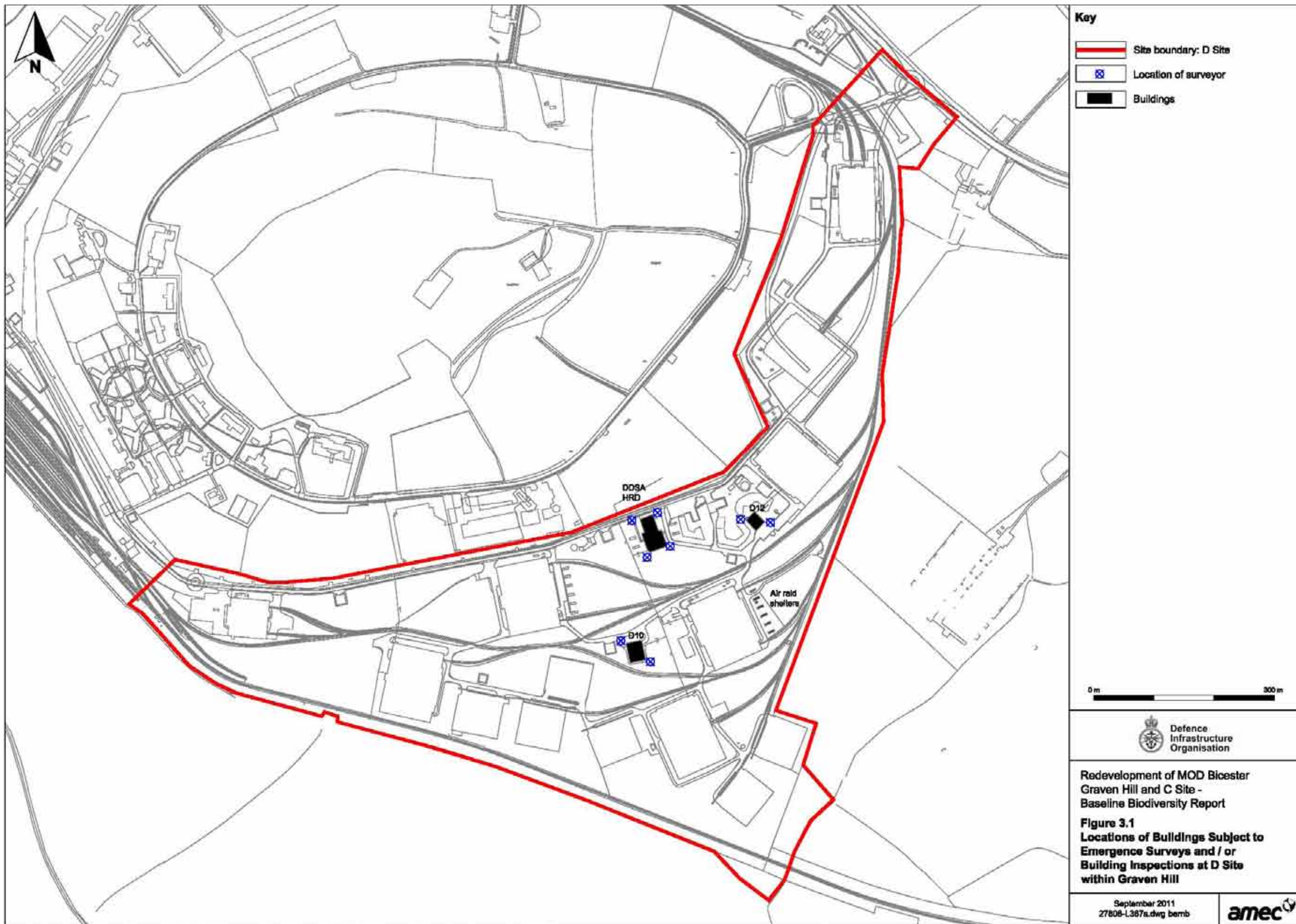




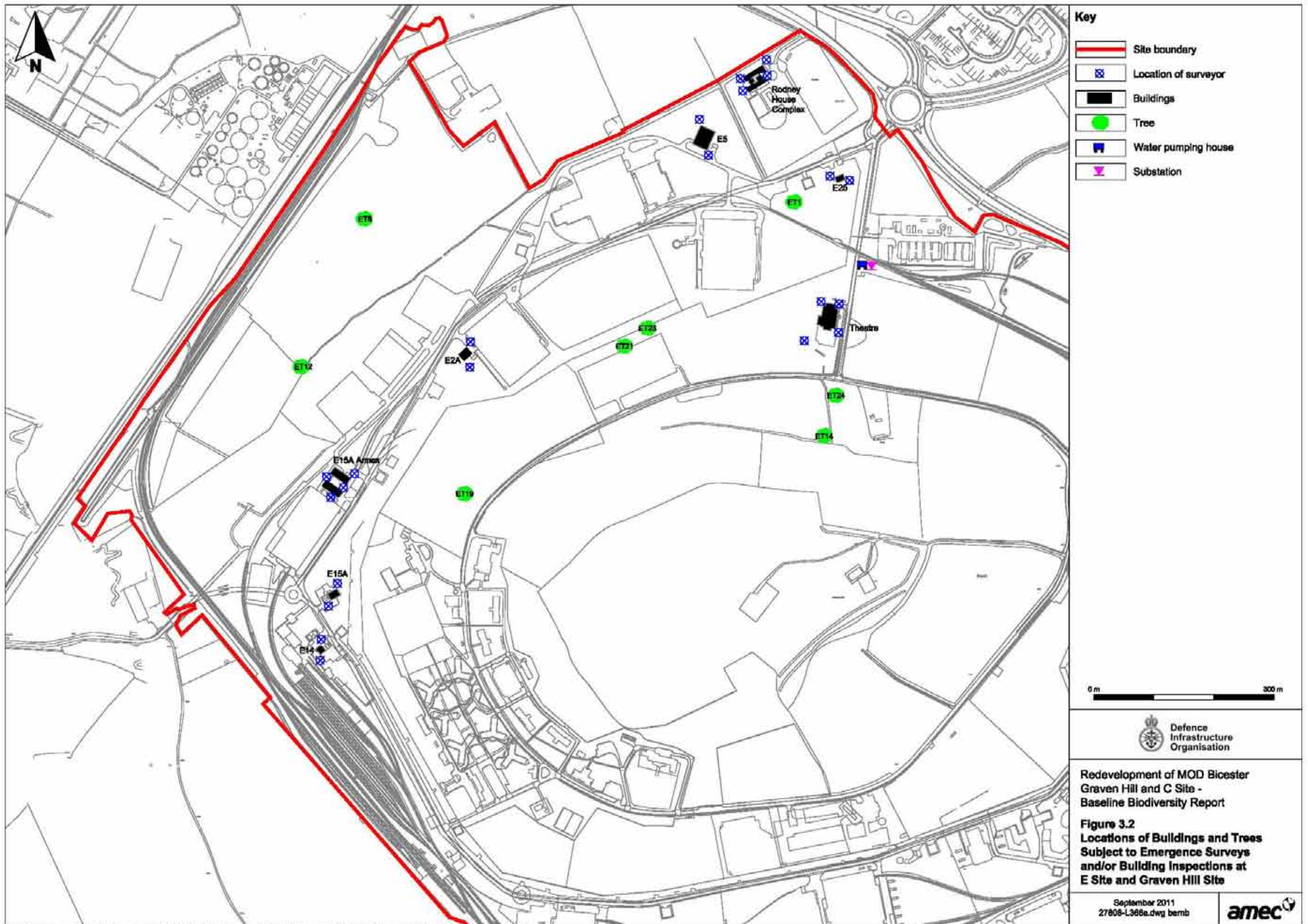




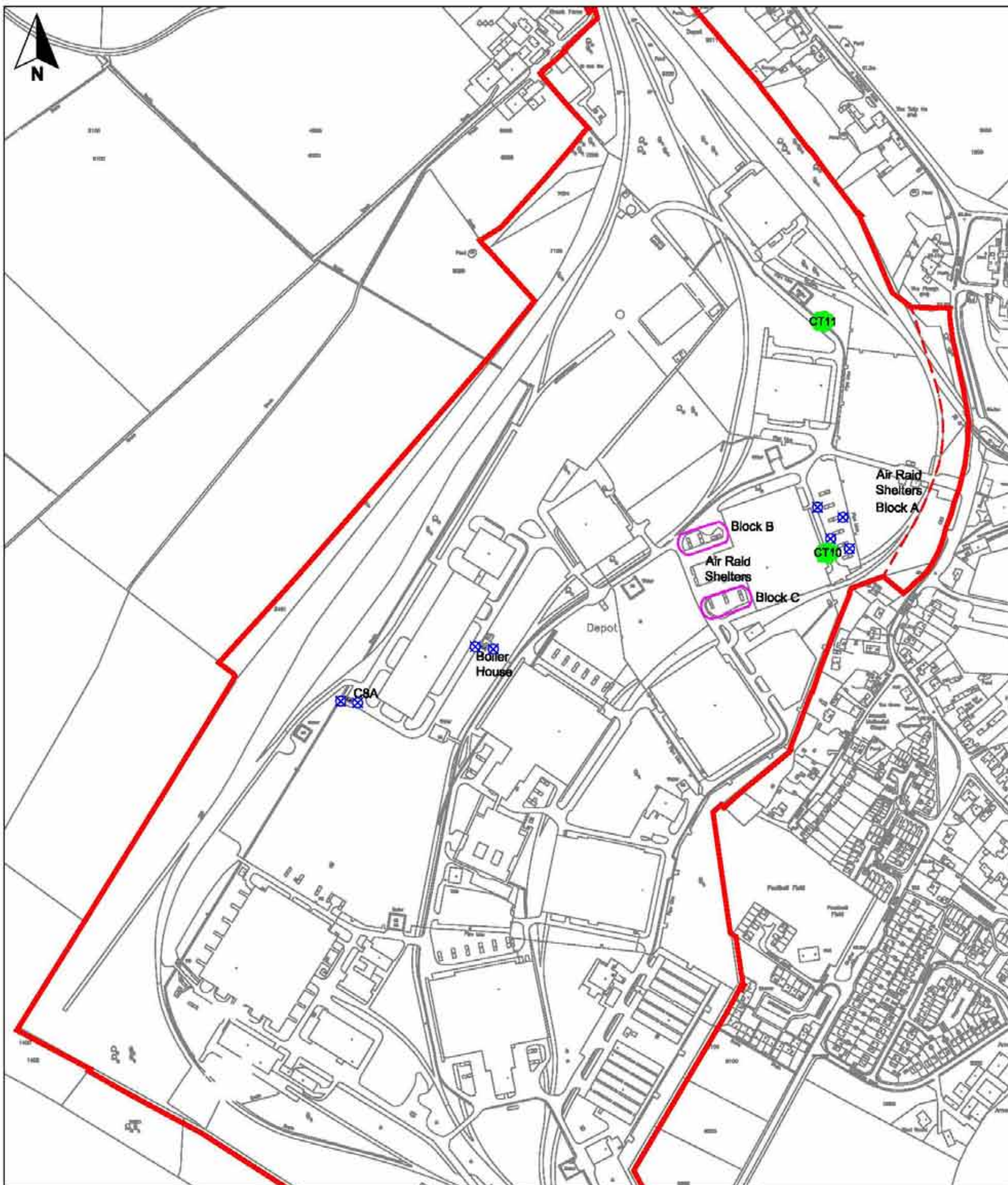












#### Key

- Site boundary
- Location of surveyor
- Buildings
- Tree
- Walking transect around air raid shelters



Defence  
Infrastructure  
Organisation

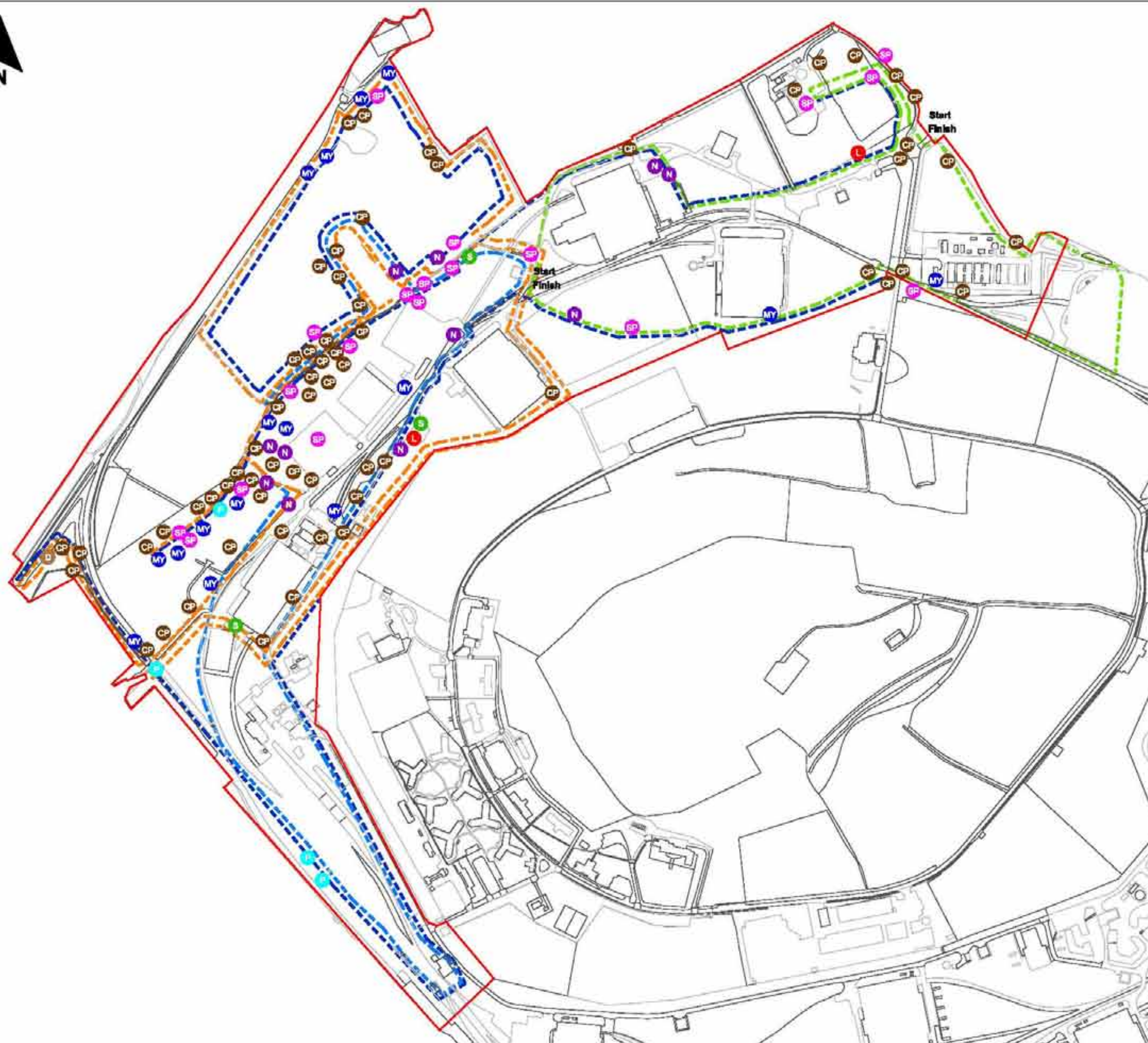
Redevelopment of MOD Bicester  
Graven Hill and C Site -  
Baseline Biodiversity Report

**Figure 3.3**  
**Locations of Buildings and Trees**  
**Subject to Emergence Surveys -**  
**C Site**

August 2011  
27608-L365.dwg bamb

**amec**





# Key

- Site boundary
- CP Common pipistrelle bat
- SP Soprano pipistrelle bat
- MY Myotis bat
- S Serotine bat
- N Noctule bat
- D Daubenton's bat
- P Pipistrelle bat
- L Leisler's bat

## Transects

- Transect A
- Transect B
- Transect C
- Transect D

0 m  300 m



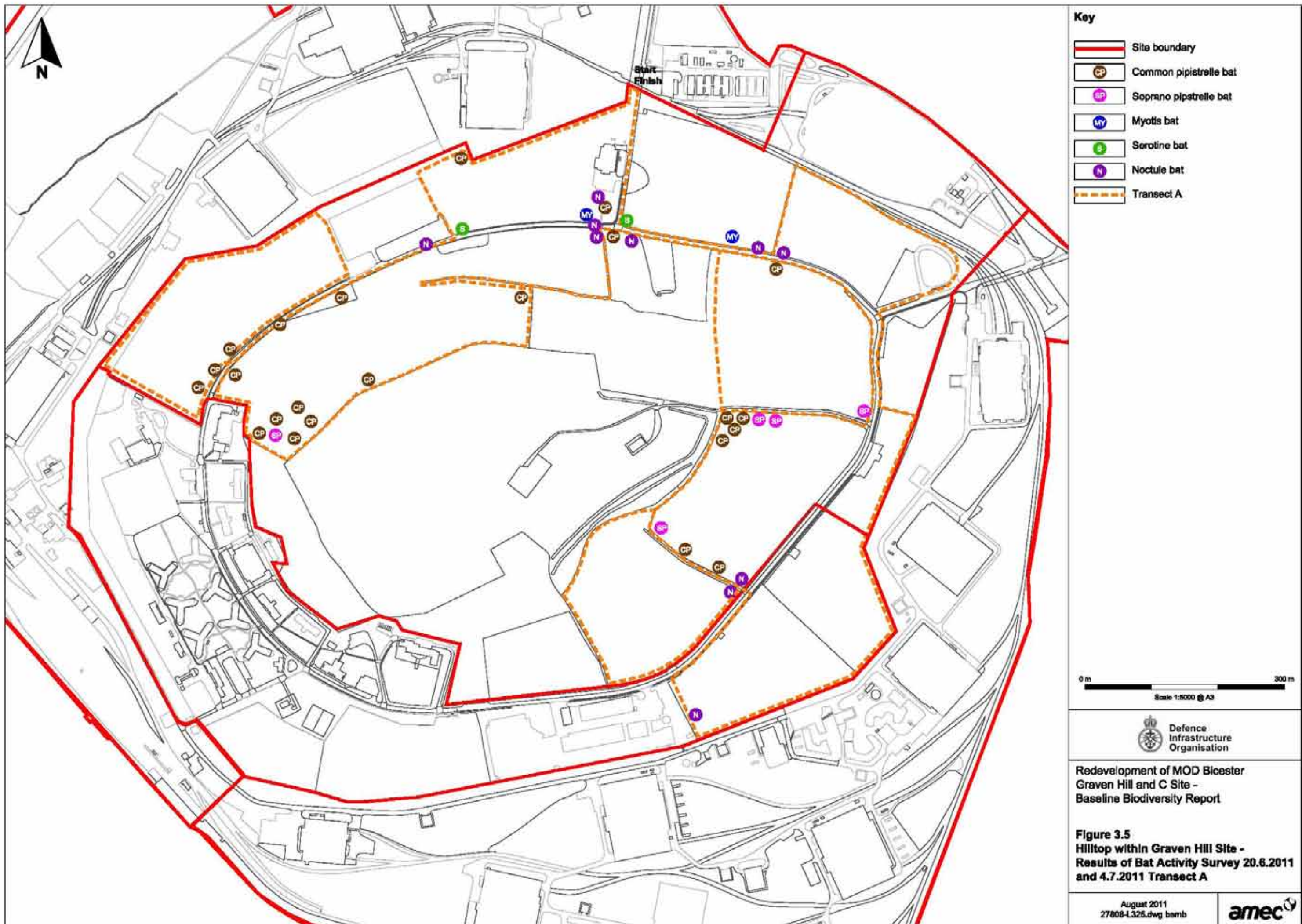
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**Figure 3.4**  
**E Site within Graven Hill Site -**  
**Results of Bat Activity Survey**  
**14.6.2011, 9.6.2011 and 30.6.2011**

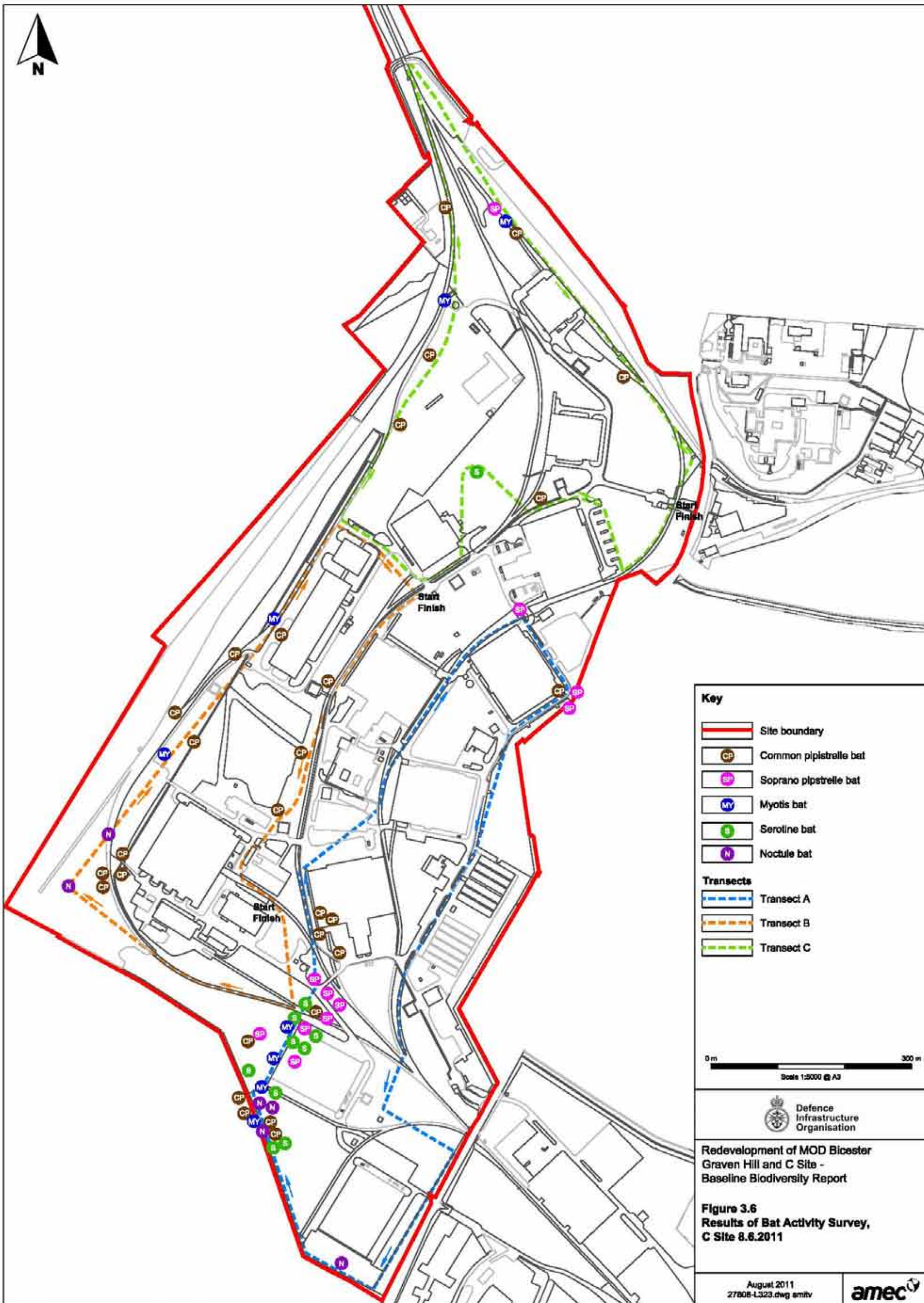
September 2011  
27806-L327a.dwg amliv



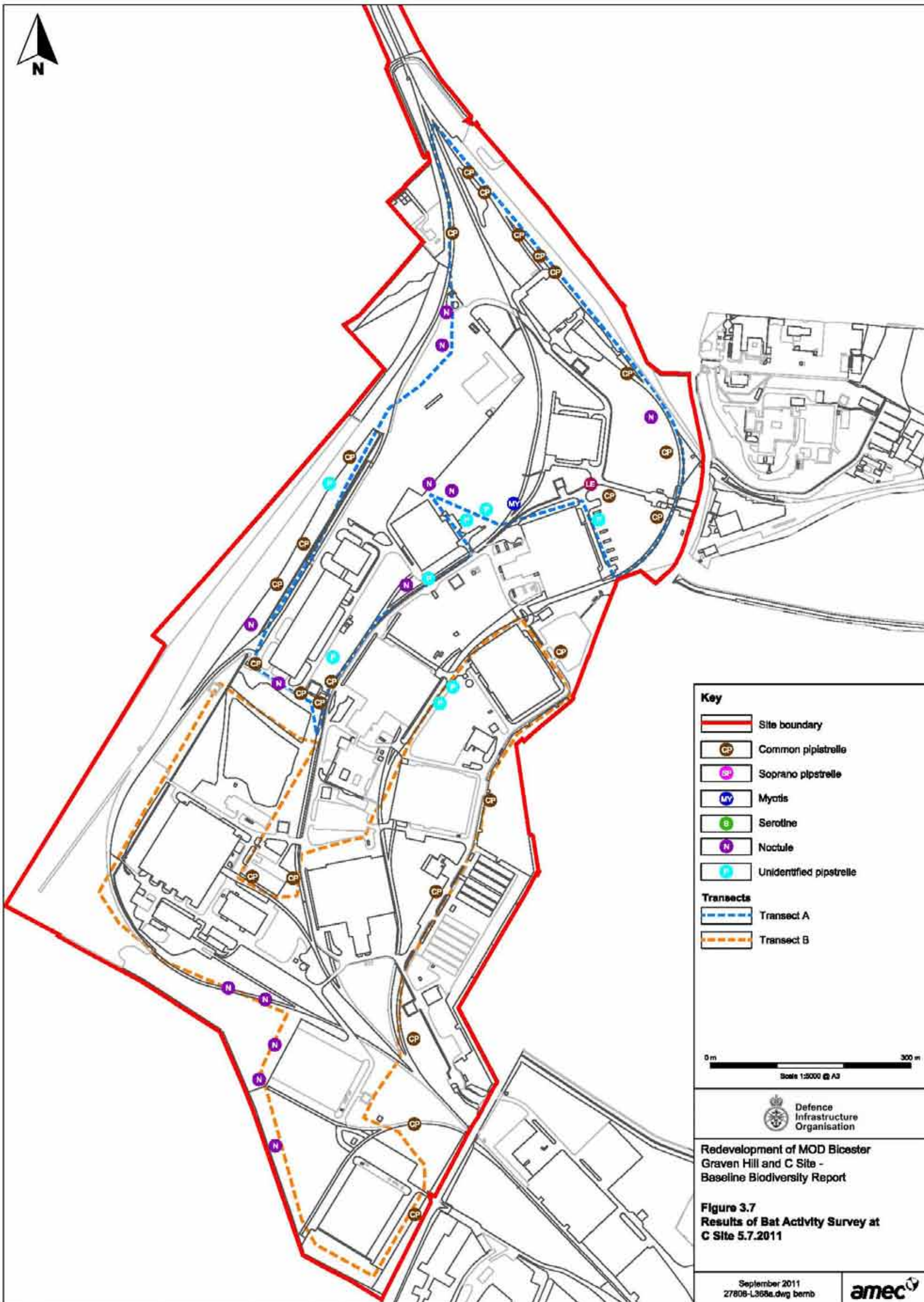




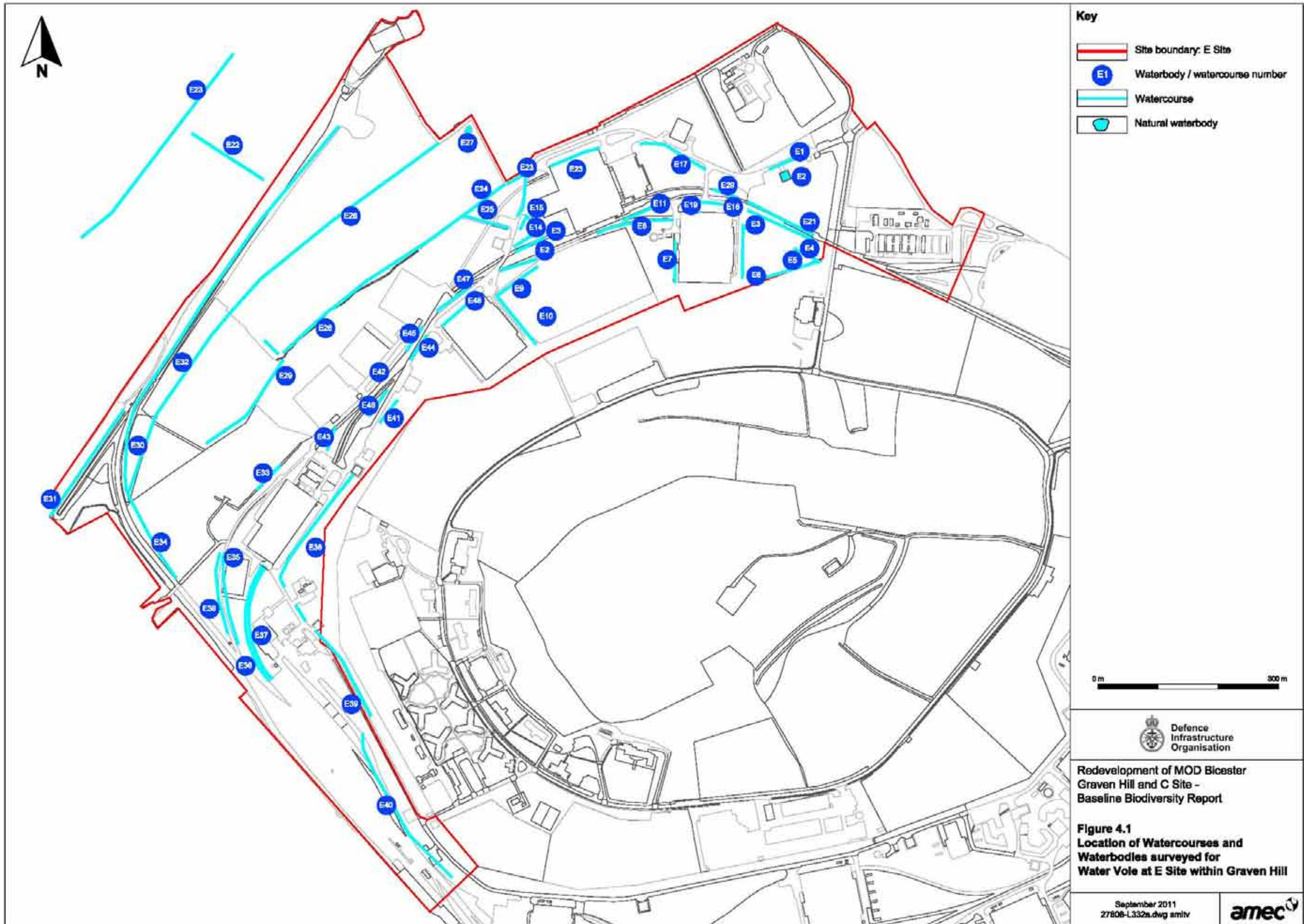




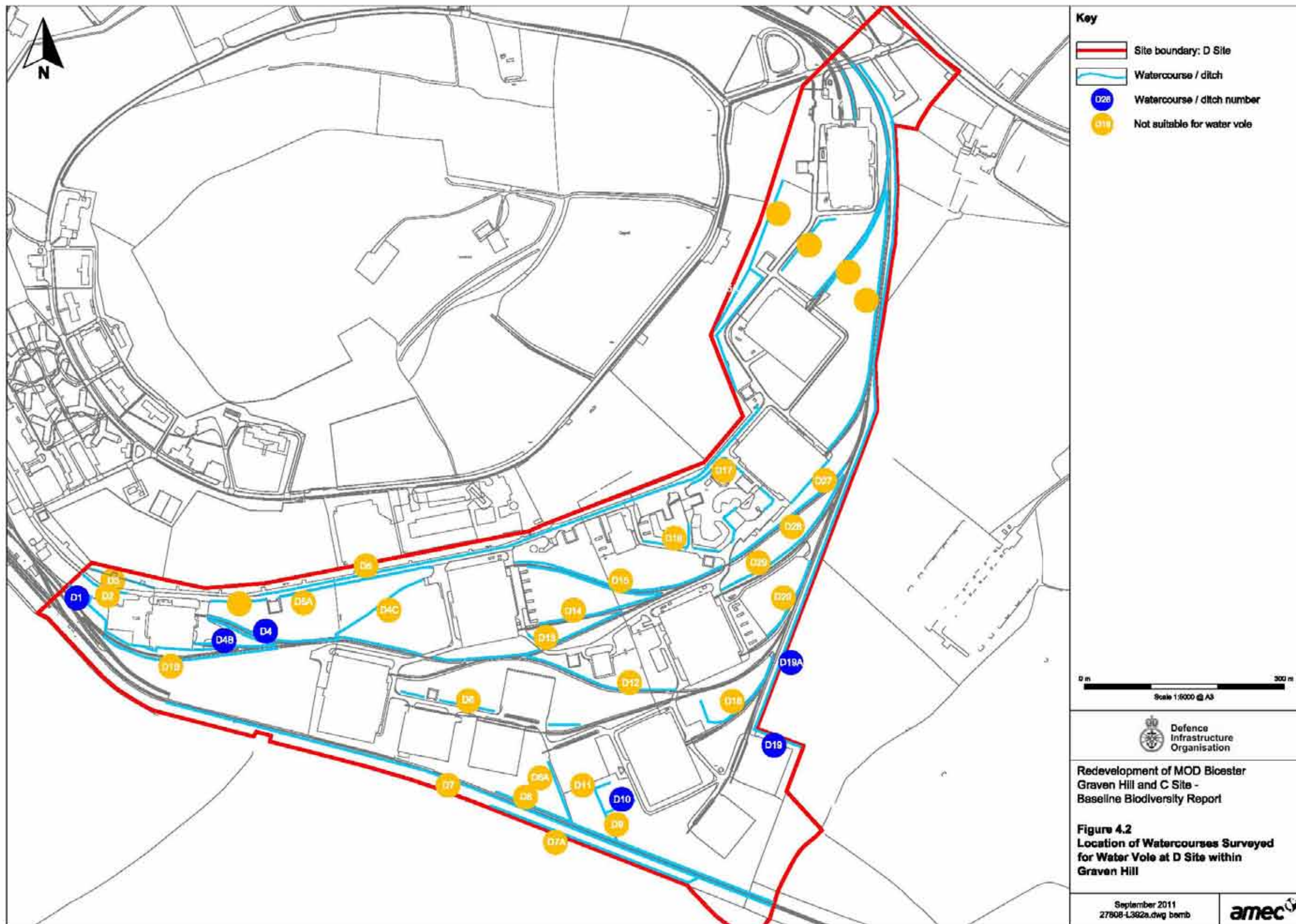




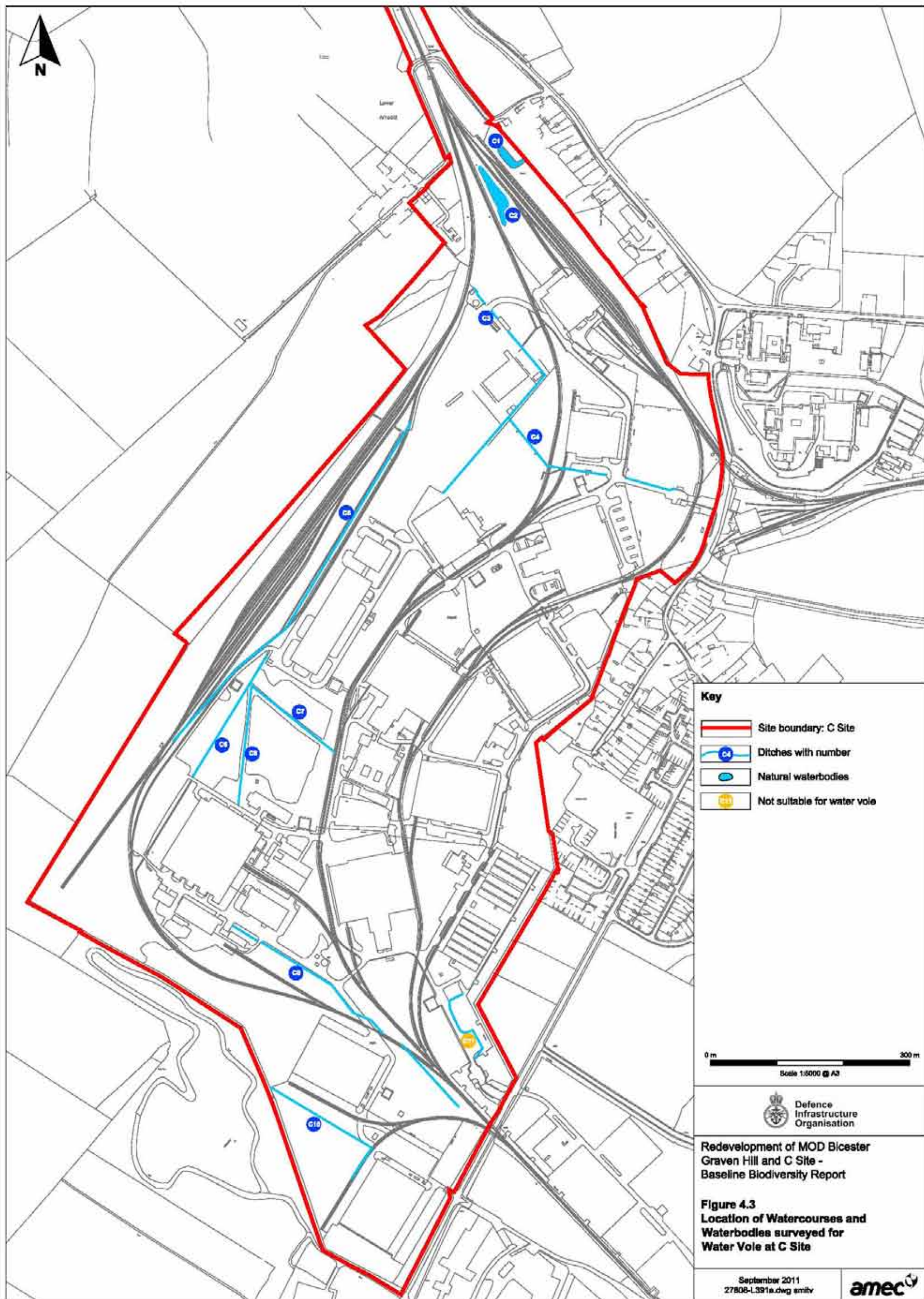














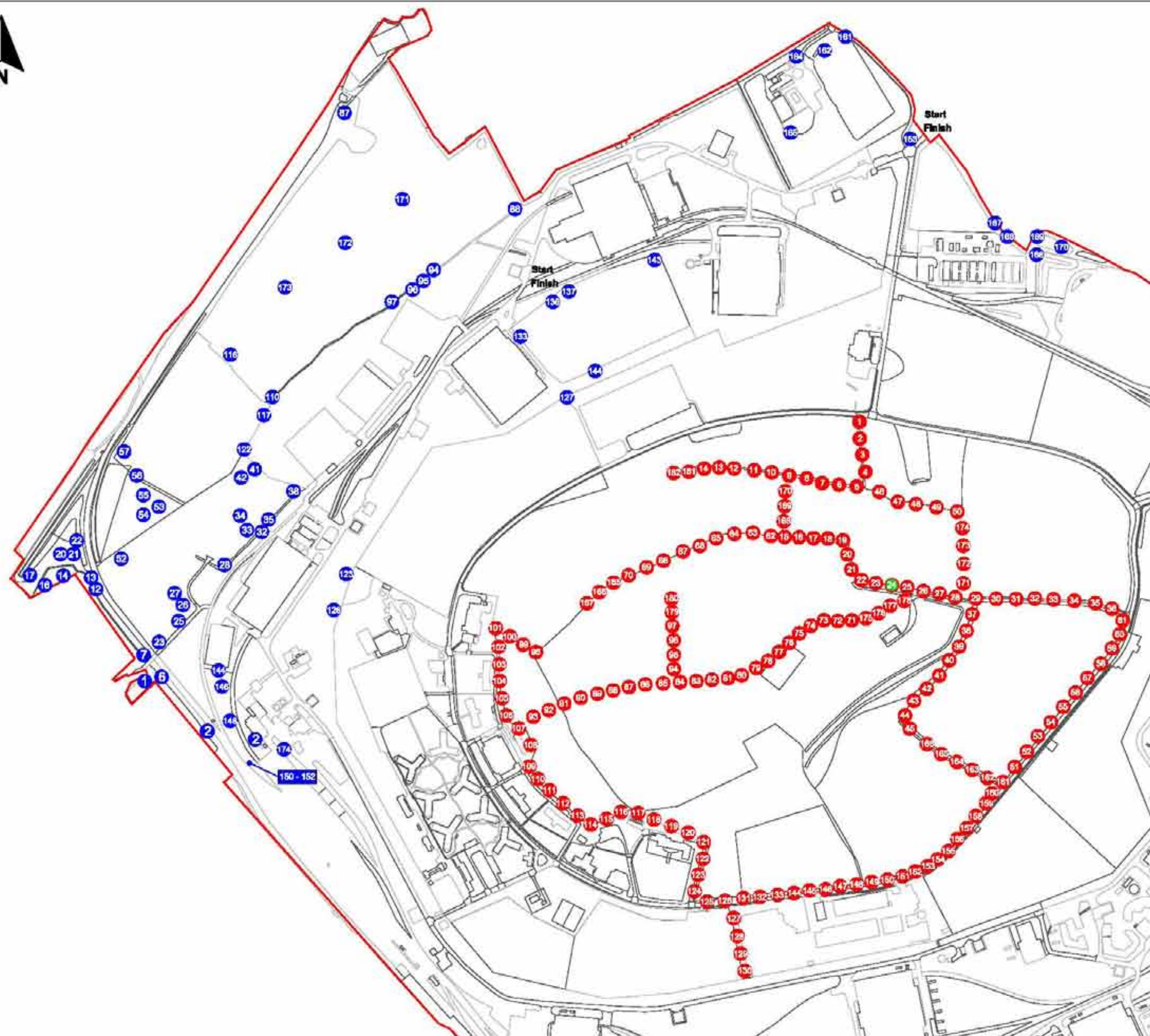






# Key

-  Site boundary
-  Dormouse tubes at E Site within Graven Hill
-  Dormouse tubes at Graven Hilltop within Graven Hill
-  Location of confirmed dormouse nest



0 m 300 m



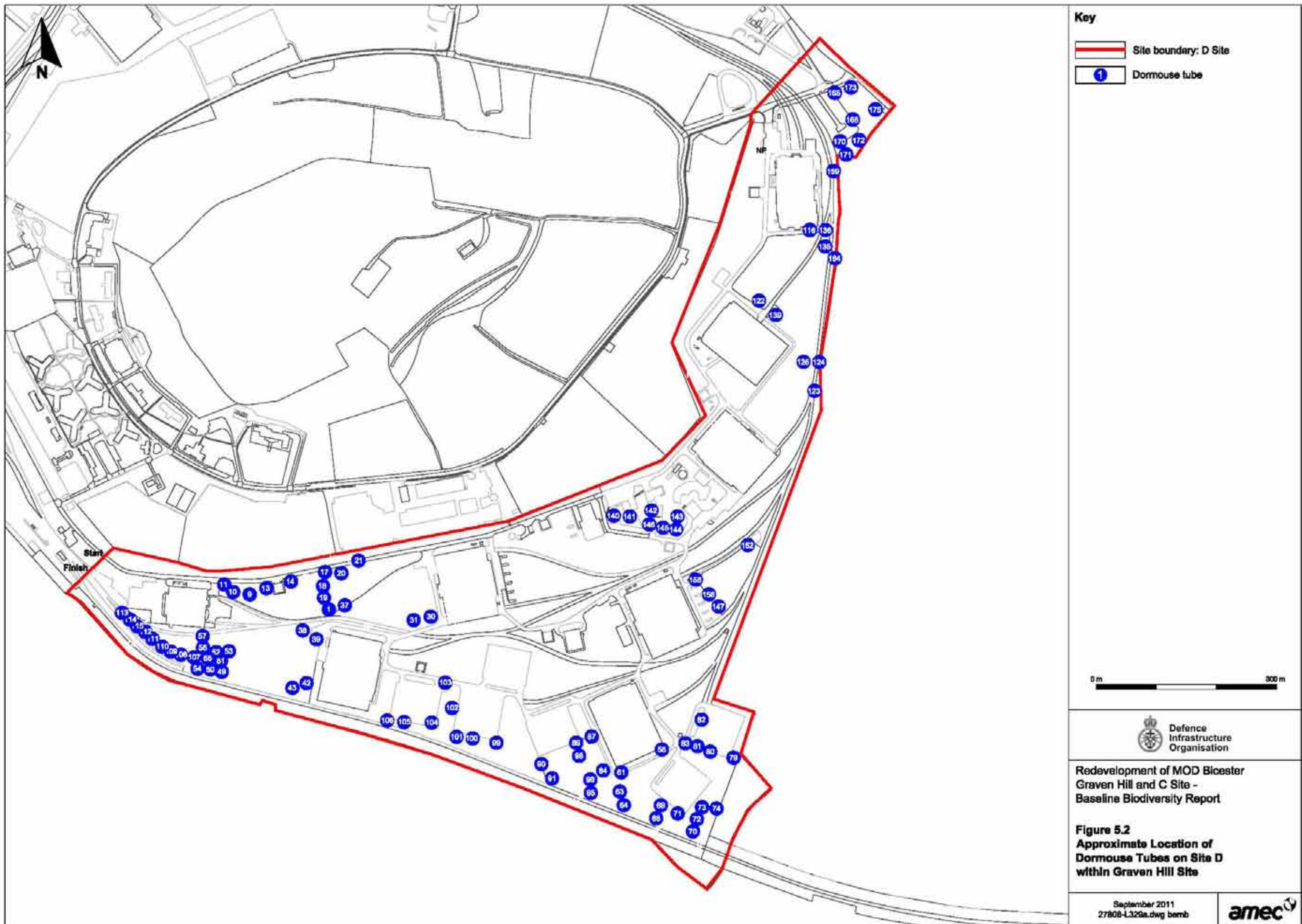
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Graven Hill and C Site -  
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**Figure 5.1**  
Approximate Location of Dormouse  
Tubes and Confirmed Dormouse  
Nest on E Site and Graven Hill  
Hilltop within Graven Hill Site

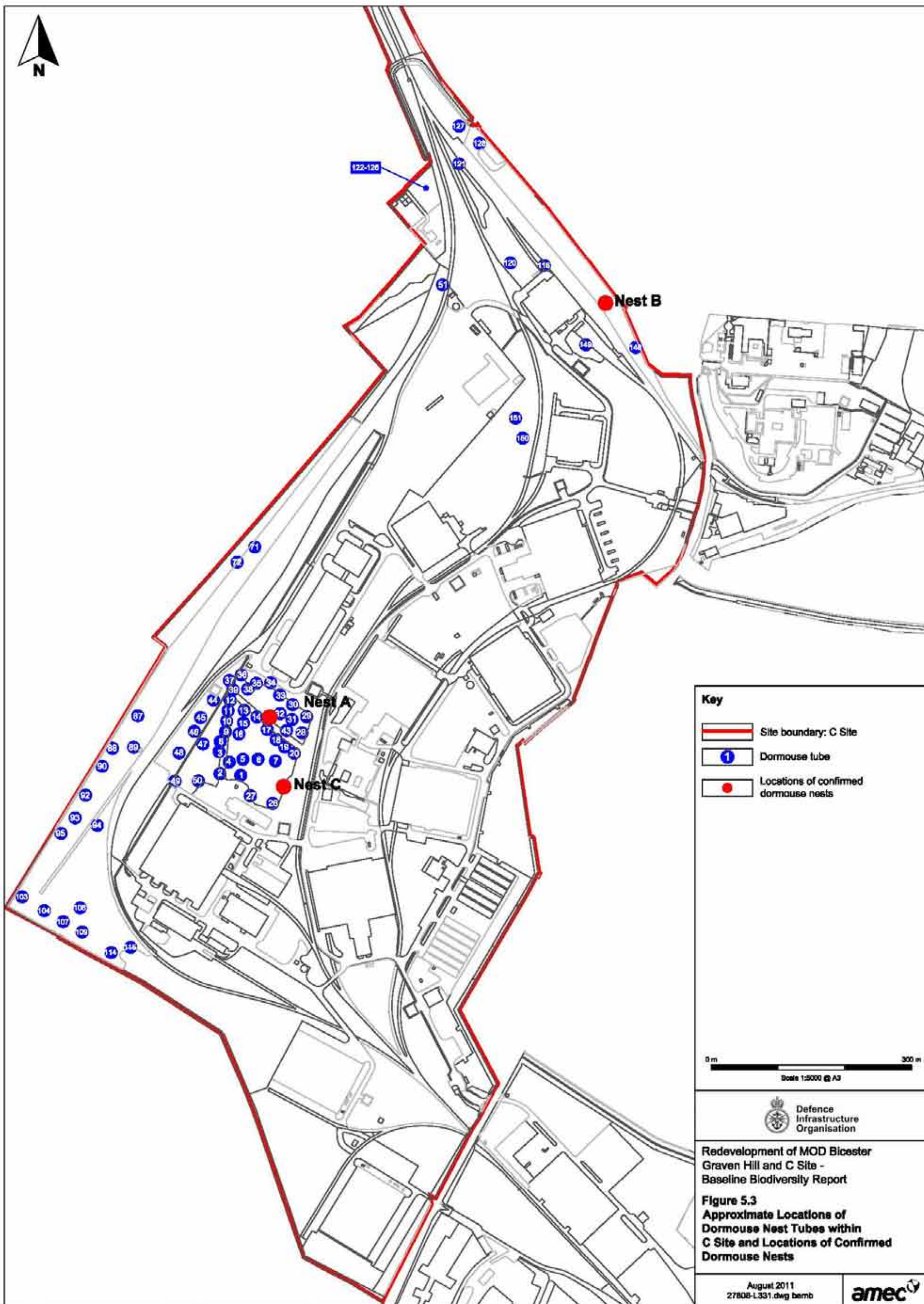
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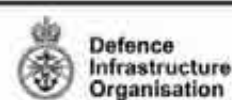




#### Key

- Site boundary: C Site
- Dormouse tube
- Locations of confirmed dormouse nests

0 m 300 m  
Scale 1:5000 @ A3



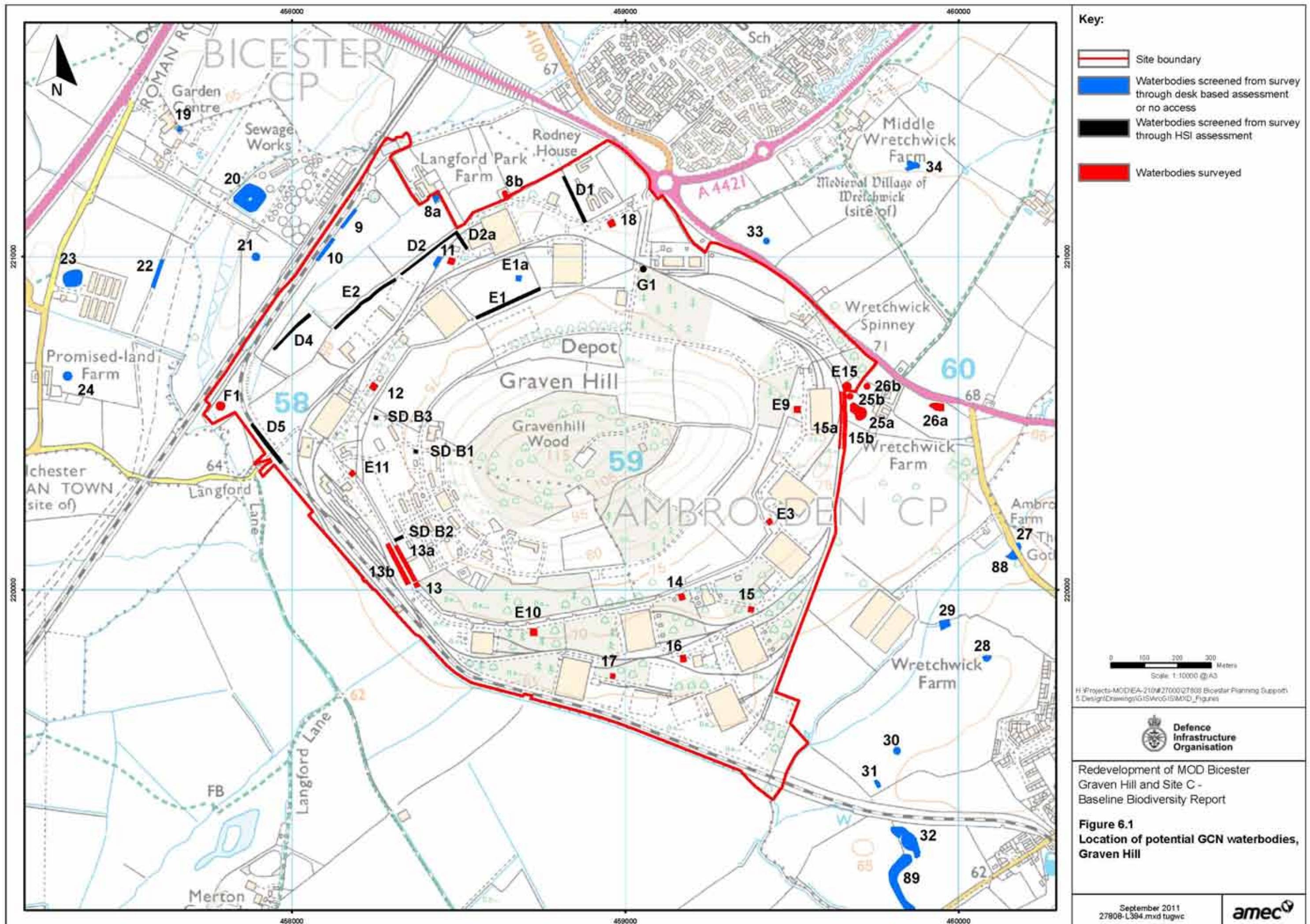
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**Figure 5.3**  
Approximate Locations of  
Dormouse Nest Tubes within  
C Site and Locations of Confirmed  
Dormouse Nests

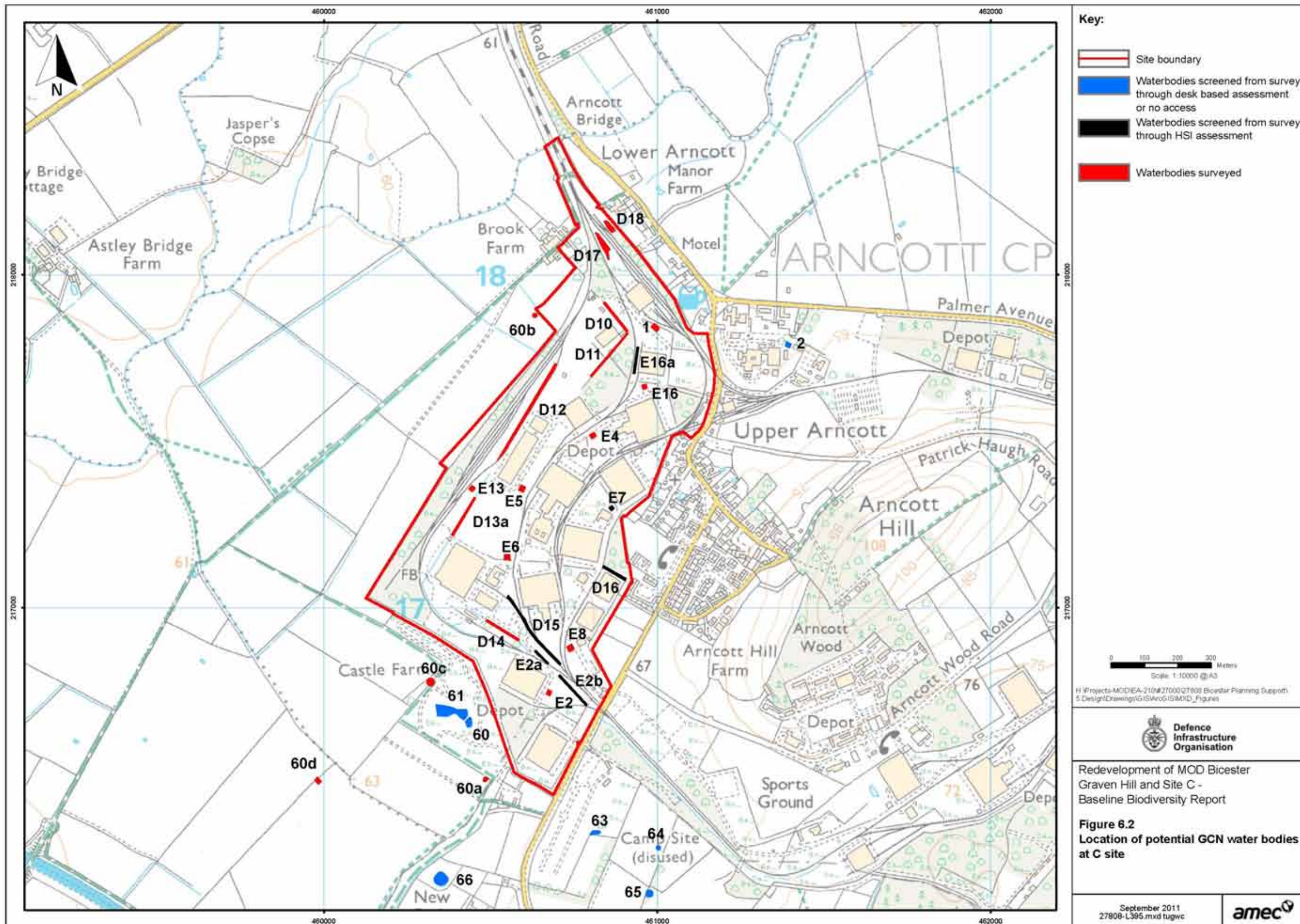
August 2011  
27808-L331.dwg bamb



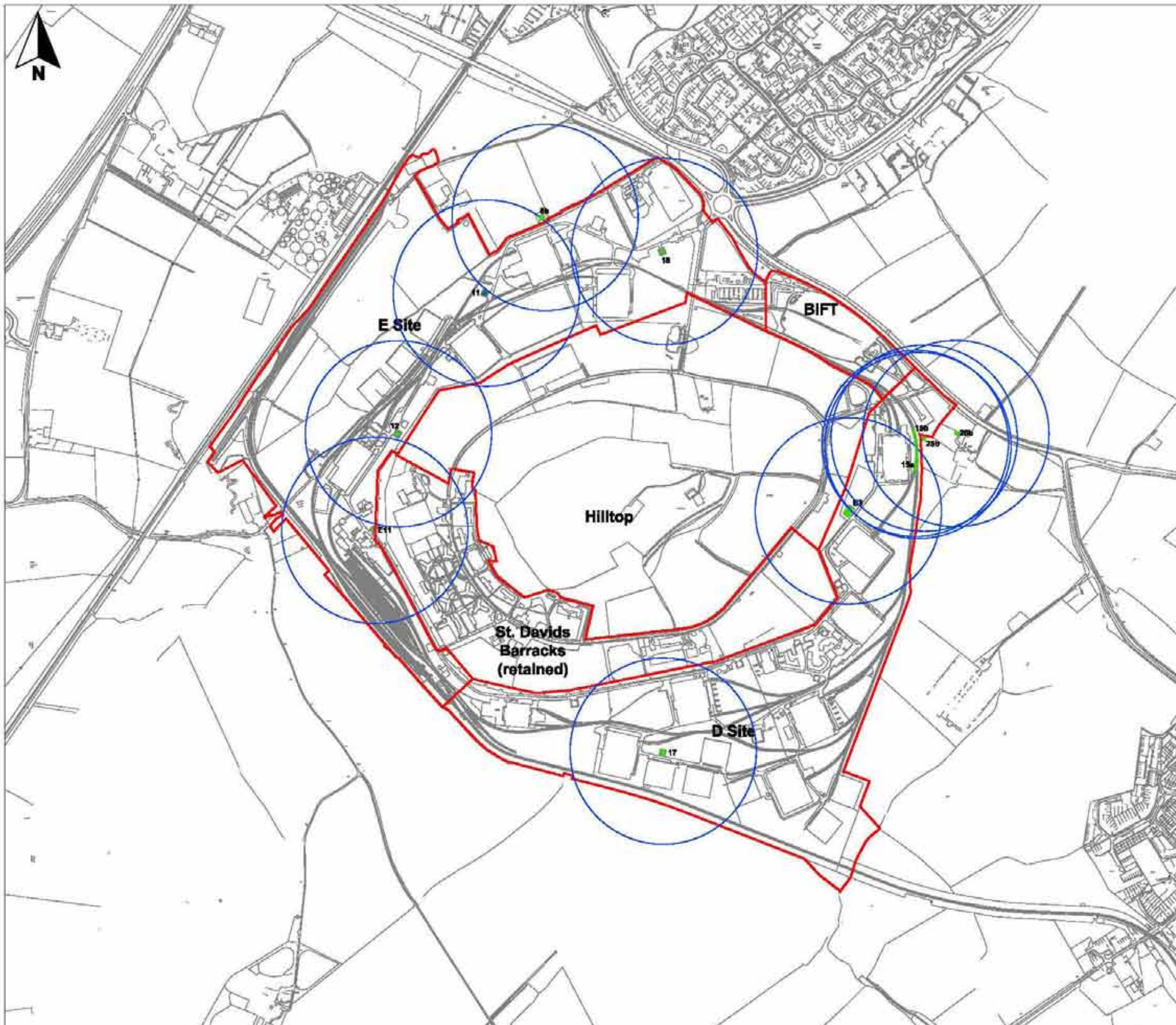








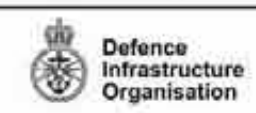




**Key**

- Site boundary
- Small population
- Large population
- 250m zone of metapopulation

0 m 500 m  
Scale 1:10,000 @ A3



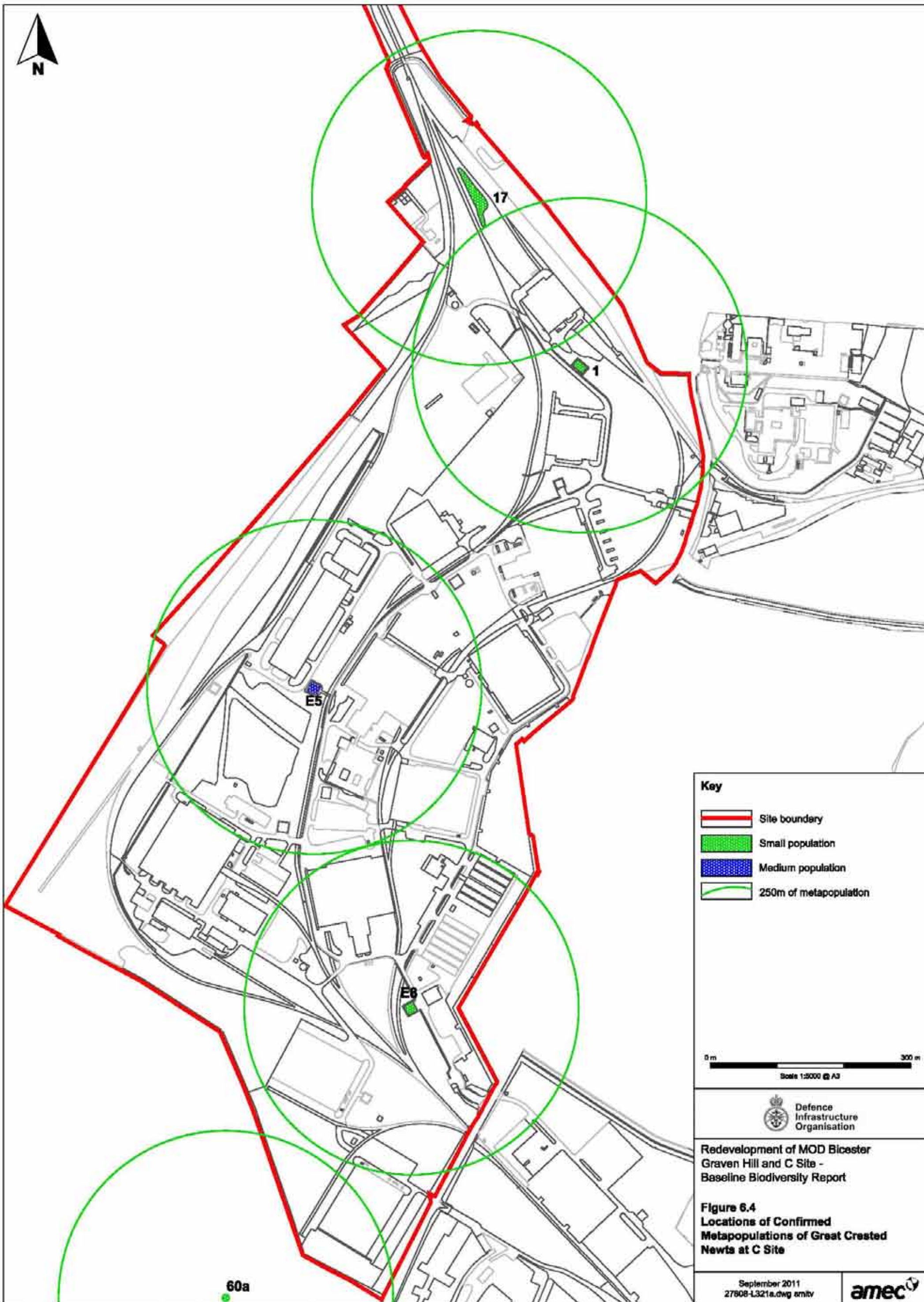
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**Figure 6.3**  
**Locations of Confirmed**  
**Metapopulations of Great Crested**  
**Newts at Graven Hill**

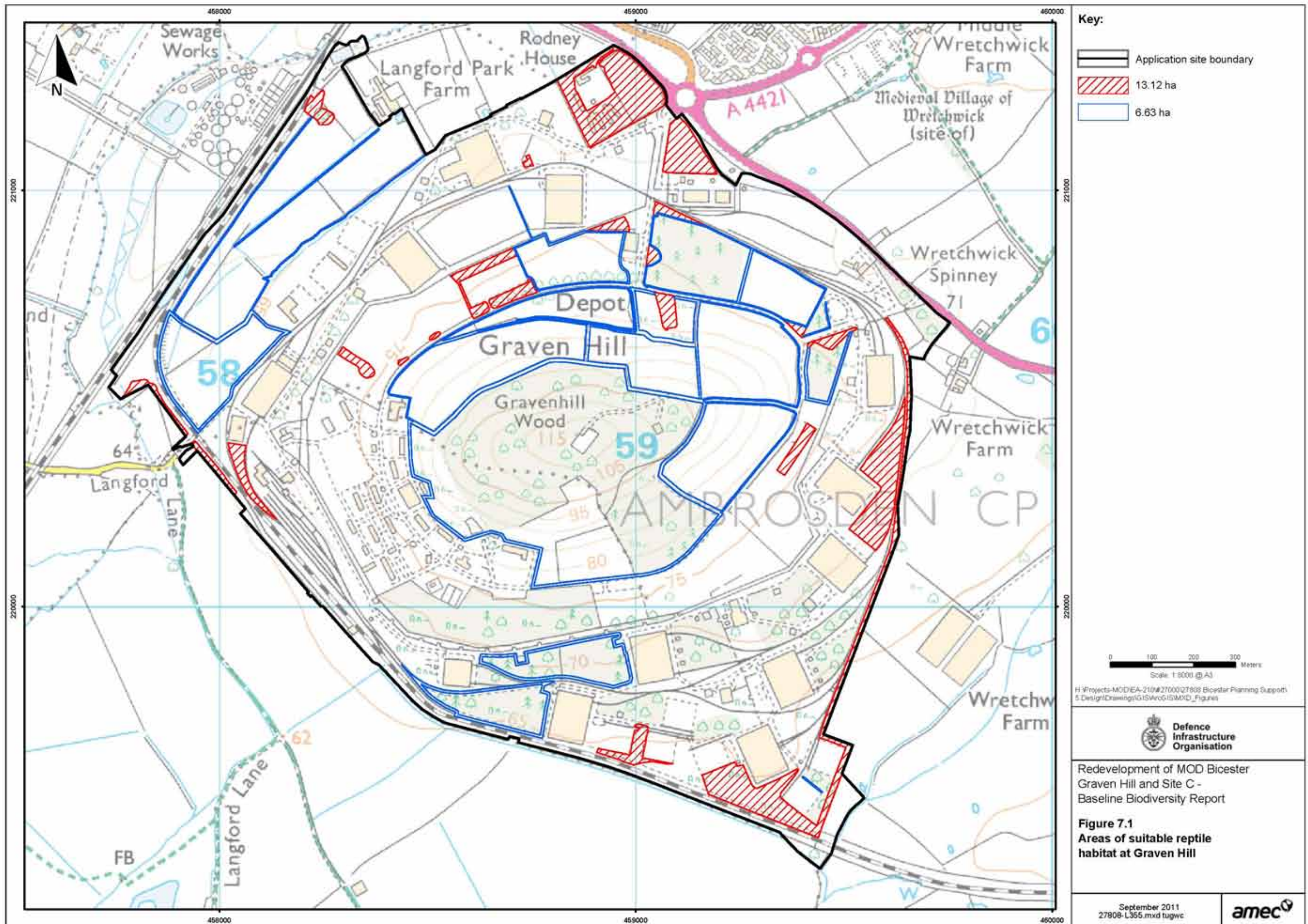
September 2011  
27808-L328a.dwg Smitv



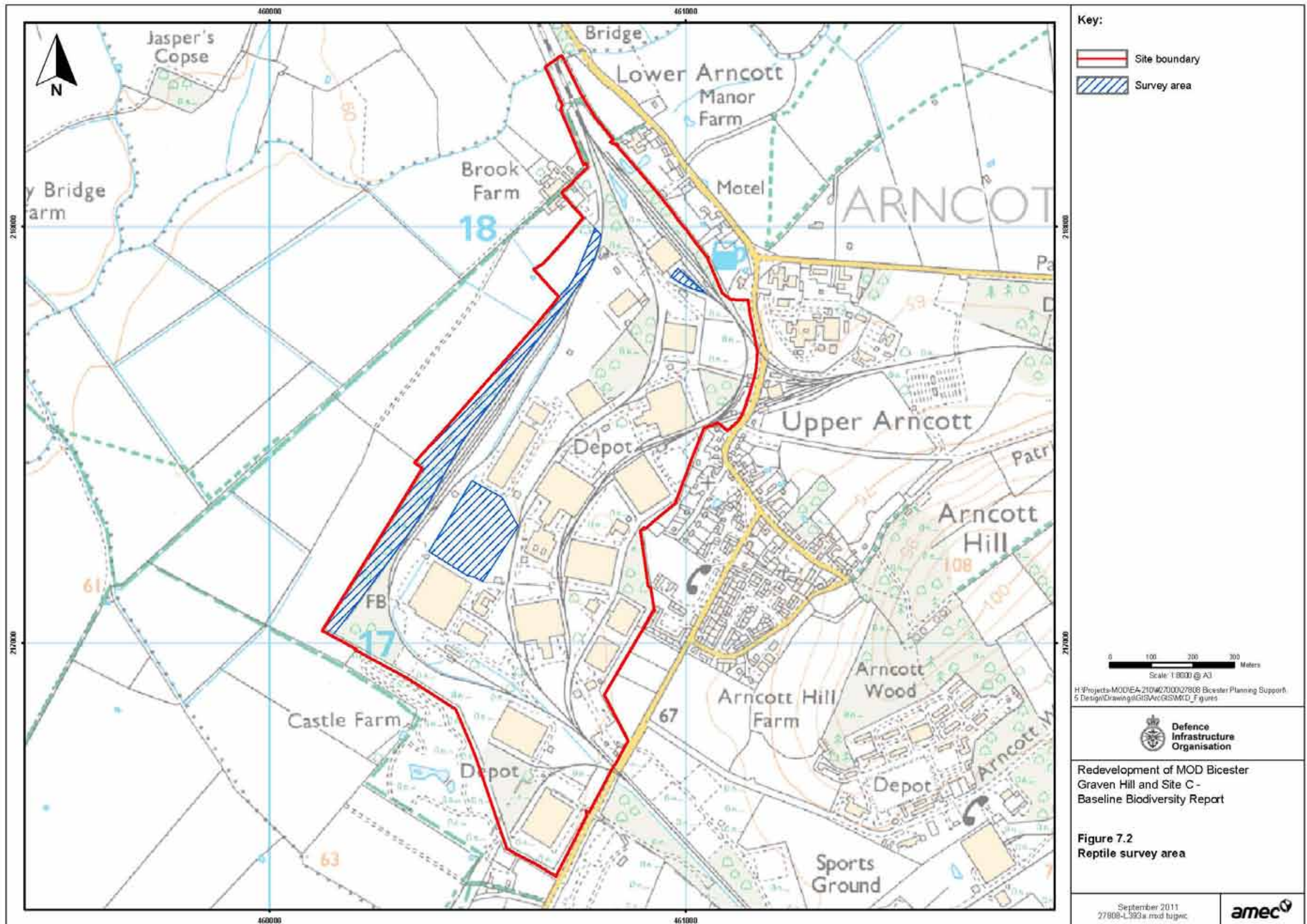




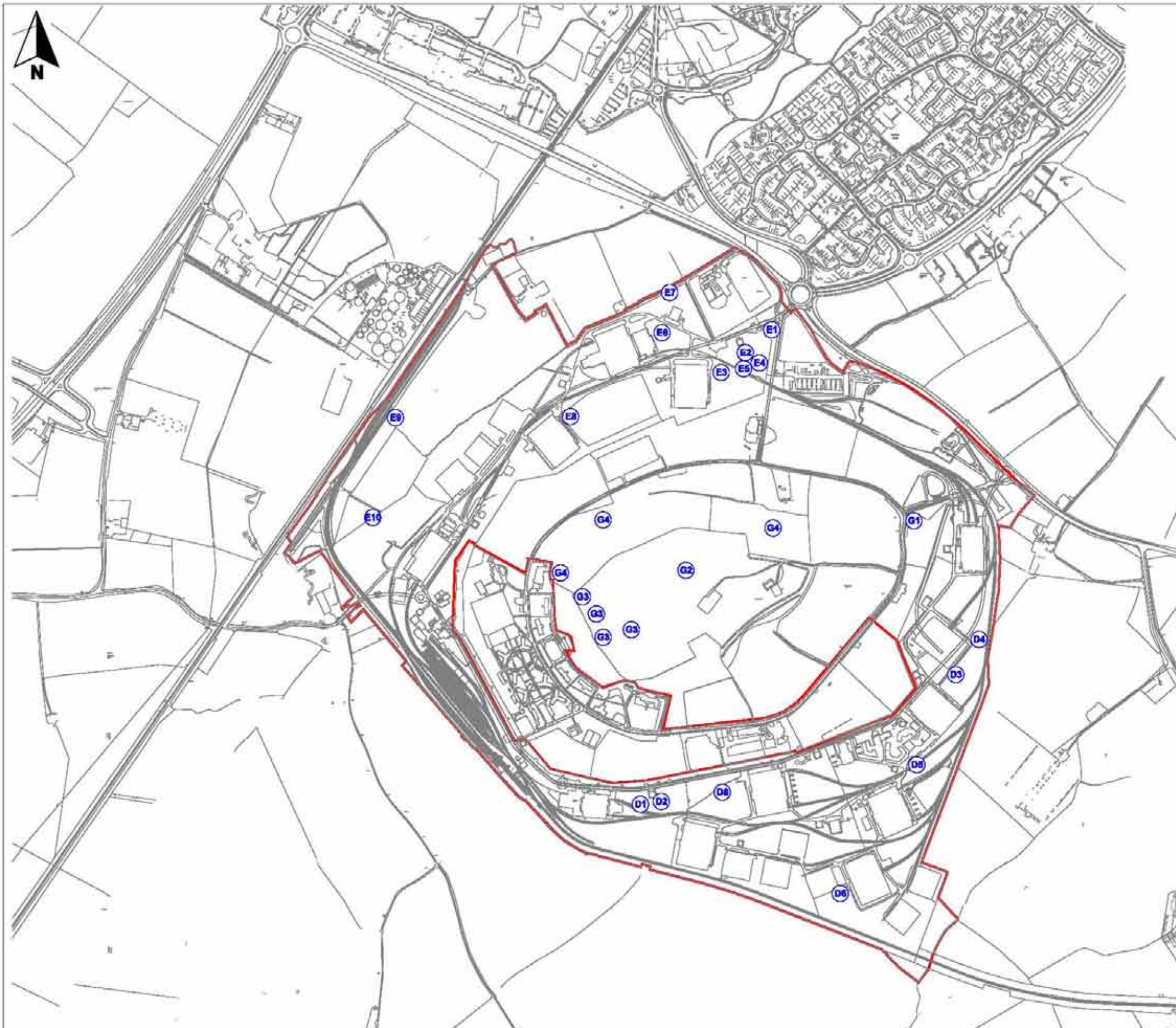












# Key

- Site boundary
- E1 Location of sample site

0 m 600 m  
Scale 1:10,000 @ A3



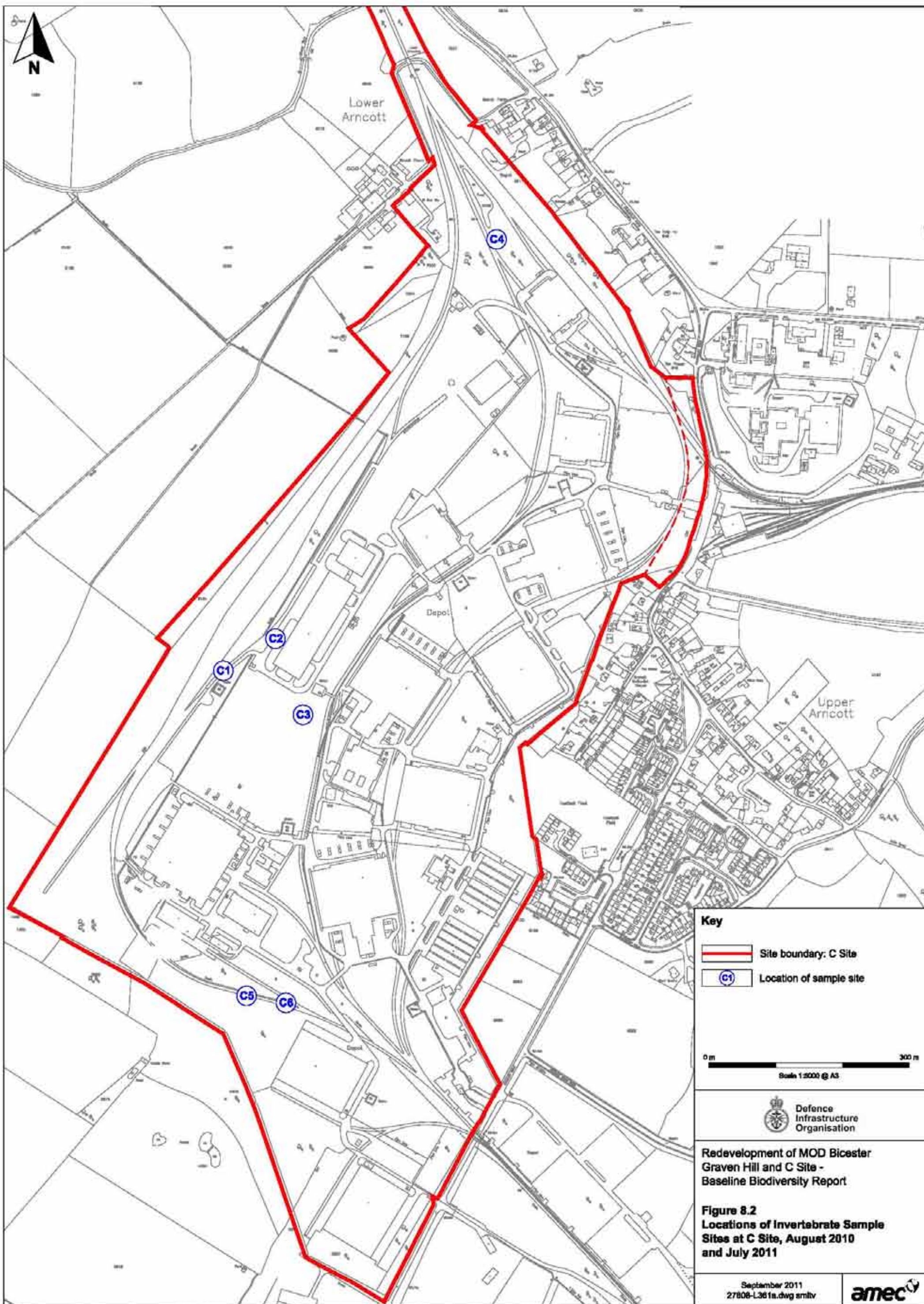
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Graven Hill and C Site -  
Baseline Biodiversity Report

**Figure 8.1**  
**Locations of Invertebrate Sample**  
**Sites at Graven Hill, August 2010**  
**and July 2011**

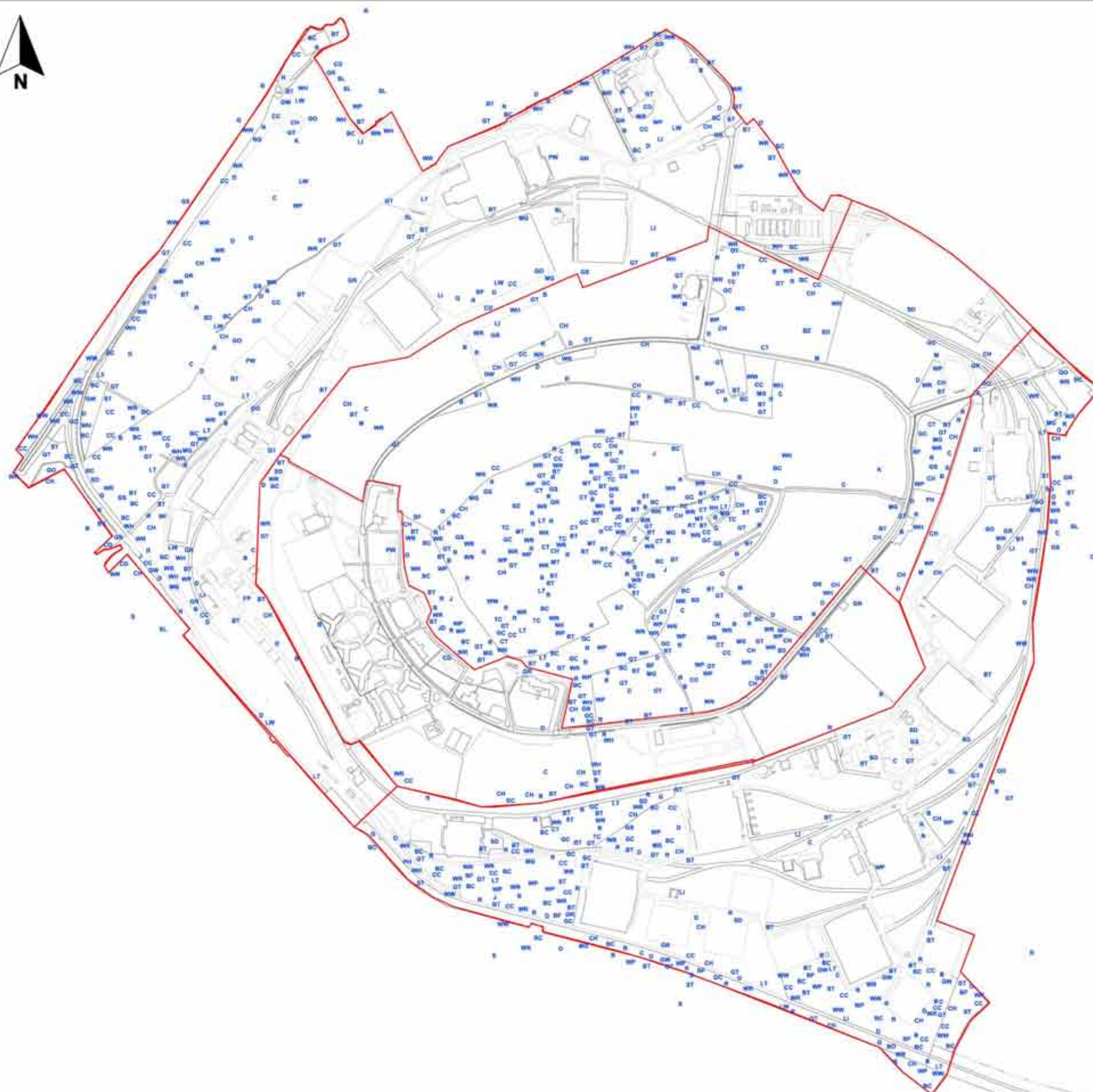
August 2011  
27808-L360.dwg bamb











## Key

Site boundary

## Bird Species

PH	Pheasant
KT	Red kite
SH	Sparrowhawk
BZ	Buzzard
K	Kestrel
FP	Feral pigeon
SD	Stock dove
WP	Woodpigeon
CD	Collared dove
BO	Barn owl
G	Green woodpecker
GS	Great spotted woodpecker
S	Skylark
SL	Swallow
PW	Pied wagtail
WR	Wren
D	Duncock
R	Robin
B	Blackbird
ST	Song thrush
M	Mistle thrush
BC	Blackcap
GW	Garden warbler
LW	Lesser whitethroat
WH	Whitethroat
CC	Chiffchaff
WW	Willow warbler
GC	Goldcrest
LT	Long-tailed tit
BT	Blue tit
GT	Great tit
CT	Coal tit
MT	Marsh tit
NH	Nuthatch
TC	Treecreeper
J	Jay
MG	Magpie
JD	Jackdaw
RO	Rook
C	Carion crow
SG	Starling
CH	Chaffinch
GR	Greenfinch
GO	Goldfinch
LI	Linnet
BF	Bullfinch

0 m 400 m  
Scale 1:7500 @ A3



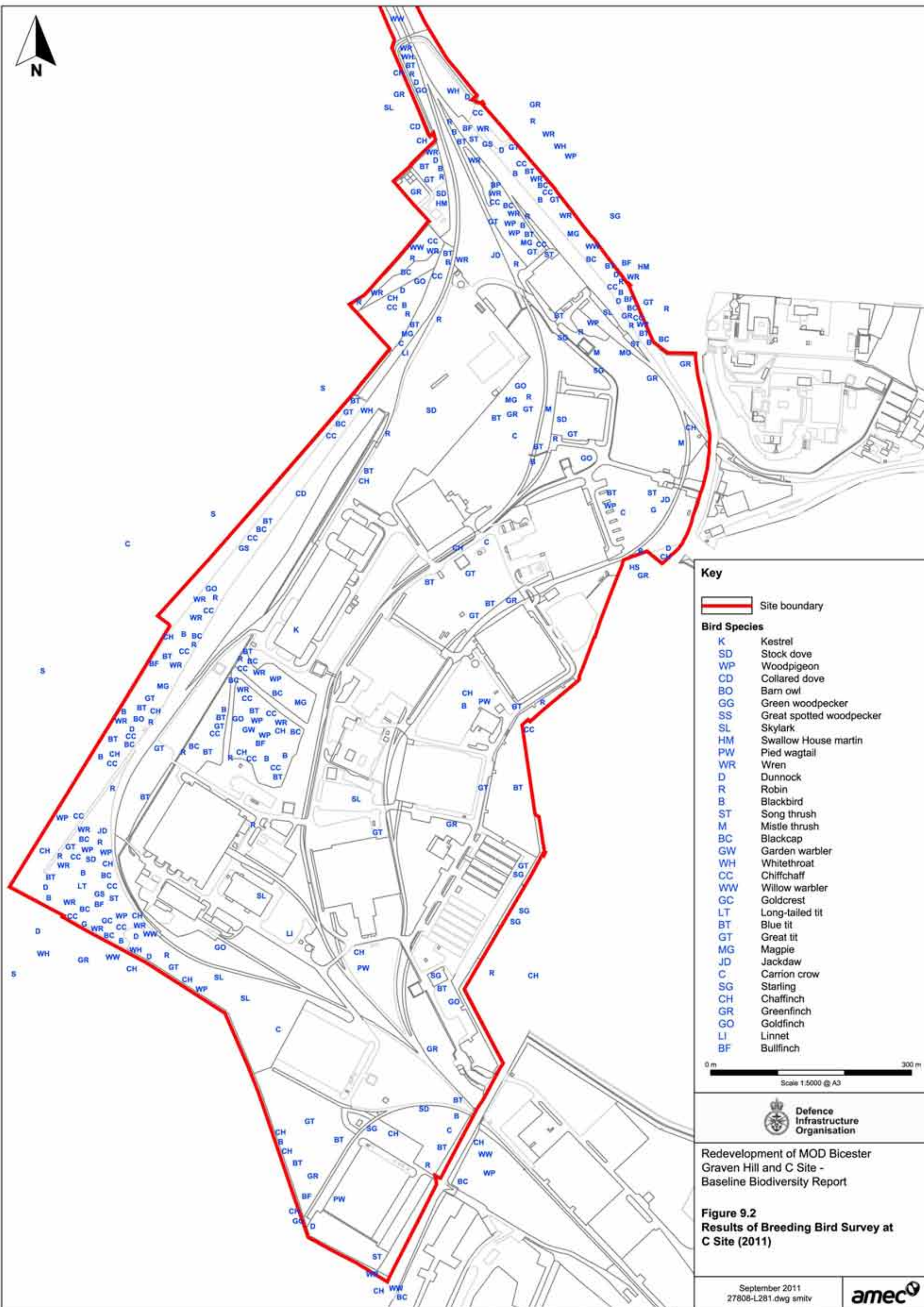
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Figure 9.1  
Results of Breeding Bird Survey at  
Graven Hill (2011)

July 2011  
27806-L281.dwg smitv







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# **Annex A**

## **Citations for Statutory Nature Conservation Sites**

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**COUNTY:** OXFORDSHIRE

**SITE NAME:** SHABBINGTON WOODS COMPLEX

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Oxfordshire County Council/South Oxon District Council/Buckinghamshire County Council/Aylesbury Vale District Council

**National Grid Reference:** SP615110

**Ordnance Survey Sheet 1:50,000:** 164, 165 **1:10,000:** SP61

**Date Notified (Under 1949 Act):** 1981 **Date of Last Revision:**

**Date Notified (Under 1981 Act):** 1987 **Date of Last Revision:**

**Area:** 305.6 ha 755.18 ac

**Other information:** Declared a Forest Nature Reserve by the Forestry Commission and managed for the butterfly and moth fauna. Parts of the site are managed by the Berkshire, Buckinghamshire and Oxfordshire Naturalists Trust as Nature Reserves.

### **Description and Reasons for Notification**

This site is the largest remaining relict of the once extensive Royal Forest of Bernwood. Many other remnants are also Sites of Special Scientific Interest including Holly Wood, Holton Wood, Stanton Great Wood and Waterperry Wood, all in Oxfordshire. The present day Shabbington Wood is almost entirely planted with pure conifer and conifer-broadleaved mixtures; only a small proportion of ancient semi-natural woodland remains. The special interest of the site lies mainly in the richness of the insect fauna associated with compartment edges and the system of woodland rides. Also included in the site are two unimproved neutral meadows with ridge and furrow topography and several shallow ponds.

The soils of the site are predominantly clays of the Denchworth Series which overlie Oxford Clay. The extreme western edge of the site has loamy clays of the Shabbington Series, while two small pockets of cherty sandstone brash occur within the central woodland. All these soils are seasonally waterlogged due partly to their structure and to the influence of the underlying impervious clay.

Much of the site has been progressively coniferised since the mid-1950s and a wide variety of conifer species have been used in the plantation with oak as the dominant deciduous tree in any mixed planting. The margins of compartments and forest rides still retain a wide variety of trees, shrubs and herbs surviving from the ancient woodland, including field maple *Acer campestre*, wild service tree *Sorbus torminalis*, alder buckthorn *Frangula alnus*, hairy brome *Bromus ramosus*, wood millet *Milium effusum*, pale sedge *Carex pallescens*, primrose *Primula vulgaris* and wood spurge *Euphorbia amygdaloides*. Oakley Wood still retains two compartments of predominantly hazel coppice with oak standards. The coppice contains a variety of shrubs and deciduous trees including aspen *Populus tremula*, birch *Betula pendula*, crab apple *Malus sylvestris* and ash.

The unimproved neutral meadows on the western side of the site are bounded by mature hedgerows which include extensive stretches of blackthorn. The herb-rich grassland sward contains over 100 species of plants, several of which are normally associated with unimproved meadows, including quaking grass *Briza media*, meadow barley *Hordeum secalinum*, adder's tongue *Ophioglossum vulgatum*, green-winged orchid *Orchis morio*, great burnet *Sanguisorba officinalis* and pepper saxifrage *Silaum silaus*.

The insect fauna is particularly rich in species normally associated with ancient deciduous woodland. The butterflies and several other groups have been intensively studied and show the site to be of national importance. Over forty species of butterfly have been recorded in the last decade and the wood currently holds breeding populations of nationally uncommon

species including Duke of Burgundy, wood white, purple emperor, pearl-bordered fritillary and marsh fritillary. The site is now the last known station for the pearl-bordered fritillary in Oxfordshire and Buckinghamshire. This species has undergone a dramatic decline throughout central and southern England and is now extinct in eastern England.

OVER/

Several areas of blackthorn thicket have been managed for the nationally rare black hairstreak butterfly. This species is also found on mature blackthorn hedgerows around certain stretches of the woodland. The whole site probably has the largest remaining complex of black hairstreak colonies in the county. The blackthorn hedgerows and thickets also provide habitat for the uncommon brown hairstreak.

The wood contains over thirty-seven nationally rare or uncommon hoverflies, of which many are typical of ancient deciduous woodland including *Epistrophe euchroma*, *Melangyna triangulifera*, *Ferdinandea ruficornis*, *Volucella inflata* and *Brachypalpoides lenta*. Many of these are associated with deadwood or sap-runs on mature trees.

The beetle fauna contains over twenty-five nationally rare or uncommon species. Many of these are likewise associated with mature deciduous woodland habitats including *Prionocyphon serricornis* (Siatidae), *Platystomos albinus* (Anthribidae), and the bark beetle *Xyleborus dispar*. Other rare insects include the lacewing *Micromus angulatus*, the solitary wasp *Symmorphus connexus*, argent and sable moth *Rheumaptera hastata*, the forester *Adscita statices*, campanula pug *Eupithecia denotata*, common fanfoot *Herminia strigilata* and the woodland grasshopper *Omocestus rufipes*.

The conifer plantations have attracted a few insects which are new to the area. These include the beetle *Cryphalus abietis*, the hoverflies *Dasysyrphus friulensis*, *Metasyrphus nielseni*, *Parasyrphus malinellus* and *Melangyna ericarum* and Blair's shoulder-knot moth *Lithophane leautieri*. Some of these are now colonising coniferous woodland in other areas of the country, but are still nationally uncommon.

The vertebrates of the site include all three British species of newt which breed in the scattered ponds, grass snakes, slow worms and fallow and muntjac deer. A large number of bird species are recorded from the wood including woodcock, green and great-spotted woodpeckers, tree pipit, grasshopper warbler, spotted flycatcher and crossbills.



**COUNTY:** OXFORDSHIRE

**SITE NAME:** ARNCOTT BRIDGE MEADOWS

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell District Council, Oxfordshire County Council

**National Grid Reference:** SP608185

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP61 NW

**Date Notified (Under 1981 Act):** 1985 **Date of Last Revision:** 1992

**Area:** 8.66 ha 21.39 ac

### **Description and Reasons for Notification**

Arcnott Bridge Meadows lie on the floodplain of the River Ray. The meadows exhibit medieval ridge-and-furrow features indicating that parts, at least, have remained unploughed for many centuries. They are managed as hay meadow and pasture and accordingly support a wide range of plant species which are largely confined to such old, unimproved, neutral grassland.

The meadows are situated on fine loamy clay drift soils of the Wickham 2 Series. Parts of the site are seasonally waterlogged which reflects the position of the site adjacent to the River Ray and the underlying geology of impermeable Oxford Clay with Kellaway Beds.

The rich flora is, in part, attributable to the variation in the soil wetness caused by the ridge-and-furrow together with field ditches and localised depressions. The wettest areas which hold standing water in winter are characterised by species such as false fox-sedge *Carex otrubae*, brown sedge *C. disticha* and soft rush *Juncus effusus*, together with the grasses creeping bent *Agrostis stolonifera* and tufted hair-grass *Deschampsia cespitosa*. Abundant herbs present include tubular water-dropwort *Oenanthe fistulosa*, ragged-robin *Lychnis flos-cuculi* and meadowsweet *Filipendula ulmaria*.

On the tops of the ridges and other drier soils, the meadow sward contains a high proportion of herbs including many species indicative of ancient, unimproved grassland. This sward is characterised by grasses such as crested dog's-tail *Cynosurus cristatus* and common bent *Agrostis capillaris* with an abundance of great burnet *Sanguisorba officinalis*, yellow-rattle *Rhinanthus minor* and common spotted-orchid *Dactylorhiza fuchsii*. Other species indicative of old meadowland include saw-wort *Serratula tinctoria*, pepper-saxifrage *Silaum silaus*, adder's-tongue *Ophioglossum vulgatum*, green-winged orchid *Orchis morio*, carnation sedge *Carex panicea* and dropwort *Filipendula vulgaris*.

The vegetation in and along the banks of the adjacent River Ray contains species which are becoming increasingly rare, both regionally and nationally. The bank grassland contains the nationally uncommon narrow-leaved water-dropwort *Oenanthe silaifolia*, a species now confined to a few sites in Britain. Other locally uncommon species along the river bank include flowering-rush *Butomus umbellatus* and bladder-sedge *Carex vesicaria*.

**COUNTY:** OXFORDSHIRE     **SITE NAME:** WENDLEBURY MEADS AND MANSMOOR CLOSES

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell District Council, Oxfordshire County Council

**National Grid Reference:** SP562175

**Ordnance Survey Sheet 1:50,000:** 164                      **1:10,000:** SP51 NE

**Date Notified (Under 1949 Act):** 1977                      **Date of Last Revision:** 1977

**Date Notified (Under 1981 Act):** 1986                      **Date of Last Revision:** 1987

**Area:** 73.2 ha   180.9 ha

### **Description and Reasons for Notification**

Wendlebury Meads consists of a series of traditionally-managed unimproved neutral meadows supporting a complex variety of plant communities that have developed in response to varying management, drainage and soils. The meadows are amongst the few surviving examples of calcareous clay pasture communities which were widespread throughout southern England at the turn of the century, but now rare owing to agricultural improvement and urbanisation.

Wendlebury Meads occupy an area of low-lying ground, about 60 metres above sea level, which drains south-eastwards into a tributary of the River Ray. The area is underlain by Oxford Clay, and much is covered by clayey or fine loamy head. Four soil types are recognised. Cambic stagnogley soils of the Rowsham series mantle the broad flat area of the site. Both deep and shallow variants of the Lawford series cover land to the west, whilst to the east there are pelo-alluvial gley and pelo-calcareous alluvial gley soils of the Thames/Fladbury series. Short term flooding often occurs with the overflow of water from the River Ray.

Almost all of the fields of Wendlebury Meads have ridge and furrow topography which is evidence of past ploughing. Aerial photographs reveal a typical reversed 'S' shape to the ridges and furrows, originating from plough teams always turning left at the end of each line. The narrower fields known as the Mansmoor Closes demonstrate an early example of enclosure by agreement (date unknown, but not later than 1622) and are of landscape and archaeological importance. These fields also have a reversed 'S' shape showing that their hedges were planted alongside ridges pre-dating this period. In contrast the ridges either side of the parish boundary hedge are unrelated in their alignment, indicating that this boundary is of an earlier origin than the ridges.

Whereas contemporary intensive agriculture can eradicate most species of broadleaved herbs, arable farming often had significantly less influence on the flora in historic times. This is partly because furrows were not cultivated, leaving a reservoir of native species, partly because there was no drilling of grasses, plants being allowed to re-establish naturally, perhaps supplemented by sweepings from the hay barn and partly because herbicides and inorganic fertilisers were never applied.

All of the site north-east of the parish boundary forms part of the abandoned Starveall Farm, for which there is detailed historical information. Although most of the farm was arable until the late 19th century, some areas have probably always been grassland. All the land has been managed as grassland since 1920, and with one exception fields have been consistently grazed or cut for hay without reseeded or drainage. Within Starveall Farm there has been no ploughing since 1920 apart from one field which was treated in 1945-6 and which remains floristically distinct today. Herbicides have never been used and fertilisers added only twice to certain fields.

The majority of the meadows which make up this site are outstanding examples of calcareous clay pasture communities. One field lying beside the tributary of the River Ray in the south-eastern corner of the site conforms to the sedge-rich meadow type which is a predominantly western community. This field is the only place known where this community is found growing in association with several species of the ridge and furrow community typical of old hay meadows in East

The flora is exceptionally diverse with more than 160 plant species present, many of which are widely distributed throughout the site and are intricately mixed within the fields.

As with all suites of meadows there are individual differences resulting from varying drainage patterns, management (summer grazing or hay) and soils. However, the general grassland type of the ridges is that of common bent *Agrostis capillaris*, red fescue *Festuca rubra*, sweet vernal grass *Anthoxanthum odoratum* and quaking grass *Briza media*, together with yellow rattle *Rhinanthus minor*, pepper-saxifrage *Silaum silaus* and devil's-bit scabious *Succisa pratensis*. The furrows are characterised by marsh foxtail *Alopecurus geniculatus*, tufted hair-grass *Deschampsia cespitosa*, amphibious bistort *Polygonum amphibium*, lesser spearwort *Ranunculus flammula*, creeping Jenny *Lysimachia nummularia*, ragged robin *Lychnis flos-cuculi* and lady's smock *Cardamine pratensis*.

Plants confined largely to the hayfields include sneezewort *Achillea ptarmica*, common spotted orchid *Dactylorhiza fuchsii*, dropwort *Filipendula vulgaris*, adder's tongue *Ophioglossum vulgatum*, green-winged orchid *Orchis morio*, common milkwort *Polygala vulgaris*, cowslip *Primula veris* and saw-wort *Serratula tinctoria*. Plants confined to the grazed field are fewer in number and include species typical of poached ground such as yarrow *Achillea millefolium*, daisy *Bellis perennis* and creeping thistle *Cirsium arvense*, all occurring within a species-rich mixture. Plants particularly associated with the sedge-rich meadow include carnation, glaucous, brown, spring and tawny sedges *Carex panicea*, *C. flacca*, *C. disticha*, *C. caryophylla* and *C. hostiana* respectively, occurring with heath grass *Danthonia decumbens* and locally abundant meadow thistle *Cirsium dissectum*. Other plants recorded which are characteristic of traditionally managed grasslands include frog orchid *Coeloglossum viride*, betony *Stachys officinalis*, dyer's greenweed *Genista tinctoria*, spiny restharrow *Ononis spinosa* and great burnet *Sanguisorba officinalis*. There is a particularly diverse flora of dandelions *Taraxacum* spp. with 11 different species currently recorded.

The hedges provide a habitat for other plants not found within the fields. They are mainly composed of hawthorn, with blackthorn and rose also abundant. The hedges with the greatest variety of species are those bordering the Mansmoor Closes and the one alongside the parish boundary. The latter has a total of 14 species recorded including field maple *Acer campestre* and spindle *Euonymus europaeus*, both of which are often associated with long-established hedges.

The bird fauna of Wendlebury Meads includes breeding snipe and curlew. Other species recorded include golden plover, whitethroat, lesser whitethroat, reed bunting, green woodpecker, grasshopper warbler and barn owl. The meadows support large numbers of common butterflies, including meadow brown, hedge brown, small copper, common blue, green veined white and marbled white.



**COUNTY:** BUCKINGHAMSHIRE

**SITE NAME:** LONG HERDON MEADOW

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Aylesbury Vale District Council

**National Grid Reference:** SP648202

**Ordnance Survey Sheet 1:50,000:** 165 **1:10,000:** SP62 SW

**Date Notified (Under 1949 Act):** 1976 **Date of Last Revision:**

**Date Notified (Under 1981 Act):** 1985 **Date of Last Revision:**

**Area:** 4.5 ha 11.1 ac

**Other information:** Owned by the Berkshire, Buckinghamshire and Oxfordshire Naturalists Trust (BBONT).

### **Description and Reasons for Notification**

An alluvial meadow adjacent to the River Ray in the low-lying Oxford Clay country of the Vale of Aylesbury, part still under ridge and furrow, and all liable to winter and spring flooding. A low intensity of management, involving a late annual hay cut followed by cattle grazing, with no use of herbicides or artificial fertilisers, has resulted in an extremely rich grassland community of a kind now drastically reduced and fragmented in lowland Britain.

Apart from a strip alongside the River Ray where dumped dredgings were seeded with perennial ryegrass *Lolium perenne*, a markedly varied mixture of grasses predominates, with cocksfoot *Dactylis glomerata*, smooth-stalked meadow grass *Poa pratensis*, brown and common bents *Agrostis canina* and *A. capillaris*, Yorkshire fog *Holcus lanatus*, red and meadow fescues *Festuca rubra* and *F. pratensis*, Timothy *Phleum pratense*, tufted hair-grass *Deschampsia cespitosa*, crested dog's-tail *Cynosurus cristatus*, meadow foxtail *Alopecurus pratensis*, meadow barley *Hordeum secalinum*, sweet vernal *Anthoxanthum odoratum* and quaking grass *Briza media* the last particularly unusual for the Vale as well as jointed and conglomerate rushes *Juncus articulatus* and *J. conglomeratus* and brown, glaucous, common and carnation sedges *Carex disticha*, *C. flacca*, *C. nigra* and *C. panicea*. Cotton-grass *Eriophorum angustifolium*, rare in the area, was recorded until a few years ago and may yet reappear.

An abundance of herbs includes meadow and creeping buttercups *Ranunculus acris* and *R. repens*, white and red clovers *Trifolium repens* and *T. pratense*, lesser knapweed *Centaurea nigra*, devil's-bit scabious *Succisa pratensis*, meadowsweet *Filipendula ulmaria*, meadow and grass vetchlings *Lathyrus pratensis* and *L. nissolia*, tufted vetch *Vicia cracca* as well as abundant meadow thistle *Cirsium dissectum* and many others which are locally uncommon such as saw-wort *Serratula tinctoria*, sneezewort *Achillea ptarmica*, pepper saxifrage *Silaum silaus*, meadow rue *Thalictrum flavum*, ragged robin *Lychnis flos-cuculi* and green-winged orchid *Orchis morio*.

The ditches, cattle ramps and riverbank provide a more permanently wet habitat for a further range of species including flote-grass *Glyceria plicata*, lesser pond sedge *Carex acutiformis*, fool's watercress *Apium nodiflorum*, wild angelica *Angelica sylvestris*, tubular water dropwort *Oenanthe fistulosa*, great hairy willow-herb *Epilobium hirsutum*, marsh bedstraw *Galium palustre*, amphibious bistort *Polygonum amphibium*, water pepper *P. hydropiper* and water plantain *Alisma plantago-aquatica*. Parts of the meadow are flanked by hedges.

Winter flooding encourages considerable numbers of wading birds to the general area, and in summer snipe and curlew have been observed displaying. Among invertebrates the damselflies *Agrion splendens* and *Ischnura elegans* have been noted.

**COUNTY:** OXFORDSHIRE

**SITE NAME:** WHITECROSS GREEN AND ORIEL WOODS

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell and Aylesbury Vale District Councils  
Oxfordshire and Buckinghamshire County Councils

**National Grid Reference:** SP603144

**Ordnance Survey Sheet 1:50,000:** 164, 165 **1:10,000:** SP51 SE, SP61 SW

**Date Notified (Under 1981 Act):** 1985 **Date of Last Revision:**

**Area:** 64.1 ha 158.4 ac

**Other information:** Purchased from the Forestry Commission in 1984 by the Berks, Bucks and Oxon Naturalists Trust (BBONT).

### **Description and Reasons for Notification**

A tract of ancient woodland, extremely rich in plant and animal life, encompassing parts of two former royal forests, Shotover and Bernwood, and of which the boundary has remained unchanged since before 1590. A substantial part of the lower-lying Whitecross Green Wood, situated on damp and heavy Oxford Clay, was felled and replanted with Scots pine in 1964, but this is being progressively removed to favour the regeneration of native species. Oriel and the adjacent Upper Wood are dense stands of neglected hazel, maple and ash coppice with oak standards and pockets of willow, which occupy the higher though still predominantly wet ground of the Corallian escarpment.

Blackthorn *Prunus spinosa* is abundant throughout, while other trees and shrubs include birch, aspen *Populus tremula*, goat willow *Salix caprea*, wild service *Sorbus torminalis*, midland hawthorn *Crataegus laevigata*, spindle *Euonymus europaeus*, buckthorn *Rhamnus catharticus*, dogwood *Cornus sanguinea*, guelder rose *Viburnum opulus* and honeysuckle *Lonicera periclymenum*. Sycamore is confined to the southern corner of Upper Wood. Typical of the field layer are bluebell *Hyacinthoides non-scripta*, yellow archangel *Lamium galeobdolon*, sanicle *Sanicula europaea* and enchanter's nightshade *Circaea lutetiana*, together with the less common cow-wheat *Melampyrum pratense*, broad and purple helleborines *Epipactis helleborine* and *E. purpurata* and narrow-leaved everlasting pea *Lathyrus sylvestris*. Dead wood and old stumps abound, especially of elm and oak.

The site is traversed by herb-rich grassy rides, some of which have been cut annually and even grazed by the former tenant's solitary cow. Of the numerous species to be found in these rides, examples are primrose *Primula vulgaris*, cowslip *P. veris*, common spotted and greater butterfly orchids *Dactylorhiza fuchsii* and *Platanthera chlorantha*, twayblade *Listera ovata*, pepper saxifrage *Silene silene*, stone parsley *Sium amomum*, greater burnet *Pimpinella major*, yellow rattle *Rhinanthus minor*, grass vetchling *Lathyrus nissolia*, centaury *Centaurea erythraea*, common and trailing tormentils *Potentilla erecta* and *P. anglica*, devil's-bit scabious *Succisa pratensis* and cut-leaved cranesbill *Geranium dissectum*.

Ditches line some of the damper rides. There is a pond at the foot of the scarp slope and an area of marsh on the slope itself. In these wetter areas no less than eight species of sedge *Carex* and six of rush *Juncus* are to be found, as well as bugle *Ajuga reptans*, ragged robin *Lychnis flos-cuculi*, wild angelica *Angelica sylvestris*, marsh thistle *Cirsium palustre*, marsh and fen bedstraws *Galium palustre* and *G. uliginosum*, corn and water mints *Mentha arvensis* and *M. aquatica*, meadowsweet *Filipendula ulmaria*, hemp agrimony *Eupatorium cannabinum*, sneezewort *Achillea ptarmica*, lesser spearwort *Ranunculus flammula* and dominating the marsh - great horsetail *Equisetum telmateia*.

The twenty-four butterflies recorded to date include particularly strong colonies of wood white *Leptidea sinapis*, white admiral *Ladoga camilla* and the nationally rare black hairstreak *Strymonidia pruni*, as well as purple emperor *Apatura iris*, though the pearl-bordered fritillary *Boloria euphrosyne* has not been seen for two seasons and may have been lost. Among the moths which have been identified, the blue-bordered carpet *Plemyria rubiginata* and four-dotted footman *Cybosia mesomella* are of restricted distribution. Other recorded insects include the dragonfly *Aeshna juncea*, the local fly *Xylota lenta* whose larvae feed on deadwood, and the spectacular great green bush cricket *Tettigonia viridissima* at the northern edge of its range in Britain.

Over thirty breeding bird species have been observed, of which the nightjar and nightingale are particularly notable. The woods harbour large numbers of fallow and muntjac deer, grass snakes are common in the more open areas, and the pond contains crested newts *Triturus cristatus*.



**COUNTY:** OXFORDSHIRE

**SITE NAME:** MURCOTT MEADOWS

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Oxfordshire County Council, Cherwell District Council

**National Grid Reference:** SP593139

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP51 NE

**Date Notified (Under 1981 Act):** 1986 **Date of Last Revision:**

**Area:** 22.8 ha 56.3 ac

### **Description and Reasons for Notification**

Murcott Meadows are a series of unimproved neutral meadows which are traditionally managed for hay. They are representative of a grassland habitat once widespread in southern England, but now rare and declining rapidly due to agricultural improvement. This site is a remnant of a grassland type which was formerly common on the Otmoor Plain. The meadows have a ridge and furrow topography which indicates ploughing at some time in their history; however, the presence of at least twenty species of plant normally associated with ancient meadows suggests a long history of traditional management without reseeding or the application of inorganic fertilisers. A small block of woodland and scrub is present on the site and is of special interest for a rare species of butterfly. A pond on the woodland edge provides an additional habitat and contains a diverse flora.

Lying north-east of Oxford, Murcott Meadows are situated on the low-lying Otmoor Plain. The site is underlain by Oxford Clay and has seasonally waterlogged soils. Most of the meadows lie on clayey soils of the Denchworth Series, with finer, loamier soils of the Shabbington series occurring on the extreme western edge. The high water table ensures that the furrows are water-filled for much of the year and winter flooding is not unusual.

The meadows fall into two distinct grassland types as defined in the National Vegetation Classification. The north-eastern field is representative of the meadow foxtail-great burnet *Alopecurus pratensis*-*Sanguisorba officinalis* flood plain community, while the remaining meadows conform to the crested dog's tail-common knapweed *Cynosurus cristatus*-*Centaurea nigra* community. There is a further distinction between the flora of the ridge and furrows, with the sward influenced by the relative water levels.

The drier ridges of the north-eastern field are dominated by great burnet in association with meadow foxtail, pepper saxifrage *Silene silaus*, dropwort *Filipendula vulgaris* and yellow rattle *Rhinanthus minor*. Other species normally indicative of unimproved grassland include meadow thistle *Cirsium dissectum*, devil's-bit scabious *Succisa pratensis*, glaucous sedge *Carex flacca*, carnation sedge *C. panicea*, dyer's greenweed *Genista tinctoria* and sneezewort *Achillea ptarmica*. Several of these species grow in dense patches within the general community. The wetter ridges are dominated by meadow foxtail along with Timothy grass *Phleum pratense*, creeping bent *Agrostis stolonifera* and creeping buttercup *Ranunculus repens*. The furrows have a flora which reflects the high water table, with tufted hair-grass *Deschampsia cespitosa* the dominant species. Locally abundant in the furrows are jointed rush *Juncus articulatus*, tubular water dropwort *Oenanthe fistulosa*, sometimes in association with false fox sedge *Carex otrubae* and lesser spearwort *Ranunculus flammula*.

The remaining meadows have their ridge flora locally dominated by common knapweed with Yorkshire fog *Holcus lanatus*, crested dog's tail, meadow barley *Hordeum secalinum* and sweet vernal grass *Anthoxanthum odoratum*. Locally abundant on the ridges are several species characteristic of traditional grassland including pepper saxifrage, yellow rattle, quaking grass *Briza media* and saw-wort *Serratula tinctoria*. Meadow vetchling *Lathyrus pratensis* and tufted vetch *Vicia cracca* are both prominent and one field contains a population of green-winged orchid *Orchis morio*. The furrows are almost exclusively dominated by tufted hair-grass, with local patches of lesser spearwort, false fox sedge and oval sedge *Carex ovina*.

A small area of scrub and woodland bisects the south-western fields. The open woodland consists of pedunculate oak standards with a hawthorn understorey. This wood grades into patches of blackthorn and an old crack willow *Salix fragilis* bed.

All the meadows and wood are enclosed by mature hedges which contain hawthorn, Midland hawthorn *Crataegus laevigata*, blackthorn, English elm and oak.

A small pond, located on the northern edge of the wood, contains broadleaved pondweed *Potamogeton natans*, water plantain *Alisma plantago-aquatica*, together with toad rush *Juncus bufonius* on the muddy shores. Other species recorded from the pond and willow bed include fool's watercress *Apium nodiflorum*, floating sweet grass *Glyceria fluitans* and the uncommon water whorl grass *Catabrosa aquatica*.

The invertebrate fauna includes a wide range of aquatic and terrestrial species. The wood and thicker hedgerows support a population of the black hairstreak butterfly, a nationally uncommon species with a distribution restricted to the Oxford clay. The dragonflies recorded from the pond include four-spotted chaser *Libellula quadrimaculata* and Emperor dragonfly *Anax imperator*. Other insects recorded include Emperor moth *Saturnia pavonia*, a species uncommon in Oxfordshire and the nationally notable yellow-legged clearwing moth *Synanthedon vespiformis*.

The willow bed and woodland support several species of breeding bird including willow warbler and reed warbler. The meadows are used as a feeding ground by snipe and other waders which regularly use Otmoor as a wintering ground.

**COUNTY:** OXFORDSHIRE

**SITE NAME:** OTMOOR

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Oxfordshire County Council, South Oxon District Council, Cherwell District Council

**National Grid Reference:** SP575130

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP51

**Date Notified (Under 1949 Act):** 1952 **Date of Last Revision:** 1972

**Date Notified (Under 1981 Act):** 1988 **Date of Last Revision:**

**Area:** 211.6 ha 522.86 ac

**Other information:** Much of the site is an MOD firing range.

### **Description and Reasons for Notification**

Otmoor is a large bowl-shaped area of land on the flood-plain of the River Ray to the east of Oxford. The area of special scientific interest represents the core of what was, until recent times, an extensive area of wetland which was flooded in winter and was traditionally managed as rough grazing marsh. Much of the land outside the special area has been drained and converted to arable or improved pasture. The site contains a wide range of habitats with many species of nationally uncommon plants and animals. Approximately half of the site is herb-rich damp grassland which grades into wet sedge and coarse grassland.

The whole site is underlain by Oxford clay; the soils are derived from river alluvium and are predominantly stoneless, and occasionally calcareous clays of the Fladbury 1 Series. On the southern edges of the site are fine loams of the Shabington series. Wetter areas of the site have a peat layer developed over the alluvium.

A series of grassland types are represented on Otmoor, ranging from coarse tussocky grassland dominated by tufted hair-grass *Deschampsia caespitosa* to a herb-rich sward. Most of the site supports neutral grassland, with local differences attributable to variation in soil type, peat cover and water levels. The more acidic soils contain plants such as purple moor grass *Molinia caerulea* while the calcareous influence is shown by the presence of upright brome *Bromus erectus*, dropwort *Filipendula vulgaris* and dyer's greenweed *Genista tinctoria*.

Herb-rich swards in the southern half of the site are largely of crested dog's-tail *Cynosurus cristatus*-black knapweed *Centaurea nigra* grassland. One field with a ridge and furrow topography is on the south-east corner of the site. The more freely draining soils have a rich flora with a local abundance of species indicative of unimproved neutral meadow, including betony *Stachys officinalis*, lady's bedstraw *Galium verum*, devil's-bit scabious *Succisa pratensis*, sneezewort *Achillea ptarmica*, saw-wort *Serratula tinctoria* and great burnet *Sanguisorba officinalis*. An unusual member of these swards is believed to be a hybrid between the heath dog violet *Viola canina* and fen violet *V. persicifolia*. The wetter areas within the herb-rich meadows contain a diverse flora of sedges including the uncommon tawny sedge *Carex hostiana* and flea sedge *C. pulicaris* and the nationally rare downy-fruited sedge *C. tomentosa*. Patches of sedge-dominated sward follow the flow of surface runnels with areas of greater pond sedge *C. riparia* swamp merging into canary reed-grass *Phalaris arundinacea* and meadowsweet *Filipendula ulmaria*. Other less common species present include meadow rue *Thalictrum flavum*, marsh valerian *Valeriana dioica*, tubular water-dropwort *Oenanthe fistulosa* and marsh stitchwort *Stellaria palustris*.

The grasslands of the northern half of the site contain a mosaic of coarse, tussocky tufted hair-grass grassland and patches of more diverse grassland on drier soils. The former includes false fox-sedge *Carex otrubae*, hard rush *Juncus inflexus*, lesser spearwort *Ranunculus flammula* and skullcap *Scutellaria galericulata*, whilst drier areas have a sward which includes crested dog's-tail, sweet vernal-grass *Anthoxanthum odoratum*, marsh foxtail *Alopecurus geniculatus*,



sneezewort, black knapweed and self-heal *Prunella vulgaris*. The northern-most fields consist of semi-improved grassland with red fescue *Festuca rubra*, tufted hair-grass, marsh foxtail and tufted forget-me-not *Myosotis laxa*, together with oval sedge *Carex ovalis*, compact rush *Juncus conglomeratus*, soft rush *J. effusus* and tubular water-dropwort in wetter areas.

#### OVER/

A woodland block forms part of the eastern boundary of the site. This is semi-natural pedunculate oak wood which has been established since 1840 on an old ridge and furrow system. It has a dense understorey of blackthorn which forms a substantial thicket along the western edge. A ride on the western side contains a mainly ruderal flora amongst which a number of meadow species survive including the nationally rare true fox-sedge *Carex vulpina* and greater burnet saxifrage *Pimpinella major*, on the edge of its range in Britain.

Several dense hedges are present throughout the site and most date back to the enclosure of Otmoor in the mid-nineteenth century. These consist predominantly of hawthorn and blackthorn together with mature pedunculate oak and crack willow.

Standing water habitats are well represented. The central area of the site regularly floods in winter and two shallow pools remain in most years. The pools and ditches are rich in submerged and emergent aquatic plants. Most contain stands of branched bur-reed *Sparganium erectum*, reed sweet-grass *Glyceria maxima*, bulrush *Typha latifolia*, water plantain *Alisma plantago-aquatica* and flowering rush *Butomus umbellatus*. Many of the ditches contain arrowhead *Sagittaria sagittifolia* swamp, with frogbit *Hydrocharis morsus-ranae*, fat duckweed *Lemna gibba*, ivy-leaved duckweed *L. trisulca* and the regionally uncommon fine-leaved water-dropwort *Oenanthe aquatica*. The largest pool, known as the Pill, is rich in uncommon aquatic species including water violet *Hottonia palustris* and bladderwort *Utricularia vulgaris*.

The invertebrate fauna of the site is diverse and contains many nationally and regionally uncommon species, including several listed in the British Red Data Book of Invertebrates. There are several species whose foodplants are found largely in unimproved meadowland. These include the sawfly *Hartiga xanthosoma* on meadowsweet, the buprestid beetle *Trachys troglodytes* and marsh fritillary butterfly on devil's-bit scabious, the longhorn beetle *Agapanthia villosa* on marsh thistle *Cirsium palustre* and the forester moth *Adscita statice* on sorrel *Rumex acetosa*. The blackthorn thickets contain large populations of the nationally restricted black hairstreak and brown hairstreak butterflies. This site has the only colony of marsh fritillary butterfly currently known in Oxfordshire, and represents the second most easterly station for this butterfly in Britain. Other regionally uncommon species present include the emperor moth *Saturnia pavonia*, the shield bug *Zicrona caerulea* and the longhorn beetle *Anaglyptus mysticus*. The ditches and pools contain several water beetles including *Agabus uliginosus*, *Enochrus isotae* and *Helophorus dorsalis*, while emergent vegetation and shallow water supports the reed-beetle *Donacia impressa*, and the hoverflies *Anasimyia transfuga* and *Parhelophilus frutetorum*. Other uncommon species recorded in recent years include the large soldier fly *Stratiomys potamida* and the dragonfly *Sympetrum sanguineum*.

Otmoor was once renowned as an outstanding site for overwintering wildfowl and waders. Although much of this interest has been lost due to drainage and agricultural improvement, the site is still of high regional value for birds with over sixty breeding species recorded in recent years. The wet grasslands in the northern half of the site are still regularly used by many species of overwintering and breeding waders and wildfowl. The wintering birds regularly include teal, wigeon, snipe, lapwing, golden plover and short-eared owl and, less frequently, merlin, hen harrier, marsh harrier, green sandpiper, jack snipe and stonechat. The scrub and grassland habitat provides nesting sites for many species of summer visitors with nightingale, grasshopper warbler and lesser whitethroat common in certain areas. Breeding waders include regionally important numbers of snipe, and there is also regular breeding by curlew and lapwing, and occasional use by redshank. Other vertebrates recorded include water shrew, badger and grass snake.

**COUNTY:** BUCKINGHAMSHIRE

**SITE NAME:** MUSWELL HILL

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Buckinghamshire County Council, Aylesbury Vale District Council

**National Grid Reference:** SP640153

**Ordnance Survey Sheet 1:50,000:** 164                      **1:10,000:** SP61 NW

**Date Notified (Under 1981 Act):** 27 March 1992                      **Date of Last Revision:**

**Area:** 0.26 ha 0.64 ac

**Description and Reasons for Notification**

Problematic sandstones and sandy ironstones of Wealden facies and underlying Jurassic occur here. Their precise age and depositional environments are uncertain. The detritus is predominantly northern (appreciable plagioclase, garnet, kyanite staurolite, sphene, epidote, etc; low tourmaline), recycled from the Portland Beds and contemporaneously weathered (less K and plagioclase feldspars, glauconite, garnet, sphene, etc; higher kaolinite; ? palaeosol).

The site has considerable potential for research in end-Jurassic early Cretaceous dating, sedimentation and palaeogeography. Work on three nearby BGS boreholes suggests that the sandstones are earliest Cretaceous in age (mid-Purbeck, *sensu* Dorset) and deposited in non-marine environments (from evidence of spores, ostracods, kaolinite 'signal'; ? palaeosol, and absence of detritus from Cornubia).





**COUNTY:** OXFORDSHIRE

**SITE NAME:** STRATTON AUDLEY QUARRIES

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell District Council, Oxfordshire County Council

**National Grid Reference:** SP60052545, SP602250

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP52 NE & SE, SP62 NW & SW

**Date Notified (Under 1949 Act):** 1975 **Date of Last Revision:** 1977

**Date Notified (Under 1981 Act):** 1986 **Date of Last Revision:**

**Area:** 8.7 ha 21.5 ac

### **Description and Reasons for Notification**

A large part of the Jurassic White Limestone, as well as the entire Forest Marble and the Lower Cornbrash (*?hodsoni* Zone-*discus* Zone) have been exposed by quarrying at Stratton Audley. The quarry is an important location for studying facies changes which occur in the upper part of the White Limestone and in the Forest Marble, when these two formations are traced from Oxfordshire eastwards towards the 'London landmass' and north-eastwards into Buckinghamshire. Micritic limestones ('lime mudstones') developed within the Forest Marble between Bicester and Milton Keynes, and well displayed in this section, are distinctly different to limestones found within the Forest Marble elsewhere. They were probably deposited as lime-muds in restricted, brackish to freshwater lagoons. The Stratton Audley section affords an excellent opportunity to study the sediments and faunas which characterised such environments in Upper Bathonian times, as well as those of the more marine and fossiliferous Lower Cornbrash above.

**COUNTY:** OXFORDSHIRE

**SITE NAME:** ARNCOTT BRIDGE MEADOWS

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell District Council, Oxfordshire County Council

**National Grid Reference:** SP608185

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP61 NW

**Date Notified (Under 1981 Act):** 1985 **Date of Last Revision:** 1992

**Area:** 8.66 ha 21.39 ac

### **Description and Reasons for Notification**

Arcott Bridge Meadows lie on the floodplain of the River Ray. The meadows exhibit medieval ridge-and-furrow features indicating that parts, at least, have remained unploughed for many centuries. They are managed as hay meadow and pasture and accordingly support a wide range of plant species which are largely confined to such old, unimproved, neutral grassland.

The meadows are situated on fine loamy clay drift soils of the Wickham 2 Series. Parts of the site are seasonally waterlogged which reflects the position of the site adjacent to the River Ray and the underlying geology of impermeable Oxford Clay with Kellaway Beds.

The rich flora is, in part, attributable to the variation in the soil wetness caused by the ridge-and-furrow together with field ditches and localised depressions. The wettest areas which hold standing water in winter are characterised by species such as false fox-sedge *Carex otrubae*, brown sedge *C. disticha* and soft rush *Juncus effusus*, together with the grasses creeping bent *Agrostis stolonifera* and tufted hair-grass *Deschampsia cespitosa*. Abundant herbs present include tubular water-dropwort *Oenanthe fistulosa*, ragged-robin *Lychnis flos-cuculi* and meadowsweet *Filipendula ulmaria*.

On the tops of the ridges and other drier soils, the meadow sward contains a high proportion of herbs including many species indicative of ancient, unimproved grassland. This sward is characterised by grasses such as crested dog's-tail *Cynosurus cristatus* and common bent *Agrostis capillaris* with an abundance of great burnet *Sanguisorba officinalis*, yellow-rattle *Rhinanthus minor* and common spotted-orchid *Dactylorhiza fuchsii*. Other species indicative of old meadowland include saw-wort *Serratula tinctoria*, pepper-saxifrage *Silaum silaus*, adder's-tongue *Ophioglossum vulgatum*, green-winged orchid *Orchis morio*, carnation sedge *Carex panicea* and dropwort *Filipendula vulgaris*.

The vegetation in and along the banks of the adjacent River Ray contains species which are becoming increasingly rare, both regionally and nationally. The bank grassland contains the nationally uncommon narrow-leaved water-dropwort *Oenanthe silaifolia*, a species now confined to a few sites in Britain. Other locally uncommon species along the river bank include flowering-rush *Butomus umbellatus* and bladder-sedge *Carex vesicaria*.

**COUNTY:** OXFORDSHIRE     **SITE NAME:** WENDLEBURY MEADS AND MANSMOOR CLOSES

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Cherwell District Council, Oxfordshire County Council

**National Grid Reference:** SP562175

**Ordnance Survey Sheet 1:50,000:** 164                      **1:10,000:** SP51 NE

**Date Notified (Under 1949 Act):** 1977                      **Date of Last Revision:** 1977

**Date Notified (Under 1981 Act):** 1986                      **Date of Last Revision:** 1987

**Area:** 73.2 ha   180.9 ha

### **Description and Reasons for Notification**

Wendlebury Meads consists of a series of traditionally-managed unimproved neutral meadows supporting a complex variety of plant communities that have developed in response to varying management, drainage and soils. The meadows are amongst the few surviving examples of calcareous clay pasture communities which were widespread throughout southern England at the turn of the century, but now rare owing to agricultural improvement and urbanisation.

Wendlebury Meads occupy an area of low-lying ground, about 60 metres above sea level, which drains south-eastwards into a tributary of the River Ray. The area is underlain by Oxford Clay, and much is covered by clayey or fine loamy head. Four soil types are recognised. Cambic stagnogley soils of the Rowsham series mantle the broad flat area of the site. Both deep and shallow variants of the Lawford series cover land to the west, whilst to the east there are pelo-alluvial gley and pelo-calcareous alluvial gley soils of the Thames/Fladbury series. Short term flooding often occurs with the overflow of water from the River Ray.

Almost all of the fields of Wendlebury Meads have ridge and furrow topography which is evidence of past ploughing. Aerial photographs reveal a typical reversed 'S' shape to the ridges and furrows, originating from plough teams always turning left at the end of each line. The narrower fields known as the Mansmoor Closes demonstrate an early example of enclosure by agreement (date unknown, but not later than 1622) and are of landscape and archaeological importance. These fields also have a reversed 'S' shape showing that their hedges were planted alongside ridges pre-dating this period. In contrast the ridges either side of the parish boundary hedge are unrelated in their alignment, indicating that this boundary is of an earlier origin than the ridges.

Whereas contemporary intensive agriculture can eradicate most species of broadleaved herbs, arable farming often had significantly less influence on the flora in historic times. This is partly because furrows were not cultivated, leaving a reservoir of native species, partly because there was no drilling of grasses, plants being allowed to re-establish naturally, perhaps supplemented by sweepings from the hay barn and partly because herbicides and inorganic fertilisers were never applied.

All of the site north-east of the parish boundary forms part of the abandoned Starveall Farm, for which there is detailed historical information. Although most of the farm was arable until the late 19th century, some areas have probably always been grassland. All the land has been managed as grassland since 1920, and with one exception fields have been consistently grazed or cut for hay without reseeding or drainage. Within Starveall Farm there has been no ploughing since 1920 apart from one field which was treated in 1945-6 and which remains floristically distinct today. Herbicides have never been used and fertilisers added only twice to certain fields.

The majority of the meadows which make up this site are outstanding examples of calcareous clay pasture communities. One field lying beside the tributary of the River Ray in the south-eastern corner of the site conforms to the sedge-rich meadow type which is a predominantly western community. This field is the only place known where this community is found growing in association with several species of the ridge and furrow community typical of old hay meadows in East



The flora is exceptionally diverse with more than 160 plant species present, many of which are widely distributed throughout the site and are intricately mixed within the fields.

As with all suites of meadows there are individual differences resulting from varying drainage patterns, management (summer grazing or hay) and soils. However, the general grassland type of the ridges is that of common bent *Agrostis capillaris*, red fescue *Festuca rubra*, sweet vernal grass *Anthoxanthum odoratum* and quaking grass *Briza media*, together with yellow rattle *Rhinanthus minor*, pepper-saxifrage *Silaum silaus* and devil's-bit scabious *Succisa pratensis*. The furrows are characterised by marsh foxtail *Alopecurus geniculatus*, tufted hair-grass *Deschampsia cespitosa*, amphibious bistort *Polygonum amphibium*, lesser spearwort *Ranunculus flammula*, creeping Jenny *Lysimachia nummularia*, ragged robin *Lychnis flos-cuculi* and lady's smock *Cardamine pratensis*.

Plants confined largely to the hayfields include sneezewort *Achillea ptarmica*, common spotted orchid *Dactylorhiza fuchsii*, dropwort *Filipendula vulgaris*, adder's tongue *Ophioglossum vulgatum*, green-winged orchid *Orchis morio*, common milkwort *Polygala vulgaris*, cowslip *Primula veris* and saw-wort *Serratula tinctoria*. Plants confined to the grazed field are fewer in number and include species typical of poached ground such as yarrow *Achillea millefolium*, daisy *Bellis perennis* and creeping thistle *Cirsium arvense*, all occurring within a species-rich mixture. Plants particularly associated with the sedge-rich meadow include carnation, glaucous, brown, spring and tawny sedges *Carex panicea*, *C. flacca*, *C. disticha*, *C. caryophylla* and *C. hostiana* respectively, occurring with heath grass *Danthonia decumbens* and locally abundant meadow thistle *Cirsium dissectum*. Other plants recorded which are characteristic of traditionally managed grasslands include frog orchid *Coeloglossum viride*, betony *Stachys officinalis*, dyer's greenweed *Genista tinctoria*, spiny restharrow *Ononis spinosa* and great burnet *Sanguisorba officinalis*. There is a particularly diverse flora of dandelions *Taraxacum* spp. with 11 different species currently recorded.

The hedges provide a habitat for other plants not found within the fields. They are mainly composed of hawthorn, with blackthorn and rose also abundant. The hedges with the greatest variety of species are those bordering the Mansmoor Closes and the one alongside the parish boundary. The latter has a total of 14 species recorded including field maple *Acer campestre* and spindle *Euonymus europaeus*, both of which are often associated with long-established hedges.

The bird fauna of Wendlebury Meads includes breeding snipe and curlew. Other species recorded include golden plover, whitethroat, lesser whitethroat, reed bunting, green woodpecker, grasshopper warbler and barn owl. The meadows support large numbers of common butterflies, including meadow brown, hedge brown, small copper, common blue, green veined white and marbled white.

**COUNTY:** OXFORDSHIRE

**SITE NAME:** OTMOOR

**Status:** Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

**Local Planning Authorities:** Oxfordshire County Council, South Oxon District Council, Cherwell District Council

**National Grid Reference:** SP575130

**Ordnance Survey Sheet 1:50,000:** 164 **1:10,000:** SP51

**Date Notified (Under 1949 Act):** 1952 **Date of Last Revision:** 1972

**Date Notified (Under 1981 Act):** 1988 **Date of Last Revision:**

**Area:** 211.6 ha 522.86 ac

**Other information:** Much of the site is an MOD firing range.

### **Description and Reasons for Notification**

Otmoor is a large bowl-shaped area of land on the flood-plain of the River Ray to the east of Oxford. The area of special scientific interest represents the core of what was, until recent times, an extensive area of wetland which was flooded in winter and was traditionally managed as rough grazing marsh. Much of the land outside the special area has been drained and converted to arable or improved pasture. The site contains a wide range of habitats with many species of nationally uncommon plants and animals. Approximately half of the site is herb-rich damp grassland which grades into wet sedge and coarse grassland.

The whole site is underlain by Oxford clay; the soils are derived from river alluvium and are predominantly stoneless, and occasionally calcareous clays of the Fladbury 1 Series. On the southern edges of the site are fine loams of the Shabbington series. Wetter areas of the site have a peat layer developed over the alluvium.

A series of grassland types are represented on Otmoor, ranging from coarse tussocky grassland dominated by tufted hair-grass *Deschampsia caespitosa* to a herb-rich sward. Most of the site supports neutral grassland, with local differences attributable to variation in soil type, peat cover and water levels. The more acidic soils contain plants such as purple moor grass *Molinia caerulea* while the calcareous influence is shown by the presence of upright brome *Bromus erectus*, dropwort *Filipendula vulgaris* and dyer's greenweed *Genista tinctoria*.

Herb-rich swards in the southern half of the site are largely of crested dog's-tail *Cynosurus cristatus*-black knapweed *Centaurea nigra* grassland. One field with a ridge and furrow topography is on the south-east corner of the site. The more freely draining soils have a rich flora with a local abundance of species indicative of unimproved neutral meadow, including betony *Stachys officinalis*, lady's bedstraw *Galium verum*, devil's-bit scabious *Succisa pratensis*, sneezewort *Achillea ptarmica*, saw-wort *Serratula tinctoria* and great burnet *Sanguisorba officinalis*. An unusual member of these swards is believed to be a hybrid between the heath dog violet *Viola canina* and fen violet *V. persicifolia*. The wetter areas within the herb-rich meadows contain a diverse flora of sedges including the uncommon tawny sedge *Carex hostiana* and flea sedge *C. pulicaris* and the nationally rare downy-fruited sedge *C. tomentosa*. Patches of sedge-dominated sward follow the flow of surface runnels with areas of greater pond sedge *C. riparia* swamp merging into canary reed-grass *Phalaris arundinacea* and meadowsweet *Filipendula ulmaria*. Other less common species present include meadow rue *Thalictrum flavum*, marsh valerian *Valeriana dioica*, tubular water-dropwort *Oenanthe fistulosa* and marsh stitchwort *Stellaria palustris*.

The grasslands of the northern half of the site contain a mosaic of coarse, tussocky tufted hair-grass grassland and patches of more diverse grassland on drier soils. The former includes false fox-sedge *Carex otrubae*, hard rush *Juncus inflexus*, lesser spearwort *Ranunculus flammula* and skullcap *Scutellaria galericulata*, whilst drier areas have a sward which includes crested dog's-tail, sweet vernal-grass *Anthoxanthum odoratum*, marsh foxtail *Alopecurus geniculatus*,

sneezewort, black knapweed and self-heal *Prunella vulgaris*. The northern-most fields consist of semi-improved grassland with red fescue *Festuca rubra*, tufted hair-grass, marsh foxtail and tufted forget-me-not *Myosotis laxa*, together with oval sedge *Carex ovalis*, compact rush *Juncus conglomeratus*, soft rush *J. effusus* and tubular water-dropwort in wetter areas.

#### OVER/

A woodland block forms part of the eastern boundary of the site. This is semi-natural pedunculate oak wood which has been established since 1840 on an old ridge and furrow system. It has a dense understorey of blackthorn which forms a substantial thicket along the western edge. A ride on the western side contains a mainly ruderal flora amongst which a number of meadow species survive including the nationally rare true fox-sedge *Carex vulpina* and greater burnet saxifrage *Pimpinella major*, on the edge of its range in Britain.

Several dense hedges are present throughout the site and most date back to the enclosure of Otmoor in the mid-nineteenth century. These consist predominantly of hawthorn and blackthorn together with mature pedunculate oak and crack willow.

Standing water habitats are well represented. The central area of the site regularly floods in winter and two shallow pools remain in most years. The pools and ditches are rich in submerged and emergent aquatic plants. Most contain stands of branched bur-reed *Sparganium erectum*, reed sweet-grass *Glyceria maxima*, bulrush *Typha latifolia*, water plantain *Alisma plantago-aquatica* and flowering rush *Butomus umbellatus*. Many of the ditches contain arrowhead *Sagittaria sagittifolia* swamp, with frogbit *Hydrocharis morsus-ranae*, fat duckweed *Lemna gibba*, ivy-leaved duckweed *L. trisulca* and the regionally uncommon fine-leaved water-dropwort *Oenanthe aquatica*. The largest pool, known as the Pill, is rich in uncommon aquatic species including water violet *Hottonia palustris* and bladderwort *Utricularia vulgaris*.

The invertebrate fauna of the site is diverse and contains many nationally and regionally uncommon species, including several listed in the British Red Data Book of Invertebrates. There are several species whose foodplants are found largely in unimproved meadowland. These include the sawfly *Hartiga xanthosoma* on meadowsweet, the buprestid beetle *Trachys troglodytes* and marsh fritillary butterfly on devil's-bit scabious, the longhorn beetle *Agapanthia villosa* on marsh thistle *Cirsium palustre* and the forester moth *Adscita statice* on sorrel *Rumex acetosa*. The blackthorn thickets contain large populations of the nationally restricted black hairstreak and brown hairstreak butterflies. This site has the only colony of marsh fritillary butterfly currently known in Oxfordshire, and represents the second most easterly station for this butterfly in Britain. Other regionally uncommon species present include the emperor moth *Saturnia pavonia*, the shield bug *Zicrona caerulea* and the longhorn beetle *Anaglyptus mysticus*. The ditches and pools contain several water beetles including *Agabus uliginosus*, *Enochrus isotae* and *Helophorus dorsalis*, while emergent vegetation and shallow water supports the reed-beetle *Donacia impressa*, and the hoverflies *Anasimyia transfuga* and *Parhelophilus frutetorum*. Other uncommon species recorded in recent years include the large soldier fly *Stratiomys potamida* and the dragonfly *Sympetrum sanguineum*.

Otmoor was once renowned as an outstanding site for overwintering wildfowl and waders. Although much of this interest has been lost due to drainage and agricultural improvement, the site is still of high regional value for birds with over sixty breeding species recorded in recent years. The wet grasslands in the northern half of the site are still regularly used by many species of overwintering and breeding waders and wildfowl. The wintering birds regularly include teal, wigeon, snipe, lapwing, golden plover and short-eared owl and, less frequently, merlin, hen harrier, marsh harrier, green sandpiper, jack snipe and stonechat. The scrub and grassland habitat provides nesting sites for many species of summer visitors with nightingale, grasshopper warbler and lesser whitethroat common in certain areas. Breeding waders include regionally important numbers of snipe, and there is also regular breeding by curlew and lapwing, and occasional use by redshank. Other vertebrates recorded include water shrew, badger and grass snake.



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## **Annex B**

# **Records of legally protected and priority species**

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**Annex B1: Protected Species Records within 1km from the C Site Study Area**

Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
Mammal	Pipistrelle bat ( <i>Pipistrellus pipistrellus</i> ).	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 624 149 SP 624 151	Roost. 8 records from Boarstall decoy bat box project.	21/07/2002 2002-04	Bat group (Oxon).
Mammal	Brown long-eared bat ( <i>Plecotus auritus</i> ).	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 601 151	Roost.	14/10/1996	TVERC. Bat group (Oxon).
								SP 626 145		21/09/1996	
								SP 625 151	2 records from Boarstall decoy bat project (see below).	2002, 2003	
								SP6004 1466	5 females in bat box	22/09/2002	
								SP6004 1466	6 males in bat box	22/09/2002	
								SP6004 1466	3 in bat box	22/09/2002	
								SP6004 1466	1 female in bat box	22/09/2002	
								SP6043 1432	5 females in bat box	22/09/2002	
Mammal	Bechstein's bat	W&C Act (Sch 5) Cons Regs.					✓	SP6043 1432	2 males in bat box	22/09/2002	TVERC.
								SP6043 1432	5 in bat box	22/09/2002	
								SP 625 172	Grounded bat Bullingdon Prison.	18/09/2001	TVERC.





Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
	<i>(Myotis bechsteinii)</i> .	UK BAP priority sp.									
Mammal	Daubenton's bat <i>(Myotis daubentonii)</i> .	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 625 172	Grounded bat Bullingdon Prison.	09/11/1997	Bat group (Oxon).
Mammal	Leisler's bat ( <i>Nyctalus leisleri</i> ).	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 624 151	One record from the bat box project at Boarstall duck decoy (see below).	29/09/2004	Bat group (Oxon).
Mammal	Noctule bat ( <i>Nyctalus nyctalus</i> ).	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.		✓				SP 628 170	Grounded bat Bullingdon Prison.	13/08/1997	Bat group (Oxon).
Mammal	45 and 55 Pipistrelle, Daubenton's, Noctule, Serotine, Leislers, Whiskered/Brandt's and potentially Bechstein's bat.	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 624 151	Boarstall duck decoy bat box scheme. Pipistrelle, brown long-eared and Leislers bats reported by bat group. Non-statutory site citation reports bat detector surveys that have shown presence of all species listed except Bechstein's. Bechstein's are known to occur within a 2-mile radius and hence the bat group believe that they are likely to use these woods.	2002-2004	BMERC (Bucks) & Oxon Bat group.
Mammal	Water vole ( <i>Arvicola</i>	W&C Act (Sch 5) Cons Regs.					✓	SP 624 151	Boarstall duck decoy.	1980	BMERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000+				
	<i>terestr/s</i> ).	UK BAP priority sp.									(Bucks).
Mammal	Hedgehog ( <i>Erinaceus europaeus</i> ).	UK BAP priority sp.					✓	SP 624 151	Boarstall duck decoy.	1980	BMERC (Bucks).
Mammal	Polecat ( <i>Mustela putorius</i> ).	UK BAP priority sp.						SP 627 168	Oxon tetrad 6216.	10/02/2001	TVERC.
Mammal	Brown hare ( <i>Lepus europaeus</i> ).	UK BAP priority sp.			✓			SP 596 169	Meadow NE of field road.	26/06/1999	TVERC.
Reptiles	Common lizard ( <i>Zootica vivipara</i> ).	W&C Act (Sch 5 parts 1, 5a&b). UK BAP priority sp.					✓	SP 600 149	6 records from Whitecross Green Wood SSSI.	16/04/2003 01/08/1996 08/02/1997 20/07/1997 04/02/1998 08/10/1998	TVERC
Amphibian	Great crested newt ( <i>Triturus cristatus</i> ).	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.	✓					SP 611 174	Arncott pond - on site.	30/11/1986	TVERC
Amphibian	Smooth newt ( <i>Triturus vulgaris</i> ).	W&C Act (Sch 5 part 5a&b).					✓	SP 623 159	Little wood CWS.	06/07/1993	TVERC

Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
Bird.	Cuckoo ( <i>Cuculus canorus</i> ).	UK BAP priority sp. BOCC amber list.			✓			SP 615 166 SP 618 177	Arncott Wood - on site. Rifle range scrub - on site.	06/05/1987.	TVERC.
Bird.	Curlew ( <i>Numenius arquata</i> ).	UK BAP priority sp. BOCC amber list.	✓					SP 609 185	Arncott Bridge meadows SSSI.	13/03/2003.	TVERC.
Bird.	Willow warbler ( <i>Phylloscopus trochilus</i> ).	BOCC amber list.	✓		✓		✓	SP 615 166 SP 628 .163	Arncott wood. Piddington Wood.	06/05/1987. 23/08/1989.	TVERC.
Bird.	Kestrel ( <i>Falco tinnunculus</i> ).	BOCC amber list.				✓		SP 609 160 SP 624 151	Bicester Garrison I Boarstall Duck decoy.	1996 1984.	BMERC (Bucks).
Bird	Green woodpecker ( <i>Picus viridis</i> ).	BOCC amber list.				✓		SP 609 160	Bicester Garrison I	1996	BMERC (Bucks)
Invertebrate	Wood white ( <i>Leptidea sinapis</i> ).	UK BAP priority sp. Notable invertebrate.					✓	SP 600 150 SP 604 149	Whitecross green wood SSSI	21/06/1997 25/06/1995	TVERC
Invertebrate	Brown hairstreak ( <i>Thecla betulae</i> ).	UK BAP priority sp. Notable invertebrate					✓	SP 600 150 SP 615 201 SP 628 163	Whitecross green wood SSSI Oxon tetrad 6020 Piddington Wood	06/09/1997 23/01/2003 09/08/1994	TVERC
Invertebrate	a ground beetle	Nationally	✓	✓				SP 598 184	Jaspers copse	22/01/2004	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
	<i>(Acupalpus exiguus)</i>	scarce						SP 605 187 SP 609 185 SP 611 184	Ambrosden SF scrub Aincott Bridge Meadows SSSI Cox Ambrosden	13/03/2003 13/03/2003 19/02/2004	
Invertebrate	A ground beetle ( <i>Bembidion clarkii</i> )	Notable invertebrate	✓			✓		SP 596 170 SP 609 185	Murcott, Oxon tetrad Aincott Bridge Meadows SSSI	28/01/1990 13/03/2003	TVERC
Invertebrate	a ground beetle ( <i>Bembidion gilvipes</i> )	Nationally scarce invertebrate	✓	✓				SP 611 184 SP 609 185	Cox Ambrosden Aincott Bridge meadows SSSI	19/02/2004 13/03/2003	TVERC
Invertebrate	Brown ant ( <i>Lasius brunneus</i> )	Notable invertebrate					✓	SP 623 159	Little wood	06/07/1993	TVERC
Invertebrate	Black hairstreak ( <i>Satyrus pruni</i> )	Notable invertebrate					✓	SP 622 158 SP 620 160 SP 600 150 SP 628 163	Little wood Little wood Whitecross green wood SSSI Piddington Wood	16/6/2009 20/06/2009 06/09/1997 09/08/1994	TVERC
Invertebrate	a rove beetle ( <i>Sepedophilus pedicularius</i> )	Notable invertebrate	✓					SP 609 185	Aincott bridge meadow SSSI	13/03/2003	TVERC
Invertebrate	Small heath ( <i>Coenonympha pamphilus</i> )	UK BAP Priority sp.			✓		✓	SP 608 188 SP 628 163	Field South of Ambrosden Piddington Wood	08/06/2004 06/06/1991	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
								SP 629 187	Road Verge	07/08/1990	
Invertebrate	Soldier beetle ( <i>Malathinus frontalis</i> )	Notable invertebrate					✓	SP 623 159	Little wood	06/07/1993	TVERC
Invertebrate	A hoverfly ( <i>Xanthandrus comitus</i> )	Notable invertebrate					✓	SP 628 163	Piddington Wood	06/07/1993	TVERC
Invertebrate	a ground beetle ( <i>Lebia chlorocephala</i> )	Nationally scarce	✓	✓				SP 605 187 SP 609 185	Ambrosden SF scrub Arncott bridge meadow SSSI	13/03/2003	TVERC
Invertebrate	a ground beetle ( <i>Pterostichus longicollis</i> )	Nationally scarce		✓				SP 611 184	Cox Ambrosden	19/02/2004	TVERC
Invertebrate	a rove beetle ( <i>Tachyporus formosus</i> )	Nationally scarce	✓					SP 609 185	Arncott bridge meadow SSSI	13/03/2003	TVERC
Plant	Tubular water drop-wort ( <i>Oenanthe fistulosa</i> )	UK BAP Priority sp. IUCN red list - vulnerable		✓		✓		SP 617 186 SP 617 186	Meadow south of river ray Meadow south of river ray	07/2008 10/07/2008	TVERC
								SP 608 188 SP 610 186 SP 617 186	Field south of Ambrosden Field east of Arncott meadows SSSI Meadow south of River Ray	08/06/2004 08/06/2004 16/06/2000	



Species Group	Name	Status	Distance from site boundary				NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000+			
Plant	True fox sedge ( <i>Carex vulpina</i> )	UK BAP Priority sp. IUCN red list - vulnerable. Nationally rare.	✓	✓				SP 608 185 SP 609 186 Aincott bridge meadow SSSI	07/06/2005	TVERC



**Annex B2: Protected Species Records within 2km from the Graven Hill Study Area**

Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
Mammal	Pipistrelle bat ( <i>Pipistrellus pipistrellus</i> )	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.				✓		SP 584 222 SP 605 196	Roost Grounded (Ambrosden)	12/07/2002 31/07/2007	Bat group (Oxon)
Mammal	Brown long-eared bat ( <i>Plecotus auritus</i> )	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.				✓	✓	SP 603 192 SP 605 196 SP6004 1466	Roost Grounded Bat box	13/01/1998 17/07/2007 22/9/2002	Bat group (Oxon) TVERC
Mammal	Leisler's bat ( <i>Nyctalus leisleri</i> )	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.				✓		SP 605 196	Grounded – Glory farm estate, Bicester	25/07/2007	Bat group (Oxon)
Mammal	Natterer's bat ( <i>Myotis nattereri</i> )	W&C Act (Sch 5) Cons Regs. UK BAP priority sp.					✓	SP 558 220	Roost	07/07/1999	Bat group (Oxon)
Mammal	Hedgehog ( <i>Erinaceus europaeus</i> )	UK BAP priority sp.					✓	SP 606 196	Road Kill	31/10/2005 02/01/2005	TVERC
Amphibian	Great crested newt ( <i>Triturus cristatus</i> )	W&C Act (Sch 5) Cons Regs. UK BAP priority				✓	✓	SP 605 199 SP 595 226	Pond in Ambrosden Gavray complex	01/04/2002 -	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000+				
		sp.									
Amphibian	Smooth newt ( <i>Triturus vulgaris</i> )	W&C Act (Sch 5 part 5a&b)				✓		SP 605 199	Pond in Ambrosden	01/04/2002	TVERC
Amphibian	Common toad ( <i>Bufo bufo</i> )	UK BAP priority sp.				✓		SP 603 195	Ambrosden Churchyard	28/09/1993	TVERC
Bird	Bittern ( <i>Botaurus stellaris</i> )	W&C Act (Sch 1). UK BAP priority sp. BOCC red list.	✓					SP 577 209	Bicester Wetlands Reserve	2000, 2001	TVERC
Bird	Merlin ( <i>Falco columbarius</i> )	W&C Act (Sch 1). BOCC Amber list.	✓					SP 577 209	Bicester Wetlands Reserve	2003	TVERC
Bird	Hobby ( <i>Falco subbuttee</i> )	W&C Act (Sch 1).	✓					SP 577 209	Bicester Wetlands Reserve	2001	TVERC
Bird	Peregrine ( <i>Falco peregrinus</i> )	W&C Act (Sch 1). BOCC amber list.	✓					SP 577 209	Bicester Wetlands Reserve	2003	TVERC
Bird	Little Ringed Plover ( <i>Charadrius dubius</i> )	W&C Act (Sch 1)	✓					SP 577 209	Bicester Wetlands Reserve	2003, 2004	TVERC
Bird	Black-Tailed Godwit ( <i>Limosa limosa</i> )	W&C Act (Sch 1). BOCC red list.	✓					SP 577 209	Bicester Wetlands Reserve	2004	TVERC
Bird	Greenshank ( <i>Tringa</i> )	W&C Act (Sch 1). UK BAP	✓					SP 577 209	Bicester Wetlands Reserve	2000	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
	<i>nebularia</i>	priority sp. BOCC red list.									
Bird	Barn Owl ( <i>Tyto alba</i> ) and	W&C Act (Sch 1). BOCC amber list.	✓					SP 577 209	Bicester Wetlands Reserve	2003	TVERC
Bird	Kingfisher ( <i>Alcedo atthis</i> )	W&C Act (Sch 1). BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2001, 02, 03, 04	TVERC
Bird	Green sandpiper ( <i>Tringa ochropus</i> )	W&C Act (Sch 1). BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2001, 02, 03, 04	TVERC
Bird	Curlew ( <i>Numenius arquata</i> )	UK BAP priority sp. BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2004	TVERC
Bird	Cuckoo ( <i>Cuculus canorus</i> )	UK BAP priority sp. BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2004	TVERC
Bird	Yellow Wagtail ( <i>Motacilla flava</i> )	UK BAP priority sp. BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2001, 02, 03, 04	TVERC
Bird	Common bull finch ( <i>Pyrrhula pyrrhula</i> )	UK BAP priority					✓	SP 612 213	Meadow NW of Blackthorn Hill	21/07/2009	TVERC
Bird	Grasshopper Warbler ( <i>Locustella naevia</i> )	UK BAP priority sp. BOCC	✓					SP 588 204	Graven Hill – on site	28/04/1987	TVERC

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Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000+				
		amber list									
Bird	Marsh Tit ( <i>Parus palustris</i> )	UK BAP priority sp. BOCC red list	✓					SP 577 209	Bicester Wetlands Reserve	2003	TVERC
Bird	Willow Tit ( <i>Parus montanus</i> )	UK BAP priority sp. BOCC red list	✓					SP 577 209	Bicester Wetlands Reserve	2001, 2002, 2003	TVERC
Bird	Linnet ( <i>Carduelis cannabina</i> )	UK BAP priority sp. BOCC red list	✓					SP 577 209	Bicester Wetlands Reserve	2002	TVERC
Bird	Yellowhammer ( <i>Emberiza citrinella</i> )	UK BAP priority sp. BOCC red list	✓				✓	SP 577 209 SP 608 210 SP 612 213	Bicester Wetlands Reserve Meadow NW of Blackthorn Hill south east field Meadow NW of Blackthorn Hill large field	2001, 02, 03, 04 21/7/2009 21/7/2009	TVERC TVERC TVERC
Bird	Reed Bunting ( <i>Emberiza schoeniclus</i> )	UK BAP priority sp. BOCC red list	✓					SP 577 209	Bicester Wetlands Reserve	2001, 02, 03, 04	TVERC
Bird	Cormorant ( <i>Phalacrocorax carbo</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2002	TVERC
Bird	Little Egret ( <i>Egretta garzetta</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2002-03	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
Bird	Mute Swan ( <i>Cygnus olor</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Greylag Goose ( <i>Anser anser</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2003	TVERC
Bird	Wigeon ( <i>Anas penelope</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2001-04	TVERC
Bird	Gadwall ( <i>Anas strepera</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Teal ( <i>Anas crecca</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Pintail ( <i>Anas acuta</i> )	W&C Act (Sch 1 pt 2). BOCC amber list.	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Shoveler ( <i>Anas clypeata</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Pochard ( <i>Aythya farina</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Water Rail ( <i>Rallus aquaticus</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Snipe ( <i>Gallinago gallinago</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Redshank ( <i>Tringa totanus</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC

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Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000 +				
Bird	Green Woodpecker ( <i>Picus viridis</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Sand Martin ( <i>Riparia riparia</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	House Martin ( <i>Delichon urbica</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2003-04	TVERC
Bird	Grey wagtail ( <i>Motacilla cinerea</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2000-04	TVERC
Bird	Green woodpecker ( <i>Picus viridis</i> )	BOCC amber list	✓					SP 577 209	Graven Hill	28/04/1987	TVERC
Bird	Willow warbler ( <i>Phylloscopus trochilus</i> )	BOCC amber list	✓					SP 577 209	Graven Hill	28/04/1987	TVERC
Bird	Stonechat ( <i>Saxicola torquata</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2002	TVERC
Bird	Willow Warbler ( <i>Phylloscopus trochilus</i> )	BOCC amber list	✓					SP 577 209	Bicester Wetlands Reserve	2003-04	TVERC
Bird	Sky lark ( <i>Alauda arvensis</i> )	UK BAP priority					✓	SP 608 210	Meadow NW of Blackthorn Hill South East Field	21/7/2009	TVERC
Invertebrate	ground beetle ( <i>Bembidion quadripustulatum</i> )	UK BAP priority sp. Nationally scarce	✓					SP 579 210	Bicester sewage farm reserve	2000	TVERC



Species Group	Name	Status	Distance from site boundary					NGR	Comments	Date	Source
			0-250	250-500	500-750	750-1000	1000+				
Invertebrate	Grizzled Skipper ( <i>Pyrgus malvae</i> )	UK BAP priority sp.	✓					SP 588 204	Graven Hill	14/06/2002	TVERC
Invertebrate	Wall ( <i>Lasiommata megera</i> )	UK BAP priority sp.	✓					SP 580 212	Oxon tetrad	22/08/1990	TVERC
Invertebrate	ground beetle ( <i>Bembidion gilvipes</i> )	Nationally scarce invertebrate					✓	SP 595 226	Gavray complex	16/01/2003	TVERC
Invertebrate	rove beetle ( <i>Philonthus fumarius</i> )	Nationally scarce invertebrate					✓	SP 595 226	Gavray complex	16/01/2003	TVERC
Invertebrate	Black hairstreak ( <i>Satyrrium pruni</i> )	W&C Act (Sch 1).					✓	SP 597 222	Gavray drive meadows	15/6/2008	TVERC
Plant	Bluebell ( <i>Hyacinthoides non-scripta</i> )	WCA (Sch 8)	✓					SP 588 204	Graven Hill	14/06/2002	TVERC





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# Annex C

## Target notes for Graven Hill and C Site

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### Graven Hill

#### Target notes

**TN1:** Woodland including Graven Hill Wood, comprising dense semi-natural mixed woodland, dominated by pedunculate oak and Scots pine, with occasional sycamore, silver birch (and field maple among other tree species found. Understorey vegetation includes wild privet (*Ligustrum vulgare*), hawthorn and hazel. A localised area of spurge laurel (*Daphne laureola*) was found on the hillside in the south-east section. Little ground vegetation was visible at the time of survey, but a number of ancient woodland indicator species were found, including abundant dog's mercury, lords and ladies and, in small clearings and along the edges of rides, dense stands of pendulous sedge. (Some of these clearings have been recently replanted with broad-leaved saplings). Primrose, ground ivy and agrimony were also noted, and extensive patches of bryophytes occur in the wetter areas. Drainage ditches criss-cross the woodland and separate the wood from the adjacent grassland, but at the time of the survey they contained little water and no vegetation. The woodland is bordered by a band of bramble scrub, and a 5m strip of the semi-improved grassland to the north has been left unmanaged, and comprises tall grass and herb vegetation.

**TN2:** Dense, species-poor unmanaged hedgerow, approximately 3m high, predominantly hawthorn/blackthorn with occasional standards and flanked by bramble scrub.

**TN3:** Standing dead tree with several woodpecker holes.

**TN4:** Hedgerows comprising a mixture of scrub trees and standards.

**TN5:** Closely spaced row of young mature standards, mostly common lime (*Tilia europaea*).

**TN6:** Small, shallow pond (approx. 8m diameter), dry at time of survey visible with colonising terrestrial grasses, indicating that the water may be semi-permanent. The water surface is largely overshadowed by scrubby trees.

**TN7:** Species-poor semi-improved grassland field, which at the time of survey was being used to produce a hay crop. There is a hedgeline of young broad-leaved trees and hawthorn with bramble scrub along the western boundary, and a row of mature broad-leaved trees along the roadside to the south.

**TN8:** Areas of dense bramble and gorse scrub along ditches by sections of railway track and encroaching onto an unmanaged grass embankment.



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*TN9:* Fenced-off field of poor semi-improved grassland with frequent marshy areas containing rush, and occasional patches of bramble scrub and small trees. A continuous band of tall, dense scrub occurs along the northern and western edges, with intermittent bramble scrub along the southern and eastern edges.

*TN10:* Small area of standing water, containing rush but no other emergent or aquatic vegetation, indicating that this is unlikely to be a permanent water body.

*TN11:* Large veteran oak trees.

*TN12:* Small pond surrounded by trees and scrub and thus partly shaded, but with a central open area containing emergent vegetation including bulrush.

*TN13:* Farmhouse and outbuildings, including some with pitched tiled roofs. The farmhouse appeared to be in good repair and occupied, but many of the outbuildings are in a dilapidated state.

*TN14:* Narrow ditch with intermittent row of blackthorn/hawthorn scrub. The eastern end of the ditch contained little water, but this became deeper to the west, with increasing amounts of emergent vegetation (rush and bulrush), and a few short (20-30m) stretches containing more permanent shallow water featuring aquatic species including watercress and water crowfoot.

*TN15:* Tall, dense continuous species-poor hedge dominated by hawthorn, with increasing numbers of standard trees, including some large mature ash, towards the western end.

*TN16:* Area of young broad-leaved plantation woodland dominated by poplar and sycamore and occasional alder, flanked by a band of bramble scrub and tall herb vegetation, with a ditch containing rushes and sedges as well as common spotted orchid along the southern edge.

*TN17:* Area of unmanaged semi-natural woodland containing large patches of bramble scrub, tall ruderal vegetation and broken hardstanding, with several piles of rubble and wood (logs and old railway sleepers).

*TN18:* Narrow strip of dense broad-leaved woodland forming a hedgerow adjacent to a ditch containing 5-10cm of slow-flowing water, the latter containing some aquatic vegetation including watercress.

*TN19:* Pond (approx. 25m x 15m) surrounded and overshadowed by trees with yellow flag iris and bur-reed. (This appears to be an overflow pond for the adjacent drainage ditch.)

*TN20:* Group of farm buildings, comprising a stable block and open-walled sheds, set within a farmyard containing a large compost heap and areas of woody scrub.

*TN21:* Fenced-off area of rough grassland with patchy bramble scrub along the southern edge, a continuous line of young mature broad-leaved trees along the northern boundary and scattered broad-leaved trees within.

*TN22:* Dense mixed plantation woodland containing trees of varying ages, with a dense understorey of secondary growth and little ground vegetation. A narrow strip of bramble scrub along the northern edge widens to the east into a mixture of scrub and tall herb vegetation.



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TN23: Dense stand of young broad-leaved plantation woodland, predominantly broad-leaved to the west and coniferous to the east.

TN24: Dense mature coniferous plantation with an understorey of broad-leaved scrub including hawthorn and little ground vegetation.

TN25: Groups of air-raid shelters with brick walls and concrete slab roofs, and with an entrance at each end and small slit apertures on either side. Only a few of these were inspected internally, and they were found to be very damp and draughty inside, although there was less air flow within the end-chambers and peacock butterflies (*Inachis io*) were found hibernating in some of these.

TN26: Stands of mature planted poplar.

TN27: Fenced works yard containing a mixture hardstanding, as well as large piles of logs and brash, with a broad band of unmanaged grass and scrub along the southern boundary.

TN28: Fenced area of tussocky grassland.

TN29: Areas of broken hardstanding with frequent patches standing water containing rush.

TN30: Ditch containing shallow (5-10cm deep) slow-flowing water and abundant aquatic vegetation (principally watercress) as well as emergent species such as bulrush.

TN31: Row of tall conifers planted as a screen outside of the security fence.

TN32 Secure fenced complex containing buildings, hardstanding and close-mown grassland.

TN33: Young, predominantly coniferous plantation woodland, containing frequent clearings. The clearings and woodland edges are largely dominated by bramble scrub and tall herb vegetation including nettle, teasel, dock (*Rumex* spp.) and cow parsley (*Anthriscus sylvestris*) with frequent marshy areas dominated by pendulous sedge and willow. Lords and ladies and dog's mercury are also present in the ground flora.

TN34: Small pond on the edge of the woodland, completely dry at time of survey and appears to have been so for some time indicated by shaded by fallen trees but with a few areas of open water with bulrush, and a logpile adjacent to it. It is likely that this water body is subject to desiccation.

TN35: Area of young broad-leaved woodland with little understorey or ground vegetation, although nettle and lords and ladies were found in places, with a single mature tree with cavities in the centre. The wood is surrounded by a band of hawthorn and willow scrub, and a dense hawthorn hedge runs along its eastern hedge. Set into the northern edge is a small area of mown grassland edged with bramble scrub: signs indicate that this is used as a shooting covert.

TN36: Area of grassland being produced for a hay crop. The sward contains few herbs.

TN37: Area of relatively species-poor semi-improved grassland with scattered trees and bramble scrub, the latter particularly concentrated to the south. This was grazed by cattle at the time of the survey.

TN38: Block of cleared woodland with recently planted broad-leaved saplings.



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*TN39:* Area of young broad-leaved woodland with little understorey vegetation but abundant dog's mercury was visible in the ground layer. A strip of young hawthorn borders the area to the north, and a patch of dense bramble scrub lies to the north-west. A thatched single-story cottage is situated at the south-east end of the wood.

*TN40:* Semi-improved grassland field that is marshy in places.

## **C Site**

### **Target Notes**

*TN1:* Area of dense scrubby woodland dominated by willow, poplar, hawthorn with some pedunculate oak and semi-mature ash. Dogwood was also recorded in this area. The ground flora is impoverished comprising mostly nettle.

*TN2:* A metal water storage tank approximately 10m by 10m in size with a depth of 50cm. The metal container is raised off the ground on concrete stilts.

*TN3:* An open ditch containing standing water. The ditch is roughly 1m wide with depths ranging between 10cm and 30cm. The substrate is predominantly mud covered by leaf litter with patches of aquatic vegetation.

*TN4:* Deep section of ditch with flowing water, approximately 1m wide, with steep sides covered in mown grassland. The water depth is in excess of 50cm deep in parts and small shoals of stickleback were present. The substrate consists of mud and stone, with patches of dense aquatic vegetation.

*TN5:* Area of colonising vegetation in vicinity of railway tracks comprising, scentless mayweed, perforate St John's-wort, great mullion, ribbed melliott, red clover, common bird's-foot trefoil, nettle, creeping thistle and umbellifers.

*TN6:* A large pond straddling the border of the site. The off-site section of the pond is open and situated within an area of grassland. The on-site section is located within an area of dense scrub/woodland, and 80% of its area is shaded. Access to most of the pond is limited by dense vegetation. Patches of bulrush and duckweed were present in the open sections of the pond, with areas beneath the canopy being covered in leaf litter. Waterfowl were noted on this water body.

*TN7:* This large pond (approximately 20m by 70m in size) is situated between two railway lines and forms part of a drainage system. The pond is bordered by thick scrub/woodland and the margins are heavily shaded. Areas of open water exist beneath this canopy of the cover. The central areas of the pond comprise both areas of open water and patches of bulrush. Access to this water body is greatly restricted by vegetation on all sides.

*TN8:* Dense areas/strips of scrub and broad-leaved woodland. The main species present included oak, silver birch, alder, hawthorn, blackthorn and bramble.

*TN9:* Large warehouse building with low extensions on two sides forming office buildings. These extensions have corrugated metal roofs with brick built bases.





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*TN10:* Small rubble pile made up of wood and hardcore, located next to a water body becoming colonised with scrub and tall ruderal vegetation.

*TN11:* Colonising grassland with abundant bird's foot-trefoil, common century, perforate St. John's-wort, fairy flax and agrimony.

*TN12:* Buildings with potential to support roosting bats.

*TN13:* Air raid shelters with potential to support roosting bats.

*TN14:* Trees with potential to support roosting bats.

*TN15:* Emergency water tanks with potential to support GCN.

*TN16:* Species-poor rank grassland dominated by tufted hair grass and which contain strips of species-poor grassland with mature oak and willow trees





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# Annex D

## Relevant Protected Species Legislation

4 Pages

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## Badger

The *Protection of Badgers Act 1992* consolidates previous legislation (including the *Badgers Acts 1973* and the *Badgers (Further Protection) Act 1991*). It makes it a serious offence to:

- kill, injure or take a badger;
- attempt to kill, injure or take a badger; or
- to damage or interfere with a sett.

Badgers could be disturbed by work near a sett even if there is no direct interference or damage to the sett. Any works which may cause disturbance to badgers within a sett will require a licence from Natural England.

## All Wild Mammals (including rabbits and foxes)

Under the *Wild Mammals (Protection) Act 1996* it is an offence intentionally to cause unnecessary suffering to any wild mammal.

## Water vole

Water voles are protected under Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended). This protects the water vole and its place of shelter. Legal protection makes it an offence to intentionally or recklessly:

- intentionally kill or injure a water vole;
- damage or destroy or obstruct access to any structure or place which water voles use for shelter or protection; and
- disturb water voles while they are using such a place.

## Otter

Otter is protected under *Wildlife and Countryside Act, 1981* (as amended). It is also protected under the *Habitats and Species Regulations 2010*. Consequently, it is an offence to:

- kill or injure an otter;
- to deliberately disturb an otter; and
- damage or destroy an otter shelter, whether intentionally or not.

## Dormouse

Dormouse is listed in Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended) and Schedule 2 of the *Conservation of Habitats and Species Regulations 2010* (Habitats Regulations). They are afforded full protection under Section 9(4) of the Act and Regulation 41 of the Habitats Regulations. These make it an offence, *inter alia*, to:

- deliberately capture, injure or kill any such animal;



- 
- deliberately disturb any such animal;
  - damage or destroy a breeding site or resting place of any such animal;
  - intentionally or recklessly disturb any of these animals while it is occupying a structure or place that it uses for shelter or protection;
  - intentionally or recklessly obstruct access to any place that any of these animals uses for shelter or protection.

### **Bats (*Rhinolophidae* and *Vespertilionidae*)**

All British bat species are listed in Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended) and Schedule 2 of the *Habitats and Species Regulations 2010*. They are afforded full protection under Section 9(4) of the Act and Regulation 39 of the Regulations. These make it an offence, *inter alia*, to:

- deliberately capture, injure or kill a bat;
- damage or destroy a breeding site or resting place of any bat; or
- deliberately disturb a bat (this applies anywhere, not just at its roost) in such a way as to be likely significantly to affect:
  - the ability of any significant group of bat species to survive, breed, or rear or nurture their young; or
  - the local distribution or abundance of that bat species.
- intentionally or recklessly obstruct access to any place that a bat uses for shelter or protection (this is taken to mean all bat roosts whether bats are present or not); or
- intentionally or recklessly disturb a bat while it is occupying a structure or place that it uses for shelter or protection.

In addition, five British bat species are listed on Appendix II of the Habitats Directive. These are:

- Greater horseshoe bat (*Rhinolophus ferrumequinum*);
- Lesser horseshoe bat (*Rhinolophus hipposideros*);
- Bechstein's bat (*Myotis bechsteinii*);
- Barbastelle (*Barbastella barbastellus*); and
- Greater mouse-eared bat (*Myotis myotis*).

In certain circumstances where these species are found the Directive requires the designation of Special Areas of Conservation (SACs) by EC member states to ensure that their populations are maintained at a favourable conservation status. Outside SACs, the level of legal protection that these species receive is the same as for other bat species.



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## Great crested newt

Great crested newt is listed in Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended) and Schedule 2 of the *Conservation of Habitats and Species Regulations 2010* (Habitats Regulations). They are afforded full protection under Section 9(4) of the Act and Regulation 41 of the Habitats Regulations. These make it an offence, *inter alia*, to:

- deliberately capture, injure or kill any such animal;
- deliberately disturb any such animal;
- damage or destroy a breeding site or resting place of any such animal;
- intentionally or recklessly disturb any of these animals while it is occupying a structure or place that it uses for shelter or protection; and
- intentionally or recklessly obstruct access to any place that any of these animals uses for shelter or protection.

## Reptiles

The four widespread<sup>20</sup> species of reptile that are native to Britain, namely common or viviparous lizard (*Zootoca vivipara*), slow worm (*Anguis fragilis*), adder (*Vipera berus*) and grass snake (*Natrix helvetica*), are listed in Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended) and are afforded limited protection under Section 9 of this Act. This makes it an offence, *inter alia*, to:

- intentionally kill or injure any of these species.

## Birds

With certain exceptions<sup>21</sup>, all wild birds, their nests and eggs are protected by section 1 of the *Wildlife and Countryside Act 1981* (as amended). Therefore, it is an offence, *inter alia*, to:

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

These offences do not apply to hunting of birds listed in Schedule 2 subject to various controls.

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<sup>20</sup> The other native species of British reptile (sand lizard and smooth snake) receive a higher level of protection under the *Conservation of Habitats and Species Regulations 2010* and (in England and Wales only) the *Wildlife and Countryside Act 1981* (as amended). However, the distribution of these species are restricted to very few sites.

<sup>21</sup> Some species, such as game birds, are exempt in certain circumstances



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Bird species listed on Schedule 1 of the Act receive further protection, thus for these species it is also an offence to:

- intentionally or recklessly disturb any bird while it is nest building, or is at a nest containing eggs or young; or
- intentionally or recklessly disturb the dependent young of any such bird.





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# Annex E

## Bat Survey Results

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# Appendix E Bat survey results

**Table E.1** Weather conditions, sunset and sunrise times during activity and emergence survey visits

Survey date	Temp (°C, start-end)	Rainfall / wind	Cloud cover (%)	Sunrise / sunset times	Type of survey
31/05/2011	12 / 12	None / light	20	21:12	D site within Graven Hill, dusk activity
01/06/2011	5 / 5	None / calm	100	04:51	D/E site within Graven Hill, dawn activity
08/06/2011	16 / 9	None / light	60	21:20	C site, dusk activity
09/06/2011	14 / 10	None / light	40	04:47	D site within Graven Hill, dawn re-entry
09/06/2011	8 / 9	None / light	40	21:20	D/E site, dusk activity
10/06/2011	7 / 8	None / light	100	04:47	D/E site within Graven Hill, dawn re-entry
14/06/2011	20 / 16	None / calm	90	21:25	E site within Graven Hill, dusk activity
15/06/2011	15 / 15	None / light	90	04:46	D site within Graven Hill, dawn re-entry
20/06/2011	14 / 14	Light / light	100	21:26	Graven Hill, dusk activity
21/06/2011	14 / 14	None / light	100	04:44	E site within Graven Hill, dawn re-entry
21/06/2011	15 / 12	None / light	30	21:27	D site within Graven Hill, dusk emergence
22/06/2011	15 / 15	None / light	60	04:44	E site within Graven Hill, dawn re-entry
22/06/2011	15 / 15	None / light	10	21:27	C Site, dusk emergence
23/06/2011	13 / 13	None / calm	50	04:46	E site within Graven Hill, dawn re-entry
27/06/2011	24 / 20	None / light	10	21:27	Hilltop Graven Hill, dusk emergence
28/06/2011	18 / 16	None / light	40	04:49	Graven Hill, dawn re-entry
28/06/2011	18 / 18	None / calm	85	21:27	C site, dusk emergence
29/06/2011	11 / 8	None / calm	0	04:48	E site within Graven Hill

Survey date	Temp (°C, start-end)	Rainfall / wind	Cloud cover (%)	Sunrise / sunset times	Type of survey
30/06/2011	16 / 12	None / calm	20	21:27	D site within Graven Hill, dusk activity
01/07/2011	10 / 7	None / light	50	04:50	D site within Graven Hill, dawn re-entry
04/07/2011	19 / 17	None / calm	25	21:26	Graven Hill, dusk emergence and activity
05/07/2011	13 / 11	None / calm	10	05:02	D site within Graven Hill, dusk emergence
05/07/2011	14 / 15	None / light	100	21:25	C site, dusk activity
06/07/2011	13 / 11	None / calm	100	04:54	C site, dawn re-entry
06/07/2011	15 / 13	None / moderate	100	21:25	D Site within Graven Hill, dusk activity
07/07/2011	13 / 13	None / moderate	100	04:55	Graven Hill, dawn re-entry
07/07/2011	15 / 15	None / light	70	21:24	C site Air raid shelters block A, dusk emergence
08/07/2011	13 / 14	Some light rain / calm	80	04:56	C Site Air raid shelters block A, dawn re-entry
11/07/2011	19 / 18	None / calm	5	21:24	E site within Graven Hill dusk emergence
12/07/2011	15 / 13	None / calm	10	5:00	Graven Hill, dawn re-entry
12/07/2011	15 / 15	None / calm	40	21:22	C site, dusk emergence
13/07/2011	15 / 14	None / light	100	05:00	E site within Graven Hill, dawn re-entry
18/07/2011	15 / 16	None / calm	100	21:14	D site within Graven Hill dusk emergence
19/07/2011	16 / 14	None / calm	100	05:09	E site within Graven Hill dawn re- entry
19/07/2011	17 / 17	None / light	80	21:13	E site within Graven Hill, dusk emergence
20/07/2011	13 / 13	None / calm	100	05:10	C Site Air raid shelters block A, dawn re-entry
25/07/2011	16 / 16	None / calm	40	21:03	E Site within Graven Hill, dusk emergence
26/07/2011	16 / 15	None / light	85	05:18	C site, dawn emergence
26/07/2011	18 / 16	None / calm	100	21:04	Graven Hill, dusk emergence
27/07/2011	15 / 15	None / calm	50	05:20	Graven Hill, dawn re-entry
28/07/2011	23 / 18	None / calm	50	21:01	E site within Graven Hill, dusk emergence
29/07/2011	18 / 18	None / light	90	05:23	C Site Air raid shelters



Survey date	Temp (°C, start-end)	Rainfall / wind	Cloud cover (%)	Sunrise / sunset times	Type of survey
25/08/2011	18 / 15	None / calm	50	20.08	blocks B and C, dawn re-entry Graven Hill, dusk emergence
26/08/2011	12 / 12	None / clam	100	06.06	E site within Graven Hill, dawn re-entry
31/08/2011	16 / 13	None / calm	20	19.54	E site within Graven Hill, dusk emergence

## Results of activity surveys at Graven Hill

**Table E.2** Transect results for D site within Graven Hill

			Notes
Time	Species of bat	No. passes	
<b>Transect B 31/05/2011</b>			
21.52	Common pipistrelle	1	
22.16	Serotine	1	
22.18	Noctule	2	
22.32	Myotis sp.	1	
22.43	Common pipistrelle	1	
22.57	Common pipistrelle	2	
22.59	Common pipistrelle	1	
23.01	Common pipistrelle	1	
23.02	Common pipistrelle	4	
23.02	Soprano pipistrelle	1	
23.02	Common pipistrelle	7	
23.05	<i>Myotis</i> sp.	1	
23.06	Soprano pipistrelle	1	
23.14	Common pipistrelle	9	
23.14	Soprano pipistrelle	2	
23.15	Common pipistrelle	3	
23.15	Soprano pipistrelle	2	

			Notes
Time	Species of bat	No. passes	
23.16	Noctule	3	
23.16	Common pipistrelle	1	
23.17	Common pipistrelle	1	
23.17	Noctule	1	
23.17	Common pipistrelle	1	
23.17	Soprano pipistrelle	1	
23.17	Noctule	3	
23.17	Common pipistrelle	2	
23.17	Noctule	1	
23.19	Myotis sp.	1	
23.20	Noctule	1	
23.20	Common pipistrelle	1	
23.20	Noctule	1	
23.24	Common pipistrelle	1	
23.27	Soprano pipistrelle	1	
23.35	Myotis sp.	2	
23.37	Myotis sp.	1	
23.37	Common pipistrelle	1	
23.39	Noctule	3	
23.41	Noctule	13	
<b>Transect A 31/05/2011</b>			
21.52	Noctule	3	
22.08	Common pipistrelle	2	
22.09	Common pipistrelle	continuous	
22.20	Soprano pipistrelle	1	
22.23	Common pipistrelle	1	
22.24	Noctule	1	
22.27	Soprano pipistrelle	5	
22.28	Common pipistrelle	8	
22.30	Common pipistrelle	2	
22.31	Common pipistrelle	2	
22.31	Soprano pipistrelle	2	

			Notes
Time	Species of bat	No. passes	
22.31	Myotis sp.	1	
22.34	Common pipistrelle	1	
22.40	Myotis sp.	2	
22.50	Leisler's	1	
22.52	Common pipistrelle	3	
22.56	Long-eared bat	1	
23.07	Noctule	1	
23.14	Noctule	1	
23.17	Soprano pipistrelle	1	
23.20	Common pipistrelle	1	
23.30	Common pipistrelle	1	
23.35	Common pipistrelle	2	
<b>06/07/2011 Transect A</b>			
22.36	Myotis	3	
22.39	>1 Myotis	Many	
22.51	Myotis	1	
22.52	Myotis	1	
22.53	Myotis	1	
22.57	Myotis	Many	
23.04	Myotis	1	
23.18	Leisler's	1	
23.22	Common pipistrelle	1	
23.35	Leisler's	1	
23.49	Leisler's / Serotine	Many	
<b>06/07/2011 Transect C</b>			
22.25	Soprano pipistrelle	2	
22.25	Common pipistrelle	1	
22.28	Common pipistrelle	1	
22.28	Common pipistrelle	1	
22.30	Noctule	1	
22.58	Serotine	1	
23.04	Leisler's	1	

			Notes
Time	Species of bat	No. passes	
23.28	Common pipistrelle	3	
23.29	Common pipistrelle	3	

**Table E.3**      **Transect results for D/E site within Graven Hill**

Time	Species of bat	Passes	Notes
<b>09/06/2011 Transect A</b>			
21:42	Common pipistrelle	1	
21:43	Common pipistrelle	1	
21:43	Common pipistrelle	1	
21:46	2 x Common pipistrelle		Along hedgerow
21:48	2 x Common pipistrelle	1	2 bats
21:53	Common pipistrelle	1	
21:54	Common pipistrelle		
22:06	Common pipistrelle	4	
22:15	Common pipistrelle	A few passes	
22:19	Common pipistrelle		Near round-a-bout
22:42	Common pipistrelle		
22:42	Noctule		On railway near edge of woodland
22:48	Noctule	2	
22:49	Common pipistrelle	1	
22:53	Myotis sp.	1	
22:53	Common pipistrelle	2	
22:56	Common pipistrelle	2	
23:12	Common pipistrelle	1	over head
23:21	Common pipistrelle	1	
23:37	Common pipistrelle	4	foraging
23:40	2 x Noctule		Foraging over bright lights
<b>09/06/2011 Transect B</b>			
21:58	Common pipistrelle	1	



Time	Species of bat	Passes	Notes
22.05	Noc	4	
22.06	Noc	3	
22.08	Noc	1	
	Noc	3	
22.12	Common pipistrelle	1	
22.13	Common pipistrelle	2	
22.13	Common pipistrelle	1	
22.13	Soprano pipistrelle	1	
22.14	Common pipistrelle	1	
22.23	Common pipistrelle	6	
22.24	Common pipistrelle	1	
22.31	Soprano pipistrelle	13	
22.47	Noc	1	
22.51	Myotis	2	
22.57	Common pipistrelle	1	
23.11	Common pipistrelle	1	
23.14	Common pipistrelle	3	
23.18	Myotis	1	
23.19	Common pipistrelle	1	
23.21	Common pipistrelle	2	
23.21	Common pipistrelle	1	
23.30	Common pipistrelle	1	
23.27	Soprano pipistrelle	1	1
23.28	Soprano pipistrelle	3	3
23.28	Soprano pipistrelle	1	1
23.28	Soprano pipistrelle	2	2
23.28	Soprano pipistrelle	1	1
23.40	Serotine	1	1
23.50	Common pipistrelle	1	1
23.54	Myotis	1	1
<b>09/06/2011 Transect C</b>			
21.43	Common pipistrelle	1	

Time	Species of bat	Passes	Notes
21.46	Common pipistrelle	1	
21.46	Common pipistrelle	1	
21.48	Common pipistrelle	1	
21.53	Common pipistrelle	1	
21.54	Common pipistrelle	2	
21.54	Soprano pipistrelle	1	
22.06	Soprano pipistrelle	1	
22.06	Common pipistrelle	2	
22.06	Soprano pipistrelle	1	
22.15	Common pipistrelle	4	
22.19	Common pipistrelle	1	
22.49	Common pipistrelle	1	
22.53	Myotis sp.	1	
22.53	Soprano pipistrelle	1	
22.56	Common pipistrelle	2	
22.57	Common pipistrelle	7	
23.12	Myotis sp.	1	
23.21	Soprano pipistrelle	1	
23.37	Common pipistrelle	1	
23.40	Noctule	3	
23.41	Noctule	13	Feeding buzz
<b>14/06/2011</b>			
<b>Transect D</b>			
21.47	Common pipistrelle	1	
21.49	Common pipistrelle	2	
21.50	Common pipistrelle	5	
21.50	Common pipistrelle	1	
21.51	Soprano pipistrelle	1	
21.52	Common pipistrelle	1	
21.53	Common pipistrelle	5	
21.55	Soprano pipistrelle	1	
21.59	Common pipistrelle	2	

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Time	Species of bat	Passes	Notes
21.59	Soprano pipistrelle	1	
22.04	Common pipistrelle	1	
22.04	Common pipistrelle	1	
22.16	Common pipistrelle	2	
22.17	Common pipistrelle	1	
22.19	Myotis sp.	2	
22.21	Soprano pipistrelle	2	
22.21	Common pipistrelle	1	
22.21	Myotis sp.	2	
22.22	Common pipistrelle	2	
22.22	Myotis sp.	2	
22.23	Myotis sp.	1	
22.23	Myotis sp.	2	
22.24	Myotis sp.	1	
22.25	Myotis sp.	1	
22.37	Soprano pipistrelle	1	
22.40	Common pipistrelle	1	
22.42	Common pipistrelle	3	
22.44	Common pipistrelle	4	
22.46	Noctule	3	
22.48	Noctule	1	
22.53	Common pipistrelle	1	
22.53	Common pipistrelle	1	
23.06	Serotine	1	
23.15	Common pipistrelle	1	
23.17	Common pipistrelle	2	
23.24	Daubenton's	1	
23.27	Common pipistrelle	1	
23.27	Common pipistrelle	1	
23.32	Common pipistrelle	1	
23.34	Common pipistrelle	3	
23.35	Common pipistrelle	3	

Time	Species of bat	Passes	Notes
23.39	Common pipistrelle	3	
23.39	Soprano pipistrelle	1	
23.39	Common pipistrelle	1	
23.50	Common pipistrelle	2	
23.11	Common pipistrelle	4	
23.11	Soprano pipistrelle	1	
23.11	Common pipistrelle	2	
23.53	Common pipistrelle	1	
<b>30/06/2011 Transect D</b>			
22.09	Myotis sp.	Many	
22.13	Soprano pipistrelle and Pipistrelle sp.	1 each	
22.16	Soprano pipistrelle and Myotis sp.	3	
22.19	Myotis sp.	2	
22.37	Myotis sp.	Many	
22.40	Common pipistrelles	2	
22.48	Myotis sp.	2	
22.52	Common pipistrelles	2	
22.53	Common pipistrelle	1	
22.55	Common and Soprano pipistrelles	Many	
22.57	Pips and Myotis	Many	
23.00	At least 2 x pipistrells		
23.17	Common pipistrelle	Several but some v faint	
23.21	Noctule, Leisler's and Sero	Many	
23.35	Noctule	2	
23.54	Leislars	1	

**Table E.3 Transect results of Graven Hill Hilltop**

Time	Species	No. of passes	Notes
<b>20/06/2011</b>			



Time	Species	No. of passes	Notes
<b>Transect A</b>			
22.11	Common pipistrelle	15	
22.12	Common pipistrelle	6	
22.13	Soprano pipistrelle	2	
22.17	Soprano pipistrelle	1	
22.19	Noctule	1	
22.32	Common pipistrelle	1	
23.00	Soprano pipistrelle	2	
23.00	Common pipistrelle	1	
23.02	Common pipistrelle	1	
23.09	Common pipistrelle	2	
23.25	Common pipistrelle	6	
23.38	Myotis sp.	1	
23.40	Serotine	1	
23.42	Noctule	1	
23.52	Common pipistrelle	1	
23.52	Noctule	1	
23.52	Serotine	1	
23.53	Noctule	2	
<b>Transect A 04/05/2011</b>			
21:55	Noctule	1	
22:15	Noctule	1	
22:22	Common pipistrelle	3	
22:23	Common pipistrelle	1	
22:24	Soprano pipistrelle	1	
22:27	Common pipistrelle	5	
22:29	Common pipistrelle	1	
22:31	Soprano pipistrelle	2	
22:35	Common pipistrelle	2	
22:35	Noctule	1	
22:37	Noctule	2	

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Time	Species	No. of passes	Notes
22:37	Myotis	1	
22:47	Noctule	1	
22:52	Noctule	1	
23:24	Common pipistrelle	4	
23:25	Common pipistrelle	1	
23:27	Common pipistrelle	1	
23:27	Common pipistrelle	5	
23:28	Common pipistrelle	1	
23:33	Common pipistrelle	1	
23:41	Common pipistrelle	8	
23:52	Common pipistrelle	1	
00:06	Common pipistrelle	1	

## Emergence surveys

### E4. Emergence/re-entry results E site within Graven Hill Building E5

Time	Species	No. of passes	Notes
<b>8/9/2011 Emergence point 1</b>			
02:55-04:52			No bats recorded
<b>8/9/2011 Emergence point 2</b>			
02:55-04:52			No bats recorded
<b>22/06/2011 Emergence point 1</b>			
03:19	Noctule	1	
03:58	Common pipistrelle	1	Re-entry into roof at north east corner of building
<b>22/06/2011</b>			

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Time	Species	No. of passes	Notes
<b>Emergence point 2</b>			
02.40	Noctule	1	No bats seen entering building
03.18	Noctule	1	

#### E.5 Emergence/re-entry results E site within Graven Hill Building E2A

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Time	Species	No. of passes	Notes
<b>10/06/2011 Emergence point 1</b>			
02:53-04:57			No bats recorded
<b>10/06/2011 Emergence point 2</b>			
02:53-05:00			No bats recorded
<b>26/08/11 (walked around both sides of building)</b>			
05:35	Soprano pipistrelle	1	No bats re-entering building
05:57	Pipistrelle sp.	1	
05:42	Common pipistrelle	3	
05:43	Common pipistrelle	2	
05:45	Common pipistrelle	2	

#### E.6 Emergence/re-entry results D site within Graven Hill - Building D12

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Time	Species	No. of passes	Notes
<b>09/06/2011 Emergence point 1</b>			
02.51	Common pipistrelle	con. 0-230s	No bats seen entering building.
02.54	Soprano pipistrelle	con. 232-351s	
02.56	Common pipistrelle	con. 351-568s	
03.00	Common pipistrelle	con. 582-905s	
03.06	Common pipistrelle	con. 2-94s	
03.08	Myotis sp.	1	
03.08	Common pipistrelle	con.178-522s	

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Time	Species	No. of passes	Notes
03.15	Myotis sp.	3	
03.15	Common pipistrelle	2	
03.15	Soprano pipistrelle	1	
03.17	Myotis sp.	2	
03.17	Common pipistrelle	3	
03.18	Common pipistrelle	2	
03.19	Common pipistrelle	5	
03.20	Soprano pipistrelle	2	
03.23	Soprano pipistrelle	2	
03.23	Common pipistrelle	1	
03.24	Soprano pipistrelle	2	
03.25	Common pipistrelle	1	
03.25	Common pipistrelle	3	
03.28	Common pipistrelle	1	
03.31	Common pipistrelle	2	
03.33	Soprano pipistrelle	1	
03.33	Common pipistrelle	1	
03.34	Common pipistrelle	con. 774-920s	
03.38	Common pipistrelle	1	
03.38	Myotis sp.	3	
03.38	Common pipistrelle	1	
03.38	Myotis sp.	7	
03.39	Common pipistrelle	3	
03.40	Myotis sp.	1	
03.40	Common pipistrelle	3	
03.41	Common pipistrelle	1	
03.41	Common pipistrelle	2	
03.41	Myotis sp.	7	
03.42	Common pipistrelle	1	
03.43	Myotis sp.	4	
03.43	Common pipistrelle	2	
03.43	Myotis sp.	1	
03.43	Common pipistrelle	2	



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Time	Species	No. of passes	Notes
03.44	Myotis sp.	3	
03.44	Common pipistrelle	con. 437-920s	
03.53	Common pipistrelle	con. 0-92s	
03.54	Soprano pipistrelle	1	
03.56	Common pipistrelle	3	
03.56	Common pipistrelle	1	
03.57	Common pipistrelle	con. 274-544s	

#### 09/06/2011 Emergence point 2

2:57 – 4:58 No bats recorded

#### 1/7/2011 Emergence point 1

03.29	Common pipistrelle	1	No bats seen entering building
03.47	Common pipistrelle	1	
04.04	Soprano pipistrelle	1	
04.05	Myotis sp.	1	

#### 1/7/2011 Emergence point 2

03.10	Common pipistrelle	Many	No bats seen entering building
03.36	Common pipistrelle	3	
03.39	Common pipistrelle	6	
03.43	Myotis sp.	1	
04.01	Long-eared bat	1	
04.09	Myotis sp.	1	

### E.7 Re-entry results D site within Graven Hill - Building E14

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Time	Species	No. of passes	Notes
<b>21/06/2011 Emergence point 1</b>			
02.51	Common pipistrelle	1	No bats seen entering building
03.15	Common pipistrelle	1	
03.35	Big bat	1	
03.51	Common pipistrelle	1	
03.54	Bat		

Time	Species	No. of passes	Notes
03:57	Soprano pipistrelle	1	
03:58	Common pipistrelle	1	
04:02	Noctule	1	
04:02	Common pipistrelle	1	
<b>21/06/2011 Emergence point 2</b>			
03:01	Noctule	1	No bats seen entering building
03:11	Common pipistrelle	1	
04:00	Serotine	1	
<b>13/07/2011 Emergence point 1</b>			
03:14	Myotis sp.	1	No bats seen entering building
03:43	Noctule	1	
03:45	Noctule	1	Very brief pass
<b>13/07/2011 Emergence point 2</b>			
03:14	Common pipistrelle	1	No bats seen entering building
03:25	Common pipistrelle	2	2 individuals
03:42	Noctule	1	
03:44	Noctule	1	
03:52	Pipistrelle sp.	1	

#### E.8 Emergence/Re-entry results D site within Graven Hill Building D10

Time	Species	No. of passes	Notes
<b>21/06/2011 Emergencepoint 1</b>			
21:27	Noctule	1	No bats seen leaving building
21:59	Common pipistrelle	1	
22:21	Common pipistrelle	5	
22:37	Common pipistrelle	4	
23:04	Common pipistrelle	3	
23:05	Serotine	1	
<b>21/06/2011 Emergence point 2</b>			
22:22	Common pipistrelle	1	No bats seen leaving building

Time	Species	No. of passes	Notes
23:05	Common pipistrelle	1	
<b>19/07/2011 Emergence point 1</b>			
22:03	Leisler's	1	No bats seen leaving building
22:10	Pipistrelle species.	2	Quick passes
22:13	Noctule	2	Two Noctules seen.
22:15	Noctule	1	
22:16	Common pipistrelle	1	
22:19	Common pipistrelle	1	
22:22	Common pipistrelle	1	
22:22	Common pipistrelle	1	
22:38	Noctule	1	
22:46	Common pipistrelle	1	Continuously foraging around water tank behind surveyor same bat.
22:48	Noctule	1	
22:49	<i>Nyctulus</i> sp.	3	
22:51	<i>Nyctulus</i> sp	2	
22:54	Common pipistrelle	1	Continuously foraging around water tank behind surveyor same bat.
23:01	Common pipistrelle	1	
23:01	<i>Nyctulus</i> sp.	1	
23:02	Noctule	1	
23:06	Common pipistrelle	1	Continuously foraging around water tank behind surveyor same bat.
<b>19/07/2011 Emergence point 2</b>			
22:03	Pipistrelles sp.	1	
22:07	Pipistrelles sp.	1	
22:39	Common pipistrelle	1	
22:43	Pipistrelles sp.	1	
22:47	Pipistrelles sp.	1	foraging

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## E.9 Re-entry results E site within Graven Hill –Building 15 A

Time	Species	No. of passes	Notes
23/06/2011 Emergence point 1			
03:12	Noctule	1	No bats seen re-entering building
03:25	Noctule	1	
03:26	Leisler's	1	
03:29	Noctule	1	
03:54	Common pipistrelle	1	
04:04	Common pipistrelle	1	
23/06/2011 Emergence point 2			
3.18	Soprano pipistrelle	2	No bats seen re-entering building
3.18	Common pipistrelle	1	
3.29	Common pipistrelle	2	
4.03	Myotis sp.	1	
31/08/2011 Emergence point1			
20.16	Common pipistrelle	1	No bats seen leaving building
20.27	Common pipistrelle	2	
20.46	Common pipistrelle		
20.48	Noctule	1	
20.53	Noctule	1	
21.01	Common pipistrelle	1	
21.06	Common pipistrelle	3	
21.13	Common pipistrelle	5	
21.19	Myotis	2	
21.22	Myotis	2	
21.22	Noctule	1	
21.25	Noctule	1	
21.26	Serotine	1	
21.27	Serotine	2	
21.30	Common pipistrelle	1	



Time	Species	No. of passes	Notes
21.39	Common pipistrelle	1	
21.44	Common pipistrelle	1	
21.45	Soprano pipistrelle	1	
21.48	Myotis	1	
21.49	Noctule	1	
21.50	Long-eared	1	
21.52	Myotis	1	
<b>31/08/2011 Emergence point 2</b>			
20.18	Pipistrelle sp.		Pipistrelle seen emerging from building
20.21	Common pipistrelle	1	
20.27	Noctule	1	
20.35	Common pipistrelle	1	
20.44	Big bat	1	
20.49	Noctule	1	
20.52	Noctule	1	
20.55	Noctule	1	
21.00	Noctule	1	
21.07	Common pipistrelle	1	
21.08	Common pipistrelle	2	
21.08	Soprano pipistrelle	1	
21.14	Common pipistrelle	1	
21.15	Noctule	1	
21.15	Common pipistrelle	2	
21.15	Common pipistrelle	1	
21.16	Common pipistrelle	1	
21.16	Common pipistrelle	1	
21.17	Soprano pipistrelle	1	
21.17	Soprano pipistrelle	6	
21.26	Noctule	1	
21.27	Myotis	1	
21.40	Serotine	1	

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Time	Species	No. of passes	Notes
21.52	Common pipistrelle	1	
21.54	Myotis	1	

#### **E10. Emergence results Graven Hill Theatre at Graven Hill**

Time	Species	No. of passes	Notes
<b>27/06/2011 Theatre point 1</b>			
21.56	Noctule	1	No bats seen leaving building
21.59	Common pipistrelle	1	
22.06	Common pipistrelle	1	
22.09	Myotis sp.	1	
22.12	Myotis sp.	1	
22.14	Common pipistrelle	1	
22.27	Common pipistrelle	1	
22.29	Common pipistrelle	1	
22.30	Common pipistrelle	1	
22.43	Common pipistrelle	1	
22.45	Soprano pipistrelle	1	
22.47	Common pipistrelle	1	
22.50	Noctule	1	
22.52	Common pipistrelle	1	
22.53	Myotis sp.	1	
22.53	Noctule	1	
22.55	Common pipistrelle	1	
22.57	Common pipistrelle	1	
23.00	Noctule	1	
23.01	Common pipistrelle	1	
23.08	Common pipistrelle	1	
23.13	Common pipistrelle	1	
23.18	Noctule	1	

Time	Species	No. of passes	Notes
23.20	Common pipistrelle	1	
23.22	Common pipistrelle	1	
23.23	Common pipistrelle	1	
<b>27/06/2011 Emergence point 2</b>			
22:00	Common pipistrelle	25	No bats seen leaving building
22:08	Common pipistrelle	6	
22:23	Common pipistrelle	5	
22:15	Common pipistrelle	9	
22:22	Common pipistrelle	4	
22:25	Common pipistrelle	20	
22:30	Soprano pipistrelle	1	
22:37	Common pipistrelle	22	
22:51	Noctule	1	
22:53	Common pipistrelle	10	
23:02	Noctule	1	
23:03	Common pipistrelle	6	
23:06	Common pipistrelle	23	
23:15	Common pipistrelle	22	
23:18	Myotis	1	
23:14	Common pipistrelle	13	
<b>27/06/2011 Emergence point 3</b>			
21.54	Common pipistrelle	1	No bats seen leaving building
22.01	Soprano pipistrelle	1	
22.01	Common pipistrelle	2	
22.02	Common pipistrelle	2	
22.03	Common pipistrelle	1	
22.04	Common pipistrelle	2	
22.05	Common pipistrelle	1	
22.05	Common pipistrelle	3	
22.06	Common pipistrelle	10	
22.12	Soprano pipistrelle	1	
22.14	Soprano pipistrelle	1	

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Time	Species	No. of passes	Notes
22.17	Common pipistrelle	1	
22.20	Soprano pipistrelle	1	
22.24	Soprano pipistrelle	1	
22.26	Common pipistrelle	1	
22.31	Common pipistrelle	1	
22.36	Myotis	1	
22.39	Soprano pipistrelle	1	
22.45	Common pipistrelle	2	
22.49	Common pipistrelle	1	
22.50	Soprano pipistrelle	1	
22.50	Soprano pipistrelle	1	
22.51	Common pipistrelle	1	
22.54	Noctule	1	
22.57	Common pipistrelle	1	
22.58	Common pipistrelle	2	
23.00	Big bat	1	
23.03	Noctule	1	
23.05	Big bat	1	
23.08	Soprano pipistrelle	1	
23.09	Common pipistrelle	1	
23.09	Soprano pipistrelle	1	
23.10	Common pipistrelle	1	
23.10	Soprano pipistrelle	1	
23.10	Common pipistrelle	1	
23.11	Soprano pipistrelle	1	
23.11	Common pipistrelle	1	
23.12	Soprano pipistrelle	6	
23.14	Pipistrelle sp.	2	
23.14	Common pipistrelle	1	
23.15	Common pipistrelle	1	
23.15	Soprano pipistrelle	1	
23.16	Common pipistrelle	1	



Time	Species	No. of passes	Notes
23.17	Soprano pipistrelle	1	
23.19	Common pipistrelle	2	
23.19	Common pipistrelle	1	
23.20	Common pipistrelle	1	
23.20	Soprano pipistrelle	2	
23.21	Common pipistrelle	1	
23.21	Common pipistrelle	2	
23.22	Soprano pipistrelle	3	
23.23	Soprano pipistrelle	2	
23.24	Soprano pipistrelle	1	
23.24	Common pipistrelle	2	
23.24	Common pipistrelle	1	
23.24	Soprano pipistrelle	1	
23.25	Common pipistrelle	1	
23.25	Common pipistrelle	2	
23.26	Common pipistrelle	3	
23.27	Common pipistrelle	1	
23.27	Soprano pipistrelle	1	
23.27	Soprano pipistrelle	1	
23.28	Soprano pipistrelle	1	
23.28	Common pipistrelle	1	
23.29	Pipistrelle sp.	2	
23.30	Common pipistrelle	2	
23.33	Common pipistrelle	1	
<b>27/06/2011 Emergence point 4 TJ</b>			
22.44	Common pipistrelle	1	No bats seen leaving building
22.45	Common pipistrelle	1	
22.54	Common pipistrelle	1	
23.29	Common pipistrelle	1	
23.32	Myotis sp.	1	
23.34	Common pipistrelle	1	

Time	Species	No. of passes	Notes
<b>25/08/2011 Emergence point 1</b>			
20.28	Common pipistrelle	1	No bats seen leaving building
20.36	Common pipistrelle	1	
20.57	Common pipistrelle	1	
21.03	Soprano pipistrelle	1	
21.03	Common pipistrelle	1	
21.04	Common pipistrelle	2	
21.07	Common pipistrelle	1	
21.08	Noctule	1	
21.09	Common pipistrelle	1	
21.10	Common pipistrelle	1	
21.13	Common pipistrelle	1	
21.13	Common pipistrelle	1	
21.14	Noctule	1	
21.19	Common pipistrelle	1	
21.20	Soprano pipistrelle	1	
21.23	Common pipistrelle	1	
21.23	Common pipistrelle	1	
21.25	Common pipistrelle	2	
21.27	Common pipistrelle	1	
21.27	Soprano pipistrelle	1	
21.28	Soprano pipistrelle	1	
21.28	Common pipistrelle	3	
21.29	Common pipistrelle	1	
21.30	Common pipistrelle	1	
21.31	Soprano pipistrelle	1	
21.31	Common pipistrelle	2	
21.32	Soprano pipistrelle	2	
21.32	Soprano pipistrelle	1	
21.33	Soprano pipistrelle	1	
21.33	Common pipistrelle	1	

Time	Species	No. of passes	Notes
21.33	Common pipistrelle	2	
21.34	Common pipistrelle	2	
21.35	Common pipistrelle	1	
21.35	Common pipistrelle	1	
21.37	Common pipistrelle	1	
21.37	Common pipistrelle	1	
21.37	Common pipistrelle	1	
21.38	Common pipistrelle	1	
21.39	Common pipistrelle	1	
21.40	Common pipistrelle	1	
21.43	Big bat	1	
21.43	Common pipistrelle	1	
21.43	Soprano pipistrelle	1	
21.45	Soprano pipistrelle	3	
21.46	Noctule	2	
21.47	Common pipistrelle	2	
21.47	Common pipistrelle	1	
21.51	Noctule	1	
21.52	Common pipistrelle	1	
21.52	Soprano pipistrelle	1	
21.52	Common pipistrelle	1	
21.56	Noctule	1	
21.57	Common pipistrelle	1	
21.58	Common pipistrelle	1	
22.00	Common pipistrelle	1	
22.05	Common pipistrelle	1	
22.06	Common pipistrelle	1	
22.07	Common pipistrelle	1	
22.08	Common pipistrelle	1	
<b>25/08/2011 Emergencepoint 2</b>			
20:22	Pipistrelle		Bat seen emerging from corner of theatre building. No other bats seen emerging.

Time	Species	No. of passes	Notes
20:40	Noctule		
20:41	Pipistrelle sp.		
20:52	Noctule		
21:01	Common pipistrelle		
21:04	Common pipistrelle		
21:08	Common pipistrelle		
21:12	Noctule		
21:16	Soprano pipistrelle		
21:30	Soprano pipistrelle		
21:32	Noctule and common pipistrelle bat		
21:35	Noctule		
21:38	Common pipistrelle		
21:42	Common pipistrelle		
21:46	Common pipistrelle		
21:53	Noctule		
22:01	Noctule		
22:03	Common pipistrelle		
<b>25/08/2011 Emergencepoint 3</b>			
20:35	Common pipistrelle	1	No bats seen leaving building
20:40	Noctule	1	
20:40	Common pipistrelle	8	
20:42	Common pipistrelle	48	
20:54	Common pipistrelle	1	
20:57	Common pipistrelle	30	
21:08	Common pipistrelle	2	
21:13	Common pipistrelle	7	
21:16	Soprano pipistrelle	1	
21:20	Common pipistrelle	9	
21:28	Common pipistrelle	1	
21:28	Big bat	1	
21:28	Common pipistrelle	18	Includes social calls

Time	Species	No. of passes	Notes
21:33	Big bat	1	
21:38	Myotis	1	
21:41	Common pipistrelle	24	1-2 individuals
21:49	Big bat	1	
21:51	Big bat	1	
21:52	Big bat	1	
21:57	Noctule	1	
21:57	Common pipistrelle	3	
22:01	Common pipistrelle	7	
22:03	Noctule	1	
<b>25/08/2011 Emergencepoint 4</b>			
20:40	Noctule	1	No bats seen leaving building
20:41	Pipistrelle sp.	5	
20:52	Noctule	2	
21:01	Common pipistrelle	2	
21:04	Common pipistrelle	2	
21:08	Common pipistrelle	continuous	
21:12	Noctule	1	
21:16	Soprano pipistrelle	1	
21:30	Soprano pipistrelle	1	
21:32	Noctule + Common pipistrelle	1 each	
21:35	Noctule	1	
21:38	Common pipistrelle	1	
21:42	Common pipistrelle	1	
21:46	Common pipistrelle	1	
21:53	Noctule	2	
22:01	Noctule	1	
22:03	Common pipistrelle	1	



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## E11. Emergence/ Re-entry results Graven Hill – Rodney Complex

Time	Species	No. of passes	Notes
<b>28/06/2011 Emergence point 1</b>			
03:03	Common pipistrelle		No bats seen re-entering building. Foraging along hedge
03:11	Common pipistrelle		Foraging along hedge
03:12	Myotis sp.	1	Commuting along hedge
03:13	Common pipistrelle		Foraging along hedge
	Common pipistrelle	1	
03:16	Myotis	1	
03:19	Common pipistrelle		Foraging up and down hedgerow
03:22	Noctule	1	
03:25	Noctule	1	
03:28	Noctule	1	
03:29	Noctule	1	
03:31	Noctule	1	
03:32	Noctule	1	
03:33	Noctule	1	
03:37	Noctule	1	
03:39	Common pipistrelle	3	foraging along hedge
03:50	Common pipistrelle	2	commuting along hedge
03:52	Common pipistrelle	1	commuting along hedge
04:03	Common pipistrelle	1	
04:04	Pipistrelle species	1	
<b>28/06/2011 Emergence point 2</b>			
3.13	Common pipistrelle	1	No bats seen re-entering building.
3.13	Soprano pipistrelle	1	
3.15	Soprano pipistrelle	1	
3.36	Common pipistrelle	1	
3.44	Common pipistrelle	1	

Time	Species	No. of passes	Notes
3.41	Noctule	1	
3.56	Common pipistrelle	1	
4.00	Common pipistrelle	1	
<b>28/06/2011 Emergence point 3</b>			
02:59	Common pipistrelle	1	No bats seen re-entering building.
03:01	Common pipistrelle	1	
03:12	Common pipistrelle	11	
03:24	Noctule	1	
03:30	Noctule	5	
03:31	Common pipistrelle	1	
03:40	Common pipistrelle	11	
03:56	Common pipistrelle	1	
04:05	Common pipistrelle	1	
04:09	Common pipistrelle	1	
<b>12/07/2011 Emergence point 1</b>			
3.12	Common pipistrelle	1	No bats seen re-entering building.
3.37	Common pipistrelle	2	
<b>12/07/2011 Emergence point 2</b>			
3.43	Noctule	1	No bats seen re-entering building.
<b>12/07/2011 Emergence point 3</b>			
3.11	Common pipistrelle	1	No bats seen re-entering building.
3.17	Common pipistrelle	1	
3.39	Soprano pipistrelle	1	
3.41	Common pipistrelle	2	
3.43	Noctule	2	
3.46	Common pipistrelle	1	
<b>12/07/2011 Emergence point 4</b>			
02:58	Long-eared bat	1	No bats seen re-entering building.
03:11	Common pipistrelle	1	With social calls
03:17	Common pipistrelle	1	With social calls
03:17	Long-eared	1	
03:25	Long-eared	1	

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Time	Species	No. of passes	Notes
03:37	Common pipistrelle	3	Some passes too faint to analyse
03:39	Soprano pipistrelle	1	
03:41	Common pipistrelle	1	With social calls
03:43	Noctule	1	
03:52	Common pipistrelle	1	
04:15	Common pipistrelle	1	

#### **E12. Emergence/re-entry results E site within Graven Hill – Building E25**

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Time	Species	No. of passes	Notes
<b>29/06/2011 Emergence point 1</b>			
03:04	Common pipistrelle	1	No bats seen re-entering building.
03:06	Noctule	1	
03:07	Common pipistrelle	3	
<b>29/06/2011 Emergence point 2</b>			
03:02	Noctule	1	No bats seen re-entering building.
03:04	Noctule	1	Pass heard
03:05	Noctule	1	Pass heard
03:08	Noctule	1	Pass heard
03:45	Common pipistrelle	1	Pass heard
04:02	Noctule	1	Pass heard
04:05	Noctule	1	Pass heard
<b>25/07/2011 Emergence point 1</b>			
21:54	Common pipistrelle	2	No bats seen leaving building.
21:56	Noctule	1	
22:08	Common pipistrelle	1	
22:16	Noctule	1	
22:31	Noctule	1	
22:32	Noctule	1	
22:35	Noctule	1	
22:37	Noctule	3	

Time	Species	No. of passes	Notes
22:41	Noctule	1	
22:43	Noctule	2	
22:45	Noctule	1	
22:48	Common pipistrelle	1	
22:51	Common pipistrelle	1	
22:59	Noctule	3	
23:01	Noctule	1	
23:01	Noctule	2	
23:02	Common pipistrelle	1	
23:03	Noctule	1	
23:03	Noctule	1	

#### 25/07/2011 Emergence point 2

21:55	Noctule	1	No bats seen leaving building.
22:10	Common pipistrelle	1	
22:31	Noctule	3	
22:37	2 x noctule	1	
22:40	Noctule	1	
22:43	Noctule	2	
22:48	Common pipistrelle	1	
22:51	Pip	1	
	Noctule	1	
22:58	Noctule	3	

#### E.13 Emergence/re-entry results D site within Graven Hill – DSDA building

Time	Species	No. of passes	Notes
<b>05/07/2011 Emergencepoint 1</b>			
22:05	Common pipistrelle	1	No bats seen leaving building
<b>05/07/2011 Emergence point 2</b>			
03:19	Noctule	1	No bats seen leaving building. Very faint, heard.

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Time	Species	No. of passes	Notes
<b>05/07/2011 Emergence point 3</b>			
2:55-4:56			No bats recorded.
<b>18/07/2011 Emergence point 1</b>			
03:09	Common pipistrelle	1	No bats seen re-entering building
03:37	Common pipistrelle	1	
<b>18/07/2011 Emergence point 2</b>			
21.14-23.16			No bats recorded
<b>18/07/2011 Emergence point 3</b>			
21.52	Noctule	1	No bats seen leaving building
22.01	Common pipistrelle	7	Feeding buzz
22.14	Big bat	1	Faint but probably a Noc
22.31	Common pipistrelle	2	Feeding buzz
22.34	Noctule	1	
22.35	Noctule	1	
22.44	Noctule	1	
<b>18/07/2011 Emergence point 4</b>			
22:05	Common pipistrelle	1	No bats seen leaving building

#### **E14. Emergence results E site within Graven Hill – E15 A Annex**

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Time	Species	No. of passes	Notes
<b>11/07/2011 Emergence point 1</b>			
21:39	Common pipistrelle	1	
21:48	Common pipistrelle	1	
21:48	Common pipistrelle	1	
21:49	Common pipistrelle	1	
21:52	Soprano pipistrelle	1	
21:54	Common pipistrelle	1	
21:58	Common pipistrelle	1	
22:02	Common pipistrelle	4	



Time	Species	No. of passes	Notes
22:10	Common pipistrelle	1	
22:11	Soprano pipistrelle	1	
22:12	Common pipistrelle	10	
22:14	Common pipistrelle	1	2 individuals
22:14	Common pipistrelle	12	
22:18	Common pipistrelle	6	
22:21	Soprano pipistrelle	1	
22:25	Noctule and Leisler's	3	Two calls simultaneously
22:26	Common pipistrelle	2	
22:27	Myotis	1	
22:28	Noctule	1	
22:29	Noctule	2	2 individuals
22:31	Noctule	1	
22:36	Common pipistrelle	1	
22:42	Noctule	1	Foraging
22:43	Common pipistrelle	2	
22:47	Noctule	1	
22:53	Common pipistrelle	1	
23:00	Common pipistrelle	1	Echolocation becomes higher at 52kHz
23:00	Common pipistrelle	1	
23:00	Common pipistrelle	1	
23:05	Common pipistrelle	1	
23:05	Common pipistrelle	7	
23:19	Common pipistrelle	6	

### 11/07/2011 Emergence point 2

21.39			Bat seen no recording flying towards wood
21.40	Common pipistrelle	1	
21.46	Common pipistrelle	1	
21.47	Common pipistrelle	1	
21.48	Common pipistrelle	2	

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Time	Species	No. of passes	Notes
21.49	Common pipistrelle	1	
21.55	Common pipistrelle	1	
21.59	Common pipistrelle	1	
22.03	Common pipistrelle	1	
22.10	Soprano pipistrelle	1	
22.12	Soprano pipistrelle	1	
22.13	Common pipistrelle	1	
22.13	Myotis sp.	1	
22.14	Common pipistrelle	2	
22.15	Common pipistrelle	1	
22.15	Common pipistrelle	1	
22.16	Common pipistrelle	1	
22.19	Common pipistrelle	1	
22.19	Common pipistrelle	1	
22.19	Soprano pipistrelle	1	
22.22	Soprano pipistrelle	1	
22.22	Common pipistrelle	2	
22.23	Serotine	1	
22.26	Serotine	1	
22.26	Noctule	1	
22.27	Noctule	1	
22.28	Myotis sp.	1	
22.28	Noctule	1	
22.29	Noctule	1	
22.31	Noctule	1	
22.32	Noctule	1	
22.43	Common pipistrelle	1	
22.44	Common pipistrelle	1	
22.46	Noctule	1	
22.47	Noctule	1	
22.54	Noctule	1	
22.56	Serotine	1	

Time	Species	No. of passes	Notes
22.59	Common pipistrelle	1	
23.01	Common pipistrelle	1	
23.02	Common pipistrelle	1	
23.03	Common pipistrelle	1	
23.04	Common pipistrelle	2	
23.04	Soprano pipistrelle	2	
23.05	Soprano pipistrelle	1	
23.05	Common pipistrelle	3	
23.05	Common pipistrelle	2	
23.06	Soprano pipistrelle	1	
23.06	Noctule	1	
23.08	Common pipistrelle	2	
23.09	Common pipistrelle	1	
23.10	Common pipistrelle	1	
23.10	Common pipistrelle	1	
23.12	Common pipistrelle	2	
23.15	Soprano pipistrelle	1	
23.17	Common pipistrelle	1	
23.20	Common pipistrelle	1	
23.21	Common pipistrelle	1	
23.21	Noctule	1	
23.22	Common pipistrelle	1	

#### 11/07/2011 Emergence point 3: Under roost

03:09	Common pipistrelle	Constant	Pipistrelles swarming near roost (3+ individuals)
03:20	Common pipistrelle?	1	Frequency decreases briefly
03:45 to 03:52	Common pipistrelle	Constant	Pipistrelles start to enter roost – 4 individuals
03:42 to 04:07	Common pipistrelle	Constant	Swarming (no entries) with pause at 03:48
04:07 to 04:21	Common pipistrelle	Constant	Swarming with entries – 4 individuals
04:21 to 04:36	Common pipistrelle	Constant	Swarming with entries – 18 individuals

Time	Species	No. of passes	Notes
04:36 to 04:47	Common pipistrelle	Constant	Swarming with entries – 26 individuals (last entry 04:47)
<b>11/07/2011 Emergence point 4</b>			
03:16	Common pipistrelle	1	Heard. Bats seen flying from hedgerow behind surveyor to roost where another surveyor is standing. Bats seen swarming around entrance to roost. Continuous activity heard
03:18	Common pipistrelle	1	
03:23	Common pipistrelle	1	
03:26	Common pipistrelle	1	
03:27	Noctule	1	Continuous activity heard
03:28	Common pipistrelle	1	
03:30	Common pipistrelle	1	
03:32	Common pipistrelle	1	
03:33	Soprano pipistrelle	1	Continuous activity heard
03:35	Common pipistrelle	7	
03:39	Common pipistrelle	1	
03:41	Common pipistrelle	1	
03:45	Pipistrelle species	1	
03:45	Pipistrelle species	1	
03:46	Common pipistrelle	2	
03:49	Common pipistrelle	2	
03:50	Common pipistrelle	1	Pass heard, more than one bat
03:50	Common pipistrelle	1	
03:51	Common pipistrelle	3	
03:59	Common pipistrelle	2	
04:03	Common pipistrelle	5	
04:07	Common pipistrelle	1	
04:15	Common pipistrelle	1	
04:16	Common pipistrelle	4	
04:22	Common pipistrelle	2	

Time	Species	No. of passes	Notes
04:26	Common pipistrelle	2	
04:28	Common pipistrelle	4	
04:30	Common pipistrelle	3	
04:32	Two Common pipistrelles	2	
04:34	Common pipistrelle	3	
04:36	Common pipistrelle	4	
04:41	Common pipistrelle	2	
<b>19/07/2011 Emergence point 3: Under roost</b>			
3.13	Myotis	1	98 bats seen emerging from building
3.13	Common pipistrelle	1	
3.13	Noc	1	
3.14	Noc	1	
	Common pipistrelle	1	
3.15	Common pipistrelle	1	
3.17	Soprano pipistrelle	2	
3.21	Common pipistrelle	1	
3.21	Common pipistrelle	1	
3.22	Noc	1	
3.24	Common pipistrelle	1	
3.25	Common pipistrelle	1	
3.29	Serotine	1	
3.31	Soprano pipistrelle	1	
3.33	Common pipistrelle	1	
3.34	Common pipistrelle	1	
3.36	Common pipistrelle	1	
3.36	Common pipistrelle	1	
3.37	Common pipistrelle	1	
	Soprano pipistrelle	1	
3.40	Common pipistrelle	1	
3.42	Common pipistrelle	1	
3.44	Common pipistrelle	1	
3.45	Common pipistrelle	1	



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Time	Species	No. of passes	Notes
3.46	Common pipistrelle	1	
3.49	Common pipistrelle	1	
	Soprano pipistrelle	1	
3.49	Common pipistrelle	3	
3.50	Common pipistrelle	1	
	Common pipistrelle	1	
3.52	Common pipistrelle	1	
3.52	Common pipistrelle	1	
	Common pipistrelle	1	
3.53	Common pipistrelle	1	
3.53	Common pipistrelle	1	
3.53	Common pipistrelle	1	
	Soprano pipistrelle	1	
3.55	Common pipistrelle	1	
3.56	Common pipistrelle	1	
3.59	Common pipistrelle	1	
	Common pipistrelle	1	
4.03	Soprano pipistrelle	1	
	Common pipistrelle	1	
4.05	Common pipistrelle	2	
4.08	Common pipistrelle	1	
4.08	Common pipistrelle	1	
4.09	Common pipistrelle	1	
4.09	Common pipistrelle	1	
4.17			
4.18	Common pipistrelle	1	
4.19			
4.21	Common pipistrelle	1	
	Common pipistrelle	1	
4.21	Common pipistrelle	1	
	Soprano pipistrelle	1	
4.21	Common pipistrelle	1	

Time	Species	No. of passes	Notes
4.22	Common pipistrelle	1	
4.23	Soprano pipistrelle	1	
	Soprano pipistrelle	1	
4.26	Common pipistrelle	1	
4.26	Common pipistrelle	1	
4.26	Soprano pipistrelle	1	
4.26	Soprano pipistrelle	1	
4.28	Common pipistrelle	1	
4.28	Common pipistrelle	1	
4.30	Common pipistrelle	1	
4.31	Common pipistrelle	3	
4.33			
4.34	Common pipistrelle	2	
4.35	Common pipistrelle	3	
4.36	Common pipistrelle	2	
4.42	Common pipistrelle	1	
4.44			
4.45	Common pipistrelle	1	
4.46	Common pipistrelle	1	

**19/07/2011**

**Emergence point 1:**

03:09		Common pipistrelle	Constant
03:09		Common pipistrelle	Constant
03:20		Common pipistrelle	1
03:45	to	Common pipistrelle	Constant
03:52			
03:42	to	Common pipistrelle	Constant
04:07			
04:07	to	Common pipistrelle	Constant
04:21			
04:21	to	Common pipistrelle	Constant
04:36			

Time	Species	No. of passes	Notes
04:36 to 04:47	Common pipistrelle	52	Constant 52 common pipistrelle recorded returning to roost
<b>19/7/2011 Emergence point 2</b>			
03:16	Common pipistrelle	1	Pass heard.  Heard. Bats seen flying from hedgerow behind surveyor to roost where another surveyor is standing. Bats seen swarming around entrance to roost. Continuous activity heard
03:18	Common pipistrelle	1	
03:23	Common pipistrelle	1	Pass heard.
03:26	Common pipistrelle	1	Pass heard.
03:27	Noctule	1	Pass heard.
03:28	Common pipistrelle	1	Pass heard.
03:30	Common pipistrelle	1	Continuous activity heard
03:32	Common pipistrelle	1	Pass heard.
03:33	Soprano pipistrelle	1	Continuous activity heard
03:35	Common pipistrelle	7	Number of passes
03:39	Common pipistrelle	1	Pass heard
03:41	Common pipistrelle	1	Pass heard
03:45	Pipistrelle species	1	Pass heard
03:45	Pipistrelle species	1	Pass heard
03:46	Common pipistrelle	2	Pass heard
03:49	Common pipistrelle	2	Passes heard
03:50	Common pipistrelle	1	Pass heard
03:50	Common pipistrelle	1	Pass heard
03:51	Common pipistrelle	3	Passes heard
03:59	Common pipistrelle	2	Pass heard, more than one bat
04:03	Common pipistrelle	5	Passes heard
04:07	Common pipistrelle	1	Pass heard
04:15	Common pipistrelle	1	Pass heard
04:16	Common pipistrelle	4	Passes heard

Time	Species	No. of passes	Notes
04:22	Common pipistrelle	2	Passes heard
04:26	Common pipistrelle	2	Passes heard
04:28	Common pipistrelle	4	Passes heard
04:30	Common pipistrelle	3	Passes heard
04:32	Two Common pipistrelles	2	Passes heard
04:34	Common pipistrelle	3	Passes heard
04:36	Common pipistrelle	4	Passes heard
04:41	Common pipistrelle	2	Passes heard
04:42	Common pipistrelle	6	Passes heard
<b>19/7/2011 Emergence point 4</b>			
4.42	Pip 55	1	
<b>28/07/2011 Emergence point 3: Under roost</b>			
21:04	Common pipistrelle		29 bats seen emerging, 1 was a soprano pipistrelle and 28 were common pipistrelles.
21:07	Common pipistrelle		
21:13	Common pipistrelle		
21:20	Common pipistrelle		
21:20	Common pipistrelle		
21:21	Common pipistrelle		
21:23	Soprano pipistrelle		
21:23	Common pipistrelle		
21:23	Common pipistrelle		
21:23	Common pipistrelle		
21:23	Common pipistrelle		
21:24	Common pipistrelle		
21:24	Common/ Soprano pipistrelle		
21:24	Common pipistrelle		
21:24	Common pipistrelle		
21:25	Common pipistrelle		
21:25	Common pipistrelle		
21:26	Common pipistrelle		

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Time	Species	No. of passes	Notes
21.26	Common pipistrelle		
21.26	Common pipistrelle		
21.27	Common pipistrelle		
21.28	Common pipistrelle		
21:31	Common pipistrelle		
21:34	Noctule		
21:37	Common pipistrelle		
21:49	Noctule		
21:50	Big bat		
21:53	Common pipistrelle		
22:08	Leisler's		
22.08	Serotine		
22.08	Serotine		
22:18	Common pipistrelle		
22:21	Noctule		
22:32	Common pipistrelle		
22:33	Noctule		
22:36	Noctule		
22:37	Noctule		
22:39	Common pipistrelle		
22:40	Noctule		
22:41	Common pipistrelle		
22:42	Noctule		
22.43	Noctule		
22:43	Common pipistrelle		
22:47	Noctule		
22:49	Common pipistrelle		
22:53	Common pipistrelle		
22.53	Noctule		
22:55	Noctule		
22:56	Common pipistrelle		
22:59	Noctule		



Time	Species	No. of passes	Notes
23:00	Noctule		
<b>28/07/2011 Emergence point 2</b>			
21.30	Noctule	1	
22.05	Serotine	2	
22.18	Noctule	1	
22.20	Big bat	1	
22.30	Noctule	1	
22.32	Noctule	1	
22.32	Noctule	1	
22.33	Noctule	1	
22.34	Noctule	1	
22.35	Noctule	1	
22.37	Noctule	1	
22.37	Common pipistrelle	1	
22.38	Noctule	1	
22.39	Noctule	1	
22.44	Noctule	1	
22.44	Noctule	1	
22.45	Noctule	2	
22.45	Noctule	1	
22.45	Common pipistrelle	1	
22.45	Noctule	2	
22.46	Common pipistrelle	1	
22.47	Noctule	2	
22.47	Common pipistrelle	1	
22.47	Noctule	1	
22.48	Common pipistrelle	1	
22.50	Noctule	1	
22.50	Noctule	1	
22.50	Common pipistrelle	2	
22.51	Noctule	1	
22.52	Noctule	1	

Time	Species	No. of passes	Notes
22.53	Noctule	2	
22.54	Noctule	1	
22.56	Noctule	1	
22.57	Noctule	1	
22.57	Noctule	3	
<b>28/07/2011 Emergence point 1</b>			
21.25	Common pipistrelle	1	
21.30	Noctule	2	
21.31	Myotis sp.	1	
21.37	Myotis sp.	1	
21.38	Common pipistrelle	1	
21.38	Common pipistrelle	1	
21.40	Common pipistrelle	1	
21.41	Myotis sp.	1	
21.50	Common pipistrelle	1	
22.04	Serotine	1	
22.04	Noctule	1	
22.17	Noctule	1	
22.25	Soprano pipistrelle	3	
22.29	Noctule	1	
22.31	Soprano pipistrelle	1	
22.34	Big bat	1	
22.37	Noctule	1	
22.45	Noctule	1	
22.45	Noctule	1	
22.45	Common pipistrelle	1	
22.47	Noctule	1	
22.47	Common pipistrelle	3	
22.47	Soprano pipistrelle	1	
22.48	Soprano pipistrelle	1	
22.48	Common pipistrelle	1	
22.48	Common pipistrelle	1	

Time	Species	No. of passes	Notes
22.49	Soprano pipistrelle	1	
22.49	Soprano pipistrelle	1	
22.49	Noctule	1	
22.49	Common pipistrelle	2	
22.50	Common pipistrelle	1	
22.51	Common pipistrelle	6	
22.51	Soprano pipistrelle	1	
22.51	Common pipistrelle	16	
22.56	Noctule	4	
<b>28/07/2011 Emergence point 4</b>			
21.32	Common pipistrelle	1	
21.34	Soprano pipistrelle	1	
21.34	Soprano pipistrelle	2	
21.35	Common pipistrelle	1	
21.39	Soprano pipistrelle	1	
21.43	Noctule	1	
21.44	Common pipistrelle	1	
21.53	Soprano pipistrelle	1	
21.55	Common pipistrelle	1	
21.58	Noctule	1	
21.58	Soprano pipistrelle	1	
21.59	Noctule	1	
22.17	Noctule	1	
22.17	Serotine	1	
22.27	Common pipistrelle	1	
22.30	Noctule	1	
22.34	Noctule	1	
22.41	Common pipistrelle	1	
22.42	Noctule	1	
22.44	Noctule	1	
22.46	Noctule	1	
22.47	Noctule	1	

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Time	Species	No. of passes	Notes
22.49	Noctule	1	
22.49	Soprano pipistrelle	1	
22.50	Noctule	2	
22.51	Noctule	1	
22.52	Common pipistrelle	1	
22.57	Noctule	2	
22.57	Noctule	1	
22.58	Common pipistrelle	1	
22.58	Noctule	1	
22.59	Common pipistrelle	1	
22.59	Noctule	2	
22.59	Common pipistrelle	1	
23.00	Common pipistrelle	3	
23.00	Noctule	2	
23.00	Soprano pipistrelle	1	
23.02	Common pipistrelle	2	
23.02	Common pipistrelle	1	
23.03	Common pipistrelle	2	
23.03	Common pipistrelle	1	
23.03	Common pipistrelle	1	

## Emergence tree surveys at Graven Hill

### E.15 Results tree emergence survey ET1

Time	Species	No. of passes	Notes
01/06/2011			
4.09	Common pipistrelle	1	No bats emerging from tree
19/07/2011			
22.06	Noctule	1	No bats emerging from tree

<b>Time</b>	<b>Species</b>	<b>No. of passes</b>	<b>Notes</b>
22.06	Common pipistrelle	1	
22.21	Common pipistrelle	1	
22.29	Soprano pipistrelle	1	
22.31	Common pipistrelle	1	
22.33	Noctule	1	
22.35	Soprano pipistrelle	1	
22.37	Noctule	1	
22.47	Noctule	3	
22.50	Noctule	1	
22.51	Noctule	1	
22.56	Common pipistrelle	1	
22.57	Noctule	1	
22.58	Noctule	1	
22.59	Noctule	1	
22.59	Noctule	1	
23.00	Noctule	1	
23.03	Noctule	1	
23.04	Noctule	2	
23.05	Noctule	1	
23.06	Common pipistrelle	2	
23.06	Noctule	1	
23.07	Noctule	1	
23.08	Noctule	2	
23.11	Serotine	1	
23.12	Common pipistrelle	1	

#### **E.16 Results of tree re-entry survey ET8**

<b>Time</b>	<b>Species</b>	<b>No. of passes</b>	<b>Notes</b>
<b>1/6/2011</b>			
3.18	Pipistrelle sp.	1	No bats emerging from tree/ survey abandoned for health and safety reasons



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### E.17 Results of tree emergence/re-entry ET12

Time	Species	No. of passes	Notes
9/6/2011			
3.06	Myotis	1	No bats returning to tree
3.12	Common pipistrelle	1	
3.13	Common pipistrelle	6	
3.15	Common pipistrelle	2	
3.17	Common pipistrelle	3	
3.19	Common pipistrelle	3	
3.20	Common pipistrelle	3	
3.21	Myotis	1	
3.23	Common pipistrelle	4	
3.24	Common pipistrelle	2	
3.25	Common pipistrelle	1	
3.25	Common pipistrelle	2	
3.27	Common pipistrelle	1	
3.31	Common pipistrelle	4	
3.35	Common pipistrelle	1	
3.37	Common pipistrelle	5	
3.38	Common pipistrelle	1	
3.38	Common pipistrelle	4	
3.39	Common pipistrelle	6	
3.40	Common pipistrelle	7	
3.44	Common pipistrelle	4	
3.44	Common pipistrelle	1	
3.45	Common pipistrelle	2	
3.45	Long-eared bat	1	
3.45	Common pipistrelle	2	
3.46	Common pipistrelle	1	
3.49	Common pipistrelle	2	
3.50	Common pipistrelle	2	
3.53	Common pipistrelle	3	

Time	Species	No. of passes	Notes
3.55	Common pipistrelle	1	
3.37	Common pipistrelle	10	
3.59	Common pipistrelle	1	
4.06	Common pipistrelle	1	
4.06	Common pipistrelle	1	
4.07	Common pipistrelle	1	
4.08	Common pipistrelle	1	
4.08	Common pipistrelle	1	
4.10	Common pipistrelle	1	
4.12	Common pipistrelle	1	
4.13	Common pipistrelle	1	
4.13	Common pipistrelle	1	
4.14	Common pipistrelle	1	
4.17	Common pipistrelle	1	
4.17	Common pipistrelle	1	
4.23	Common pipistrelle	1	
4.25	Common pipistrelle	1	
<b>26/08/2011</b>			
5.16	Common pipistrelle	1	No bats seen re-entering tree
5.22	Common pipistrelle	1	
5.27	Common pipistrelle	1	
5.43	Common pipistrelle	1	
5.43	Noctule	1	
5.51	Common pipistrelle	1	

#### E.17 Results of tree re-entry survey ET14

Time	Species	No. of passes	Notes
<b>07/07/2011</b>			
2.57	Myotis sp.	1	No bats seen re-entering tree
3.08	Noctule	1	
3.18	Myotis sp.	1	

Time	Species	No. of passes	Notes
3.18	Noctule	1	
3.25	Soprano pipistrelle	2	
3.30	Myotis sp.	1	
3.31	Common pipistrelle	5	
3.32	Soprano pipistrelle	1	
3.32	Leisler's	1	
3.55	Noctule	1	
3.36	Noctule	1	
3.37	Noctule	1	
3.42	Common pipistrelle	1	
3.43	Common pipistrelle	1	
3.45	Common pipistrelle	1	
3.53	Myotis sp.	1	
3.55	Soprano pipistrelle	1	
3.57	Big bat	1	
3.58	Big bat	1	
4.03	Common pipistrelle	1	
4.04	Common pipistrelle	2	
4.14	Common pipistrelle	2	
4.21	Soprano pipistrelle	1	
<b>29/07/2011</b>			
3.28	Myotis sp.	2	No bats seen re-entering tree
3.29	Myotis sp.	1	
3.29	Myotis sp.	1	
3.30	Myotis sp.	1	
3.30	Myotis sp.	4	
3.31	Soprano pipistrelle	7	Fedding buzz
3.34	Myotis sp.	continuous	Fedding buzz
3.36	Common pipistrelle	continuous	
3.36	Myotis sp.	continuous	
3.40	Common pipistrelle	continuous	Feeding buzz continuous calls for 180sec
3.43	Soprano pipistrelle	2	

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Time	Species	No. of passes	Notes
3.43	Common pipistrelle	continuous	Feeding buzz continuous calls until 597sec
3.49	Myotis sp.	1	Foraging
3.50	Myotis sp.	3	
3.51	Myotis sp.	continuous	Foraging
3.51	Common pipistrelle	1	
	Common pipistrelle		Foraging
3.52		1	
3.52	Myotis sp.	continuous	Foraging
3.54	Common pipistrelle	1	
3.54	Myotis sp.	continuous	
3.56	Common pipistrelle	continuous	Foraging
3.57	Myotis sp.	continuous	Foraging
3.57	Common pipistrelle	continuous	
3.58	Myotis sp.	continuous	
3.59	Common pipistrelle	continuous	
4.01	Myotis	continuous	Foraging
4.01	Common pipistrelle	continuous	Foraging
4.07	Noctule	1	
4.07	Common pipistrelle	continuous	Foraging
4.07	Myotis sp.	continuous	
4.11	Myotis sp.	continuous	Foraging
4.11	Common pipistrelle	continuous	Foraging
4.16	Soprano pipistrelle	continuous	Foraging
4.19	Common pipistrelle	continuous	Foraging
4.20	Myotis sp.	1	
4.21	Myotis sp.	continuous	
4.21	Common pipistrelle	continuous	
4.23	Common pipistrelle	continuous	
4.26	Common pipistrelle	continuous	
4.26	Myotis sp.	continuous	Foraging
4.31	Myotis sp.	1	
4.31	Common pipistrelle	2	

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Time	Species	No. of passes	Notes
4.37	Myotis sp.	2	
4.40	Common pipistrelle	2	foraging
4.55	Soprano pipistrelle	1	

#### E.18 Results of re-entry survey at ET21

Time	Species of bat	No. passes	Notes
<b>27/07/2011</b>			
03:52	Bat	1	No bats seen re-entering tree
03:55	Pipistrelle	1	
03:56	Bat and pipistrelle species	2	Two bats
03:57	Pipistrelle species	5	Foraging around edge of hedgerow
04:02	Noctule	1	
04:27	Common pipistrelle	1	
04:33	Noctule	1	
04:39	Pipistrelle species	1	Foraging along hedgerow, feeding buzzes.
04:41	Noctule	2	
04:47	Common pipistrelle	1	Seen foraging continuously. Same bat seen.
04:51	Common pipistrelle	1	Seen foraging continuously. Same bat seen.
<b>07/07/2011</b>			
03:52	Common pipistrelle	1	No bats seen re-entering tree
03:56	Common pipistrelle	2	
4.00	Common pipistrelle	2	
4.02	Common pipistrelle	2	
4.04	Common pipistrelle	1	
4.06	Common pipistrelle	1	
4.08	Common pipistrelle	5	



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**E.19 Results of emergence survey ET 23**

Time	Species	No. of passes	Notes
<b>25/07/2011</b>			
21.52	Common pipistrelle	2	No bats seen leaving tree
22.11	Common pipistrelle	1	
22.23	Serotine	1	
22.35	Noctule	1	
22.44	Common pipistrelle	1	
22.48	Myotis sp.	1	
22.59	Common pipistrelle	1	
<b>26/08/11</b>			
4.28-05.57			No bats recorded

**E.20 Results of emergence survey ET 24**

Time	Species	No. of passes	Notes
<b>27/7/2011</b>			
3.41	Common pipistrelle	1	No bats seen re-entering tree
3.43	Myotis sp.	1	
3.43	Noctule	1	
3.49	Noctule	1	
4.02	Pipistrelle sp.	1	
4:21	Myotis sp.	1	
4.31	Common pipistrelle	1	
<b>29/7/2011</b>			
03:40	Common pipistrelle	1	No bats seen re-entering tree
3.41	Leislars	1	
04:21	Common pipistrelle	5	
04:28	Common pipistrelle	1	
04:31	Leislars	1	
04:45	Common pipistrelle	1	
04:49	Common pipistrelle	1	

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Time	Species	No. of passes	Notes
04:55	Soprano pipistrelle	1	

## C site activity surveys

### E.21 Transect results for C Site

Time	Species of bat	No. passes	Notes
08/06/2011 Transect C			
21.57	Common pipistrelle	2	
21.57	Soprano pipistrelle	2	
21.57	Common pipistrelle	1	
22.06	Myotis sp.	4	
22.10	Common pipistrelle	1	
22.37	Serotine	1	
23.02	Common pipistrelle	1	
23.27	Myotis	2	
23.32	Common pipistrelle	2	
23.34	Common pipistrelle	1	
08/06/2011 Transect B			
21.48	Noctule	1	
21.53	Noctule	1	
21.59	Myotis sp.	1	
22.02	Common pipistrelle	2	
22.09	Myotis sp.	1	
22.10	Common pipistrelle	2	
22.23	Common pipistrelle	10	
22.37	Common pipistrelle	1	
22.30	Common pipistrelle	31	
22.49	Common pipistrelle	25	
22.57	Common pipistrelle	13	
23.25	Common pipistrelle	7	
23.47	Common pipistrelle	1	

Time	Species of bat	No. passes	Notes
23.48	Common pipistrelle	1	
23.49	Common pipistrelle	1	
23.50	Common pipistrelle	10	
<b>08/06/2011 Transect A</b>			
21.51	Common pipistrelle	1	
21.52	Noctule	1	
21.53	Noctule	2	
21.56	Noctule	15	
22.00	Soprano pipistrelle	1	
22.00	Serotine	3	
22.01	Serotine	2	
22.01	Myotis	2	
22.01	Serotine	1	
22.01	Myotis	1	
22.02	Soprano pipistrelle	6	
22.02	Serotine	1	
22.02	Soprano pipistrelle	2	
22.02	Serotine	1	
22.02	Myotis	1	
22.02	Serotine	1	
22.02	Soprano pipistrelle	7	
22.03	Common pipistrelle	1	
22.03	Serotine	1	
22.03	Soprano pipistrelle	2	
22.04	Serotine	1	
22.04	Soprano pipistrelle	1	
22.04	Serotine	3	
22.08	Soprano pipistrelle	3	
22.35	Soprano pipistrelle	1	
22.39	Common pipistrelle	2	
22.39	Soprano pipistrelle	2	
22.39	Common pipistrelle	1	

Time	Species of bat	No. passes	Notes
23.01	Noctule	1	
23.09	Myotis	1	
23.10	Common pipistrelle	2	
23.11	Common pipistrelle	1	
23.13	Common pipistrelle	5	
23.23	Common pipistrelle	1	
23.45	Common pipistrelle	1	
23.47	Common pipistrelle	2	
<b>05/07/2011 Transect A</b>			
21:32	Common pipistrelle	1	
21:33	Common pipistrelle	1	
21:34	Common pipistrelle	1	
21:48	Common pipistrelle	13	
21:54	Common pipistrelle	5	
21:57	Common pipistrelle	11	
22:02	Noctule	1	
22:11	Common pipistrelle	7	
22:20	Common pipistrelle	1	
22:21	Common pipistrelle	1	
22:35	Myotis	1	
22:49	Common pipistrelle		
22:54	Common pipistrelle	9	
23:00	Common pipistrelle	12	
23:05	Common pipistrelle	1	
23:11	Common pipistrelle	1	
23:35	Common pipistrelle	7	
23:28	Noctule	7	
23:41	Common pipistrelle	1	
23:43	Common pipistrelle	2	
23:50	Noctule	1	
23:51	Common pipistrelle	1	
23:59	Noctule	1	
00:00	Common pipistrelle	1	

Time	Species of bat	No. passes	Notes
00:01	Noctule	2	2 individuals
00:14	Common pipistrelle	1	
00:16	Common pipistrelle	1	
<b>05/07/2011 Transect B</b>			
21:42	Common pipistrelle	1	Travelling east
21:51	Common pipistrelle	1	
21:59	Noctule	1	
22:01	Noctule	1	
22:03	Noctule	1	
22:10	Noctule	1	
22:11	Noctule	1	
22:42	Common pipistrelle	1	
22:46	Common pipistrelle	3	
22:54	Common pipistrelle	1	
23:04	Pipistrelle sp.	1	Foraging
23:05	Pipistrelle sp.	1	Foraging
23:11	Common pipistrelle	2	
23:14	Common pipistrelle	3	
23:18	Common pipistrelle	1	
23:30	Common pipistrelle	1	
23:34	Common pipistrelle	1	
23:38	Common pipistrelle	12	

## C Site Emergence Surveys

### E22. Emergence survey results - Boiler house

Time	Species	No. of passes	Notes
<b>22/06/2011 Emergence point 1</b>			
22:38	Common pipistrelle	1	Pass following tree line behind surveyor



Time	Species	No. of passes	Notes
22.44	Common pipistrelle	1	Pass following tree line behind surveyor
23.01	Common pipistrelle	1	Pass following tree line behind surveyor
23.01	Soprano pipistrelle	1	Pass following tree line behind surveyor
23.13	Common pipistrelle	1	Pass following tree line behind surveyor
<b>22/6/2011 Emergence point 2</b>			
22.10	Soprano pipistrelle	1	No bats seen leaving building
<b>20/7/2011 Emergence point 1</b>			
03:29	Common pipistrelle	1	No bats seen re-entering building
03:30	Common pipistrelle	1	
03:58	Common pipistrelle	1	
04:12	Common pipistrelle	1	
04:22	Soprano pipistrelle	1	
<b>20/7/2011 Emergence point 2</b>			
3.18	Myotis sp.	2	
3.20	Myotis sp.	1	
3.27	Common pipistrelle	1	
3.37	Myotis sp.	1	
3.45	Myotis sp.	1	
3.45	Myotis sp.	1	
3.49	Myotis sp.	1	
4.00	Myotis sp.	1	
4.10	Myotis sp.	1	
4.17	Common pipistrelle	1	
4.17	Common pipistrelle	1	
4.18	Soprano pipistrelle	1	
4.20	Common pipistrelle	1	
4.21	Common pipistrelle	1	
4.21	Common pipistrelle	1	
4.24	Common pipistrelle	1	
4.33	Common pipistrelle	1	

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Time	Species	No. of passes	Notes
4:38	Common pipistrelle	1	

#### E.24 Results of emergence survey C8A

Time	Species of bat	No. passes	Notes
<b>26/07/2011 Emergence point 1</b>			
03:18	Common pipistrelle	10	Continuous activity around this area. Social calls and passes. At least two common pipistrelles.
03:31	Common pipistrelle	4	Continuous activity around this area. Social calls and passes. Two Common pips.
03:35	Common pipistrelle	4	Social calls and passes. Continuous activity around this area.
03:38	Leisler's	2	
03:43	Common pipistrelle	1	Social call.
03:47	Likely leisler's or serotine	1	Quick pass seen and heard. Bat flying from east to west, following drainage ditch and hedgerow.
03:48	Bat	1	
04:20	Common pipistrelle	1	
04:35	Common pipistrelle	1	Did not go into roost. However, bat flew into building and back out down towards C8 and then hedge.
04:47	Common pipistrelle	1	
<b>26/7/2011 Emergence point 2</b>			
03:17	Common pipistrelle	1	No bats seen re-entering building
03:18	Common pipistrelle	Many	
03:45	Noctule	1	

Time	Species of bat	No. passes	Notes
04:20	Common pipistrelle	1	
04:24	Common pipistrelle	1	
04:35	Common pipistrelle	2	
04:40	Common pipistrelle	1	
04:46	Common pipistrelle	1	
<b>28/6/2011 Emergence point 1</b>			
21:52	Common pipistrelle	1	Single common pipistrelle, emerged from building apex from under slates and straight to edge of hedgerow
22:05	Myotis sp.	1	Along hedge
22:12	Pipistrelle species	1	Pass along hedge
22:15	Noctule	1	
22:19	Noctule	2	
22:21	Noctule	3	Foraging
22:21	Common pipistrelle	1	
22:32	Noctule	1	
22:33	Noctule	1	
22:33	Common pipistrelle	1	Foraging
22:33	Common pipistrelle	1	Foraging
22:38	Common pipistrelle	1	Continuous foraging same bat
22:42	Common pipistrelle	2	
22:45	Noctule	1	
22:47	Common pipistrelle		Foraging

Time	Species of bat	No. passes	Notes
<b>Emergence point 2 28/6/2011</b>			
22:20	Common pipistrelle	3	No bats seen leaving building
22:22	Leisler's	1	
22:22	Common pipistrelle	2	
22:22	Common pipistrelle	1	
22:22	Soprano pipistrelle	1	
22:27	Noctule	1	
22:33	Noctule	1	Foraging
22:38	Common pipistrelle	1	
22:44	Common pipistrelle	2	
22:47	Noctule		
22:53	Common pipistrelle	9	
22:58	Serotine	1	
22:59	Common pipistrelle	5	
23:00	Serotine	1	
23:01	Common pipistrelle	27	
23:03	Common pipistrelle	3	
23:15	Common pipistrelle	16	
23:37	Common pipistrelle	2	

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**E.25 Results of emergence surveys - Air raid shelters (Block A, B and C)**

Time	Species	No. of passes	Notes
<b>07/07/2011 Block A</b>			
21.45	Common pipistrelle	1	
21.51	Common pipistrelle	3	
21.51	Common pipistrelle	1	
21.53	Common pipistrelle	1	
21.53	Common pipistrelle	1	
22.00	Common pipistrelle	1	
22.00	Common pipistrelle	1	
22.01	Common pipistrelle	1	
22.15	Soprano pipistrelle	1	
<b>07/07/2011 Block A</b>			
03:56	Common pipistrelle	2	
<b>08/07/2011 Block A</b>			
4.10	Common pipistrelle	1	
4.17	Common pipistrelle	1	
<b>08/07/2011 Block A</b>			
03:29	Common pipistrelle		
03:34	Myotis sp.		
03:36	Myotis sp. x 2		
03:41	Myotis sp.		
<b>20/07/2011 Block A</b>			
3.18	Myotis sp.	2	
3.20	Myotis sp.	1	
3.27	Common pipistrelle	1	
3.37	Myotis sp.	1	
3.45	Myotis sp.	1	
3.45	Myotis sp.	1	
3.49	Myotis sp.	1	
4.00	Myotis sp.	1	
4.10	Myotis sp.	1	
4.17	Common pipistrelle	1	



Time	Species	No. of passes	Notes
4.17	Common pipistrelle	1	
4.18	Soprano pipistrelle	1	
4.20	Common pipistrelle	1	
4.21	Common pipistrelle	1	
4.21	Common pipistrelle	1	
4.24	Common pipistrelle	1	
4.33	Common pipistrelle	1	
4.38	Common pipistrelle	1	
<b>20/07/2011 (Block A)</b>			
04:01	Common pipistrelle	1	
04:13	Bat	1	Bat seen flying past south east towards residential housing.
04:18	Common pipistrelle	1	
04:21	Common pipistrelle	1	
04:26	Common pipistrelle	1	
<b>20/07/2011 (Block B)</b>			
03.27	Common pipistrelle	1	Foraging
03.43	Common pipistrelle	1	Foraging
03.50	Common pipistrelle	1	Foraging
03.52	Common pipistrelle	1	Foraging
04.14	Common pipistrelle	1	Foraging
04.19	Common pipistrelle	1	Foraging
04.20	Common pipistrelle	1	Foraging
04.25	Common pipistrelle	1	Foraging
<b>29/7/2011 (Block B)</b>			
04.46	Common pipistrelle	1	Foraging
<b>12/7/2011 Block C</b>			
21:45	Pipistrelle sp.	1	No bats emerging
21:56	Common pipistrelle	1	
22:35	Common pipistrelle	1	
22:58	Common pipistrelle	1	
23:04	Common pipistrelle	1	

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Time	Species	No. of passes	Notes
21:45	Pipistrelle sp.	1	
<b>29/7/2011 (Block C)</b>			
03.24-05.23			No bat recordings

## E26. Results of emergence survey CT10

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Time	Species of bat	No. of passes	Notes
<b>06/7/2011</b>			
02:54	Noctule	1	
03:49	Common pipistrelle	1	
03:53	Two common pipistrelles	2	
03:56	Common pipistrelle	1	
03:58	Pipistrelle species	1	
03:59	Common pipistrelle	1	
04:01	Common pipistrelle	1	Commuting towards residential area outside of site boundary
04:04	Common pipistrelle	1	Commuting towards residential area outside of site boundary
04:10	Common pipistrelle	1	Bat seen flying behind tree line. Bat appeared to return to tree.
04:14	Common pipistrelle	1	Commuting towards residential area outside of site boundary
04:17	Noctule	1	
04:26	Noctule	1	
<b>26/7/2011</b>			
21:14	Common pipistrelle	1	No bats seen re-entering tree
21:18	Common pipistrelle	1	
21:21	Common pipistrelle	1	Travelling from South to North past tree. Seen commuting from direction of nearby residential area

Time	Species of bat	No. of passes	Notes
			along tree line.
21:22	Common pipistrelle	2	Foraging around trees
21:22	Common pipistrelle	1	Pass heard and seen travelling from residential area, northwards following tree-line.
21:23	Noctule	1	
21:23	Common pipistrelle	1	
21:30	Common pipistrelle	1	
20:33	Common pipistrelle	3	Foraging around trees, feeding buzzes.
21:36	Noctule	1	
21:39	Common pipistrelle	5	Continuously foraging
21:44	Common pipistrelle	3	Continuously foraging
21:49	Common pipistrelle and Myotis	2	Two bats.
22:07	Common pipistrelle	2	Foraging
22:11	Noctule	1	
22:17	Common pipistrelle	1	
22:20	Noctule	1	
22:22	Common pipistrelle	9	Foraging nearby.
22:46	Common pipistrelle	1	
22:51	Common pipistrelle	1	

#### E27. Results of emergence survey - CT11

Time	Species	No. of passes	Notes
<b>06/7/2011</b>			
03:04	Common pipistrelle	1	No bats seen re-entering tree
03:28	Myotis	1	
03:29	Common pipistrelle	1	
03:30	Common pipistrelle	1	
03:49	Common	1	

Time	Species	No. of passes	Notes
	pipistrelle		
03:52	Common pipistrelle	2	
04:00	Common pipistrelle	1	
04:13	Common pipistrelle	1	
04:15	Common pipistrelle	14	
<b>26/7/2011</b>			
21.23	Pipistrelle sp.	1	
21.28	Common pipistrelle	Many	
21.38	Soprano pipistrelle	Many	
22:19	Noctule	1	
22:26	Pipistrelle sp.	1	

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# Annex F

## Not used

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# Annex G

## Water Vole Survey Results

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**TableG1 Results of water vole surveys May 2011 for Graven Hill Site and C Site**

Watercourse/ ditch reference number	Evidence of water vole	Description of watercourse and suitability to support water voles
Graven Hill		
D1	No	Ditch mainly dry during survey, except for a short section located between SP 58578 19811 - SP 58623 19812. This contained approximately 10 - 25cm of water. The ditch is V shaped and the grassy embankments support rushes, sedges, cowslip ( <i>Primula veris</i> ), ground ivy, cleavers, willow and hawthorn. The ditch is assessed as being of low suitability to support a population of water voles mainly as a result of the low water levels and the lack of suitable vegetation on which to forage and to provide shelter.
D4	No	Ditch mainly dry during survey, with a maximum of 15cm of water present in damp sections. The ditch is likely to be completely dry during the summer months. The short grassy banks support common species including ribwort plantain, ground ivy, mosses, bramble, sedges and rushes. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation for foraging/ provision of shelter.
D4b	No	Ditch mainly dry during survey and is likely to be completely dry during the summer months. The short grassy embankments support common herb species, sedges and rushes. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation for foraging/ provision of shelter.
D10	No	Predominantly dry ditch with the exception of a 7m stretch, which at the time of survey contained less 30cm of water. The ditch is V shaped and supports rushes and docks ( <i>Rumex</i> sp.), although there are some areas with exposed soil. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation for foraging/ provision of shelter.
D19	No	Predominantly dry/damp ditch with only a short section containing water. The grassy banks support of lady's bedstraw ( <i>Galium verum</i> ), bulrush and teasel. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation for foraging/ provision of shelter.
D19a	No	Predominantly dry/damp ditch with wetter sections supporting bulrush and duckweed and water mint. Short grassy banks supporting lady's bedstraw, bramble, teasel and blackberry. Some areas of dense scrub occur along this section of the watercourse comprising of European gorse, bramble, dog rose, hawthorn and blackthorn. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and higher levels of shading from surrounding scrub.
D21	No	Predominantly dry/ damp ditch with some sections containing between 5-20cm of water. Parts of the ditch are inaccessible due to the density of surrounding scrub. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and extensive shading in part.
D23	No	Predominantly dry/ damp ditch with some sections containing a maximum of 20cm of water. Ditch surrounded by dense vegetation in part comprising mostly hawthorn, blackthorn, European gorse, bramble and dog rose. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels, lack of suitable vegetation on which to forage and the extensive shading of the channel.



E1	No	Predominantly dry/ damp, v-shaped ditch with some wet sections, containing water to a depth of a maximum of 10cm. Short grassy banks supporting ribwort plantain, rushes, creeping thistle and white clover. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E2	No	Predominantly dry/ damp, shallow v-shaped ditch with some wet sections, containing water to a maximum depth of 10cm. Short grassy banks supporting grasses and tall ruderal vegetation. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E3	No	At the time of survey this ditch was completely dry. The channel is grassed over in part suggesting that the ditch has been dry for some time. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E4	No	Predominantly dry/ damp, v-shaped ditch with some wet sections, containing water to a depth of a maximum of 15cm. Short grassy banks supporting rushes, hogweed hawthorn, broad-leaved dock, nettle, hedge woundwort, bird's-foot trefoil and common cleavers. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E5	No	At the time of survey this ditch was completely dry. Short grassy banks supporting rushes bird's-foot trefoil, vetches, bristly ox tongue, ground ivy and hawthorn scrub. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E6	No	This ditch feeds into a small hollow which likely retains water during periods of high rainfall. The water body is completely surrounded by scrub and tall ruderal vegetation. The ditch/water body is assessed as being of low suitability to support a population of water voles on the basis of the low water levels, lack of suitable vegetation on which to forage and the shading by surrounding scrub.
E7	No	Dry v-shaped with short grassy banks supporting rushes, hogweed, bird's-foot-trefoil and common cleavers grassy banks. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E8	No	Dry/damp ditch containing water to a maximum depth of 15cm. The channel supports bulrush. The grassy banks also support hawthorn and blackthorn. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E9	No	Predominantly wet ditch containing water to a maximum depth of approximately 20-30cm. The grassy banks are vegetated with hedge woundwort, hawthorn, rosebay willowherb, broad-leaved dock, common cleavers and other tall ruderal species. The channel is shaded in part. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels, lack of suitable vegetation on which to forage and abundant shading of the channel.
E10	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E11	No	Predominantly dry ditch supporting some rushes, though becoming increasingly colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E12	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E13	No	A section of wet ditch containing water to a depth of between 20-40cm, the remainder of the ditch is dry. The short grassy banks are vegetated with species such white clover and bird's-foot trefoil. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels



		and lack of suitable vegetation on which to forage.
E14	No	A section of wet ditch containing water to an approximate depth of between 40 - 60cm. The grassy banks are vegetated with vetches, plantain and broad-leaved dock. Aquatic vegetation comprises mostly bulrush. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E15	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E16	No	Predominantly dry/damp ditch with water to a maximum depth of 30cm in part. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E17	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E18	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E19	No	A section of wet ditch, with a maximum water depth of 30cm in parts. Rushes are present within the channel. The short grassy banks are vegetated with vetches, bird's-foot trefoil, buttercup and red clover. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E20	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E21	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E22	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E23	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E24	No	Dry/damp ditch with occasional areas of water to a maximum depth of 30-50cm. The grassy banks are closely mown on one side and have hedge on the other. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels, lack of suitable vegetation on which to forage and shading.
E25	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E26	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E27	No	A small water body surrounded by scrub bramble, elder and hawthorn. Although the water body contained some water at the time of survey, the dense shading means that there is virtually no aquatic vegetation. The water body is assessed as being of low suitability to support a population of water voles on the basis of the lack of suitable vegetation on which to forage and the dense shading of the water body.
E28	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is





		assessed as being of low suitability to support a population of water voles on the basis of the low water levels, lack of suitable vegetation on which to forage and heavy poaching of the banks by the cattle.
E29	No	A section of wet ditch with a maximum water depth of between 20-50cm. Aquatic vegetation comprises mostly bulrush. The gradually sloping banks provide some suitable habitat for water voles, albeit there is no evidence to suggest that water voles are using this section of wet ditch.
E30	No	Inundated area to a depth of 30cm situated within an area of broad-leaved/scrub woodland. It is likely that this will dry out during periods of low rainfall. There is virtually no aquatic vegetation due to the dense shading. The water body is assessed as being of low suitability to support a population of water voles on the basis of the lack of suitable vegetation on which to forage and the dense shading of the water body.
E31	No	Dry/ damp ditch to a maximum depth of 30cm. Parts of the channel are shaded by willow and bramble scrub. The water body is assessed as being of low suitability to support a population of water voles on the basis of the lack of suitable vegetation on which to forage and the dense shading of the ditch.
E32	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E33	No	Dry/damp ditch containing water to a maximum depth of 20cm. Ditch extends along hedgerow and woodland. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation on which to forage.
E34	No	Dry/damp ditch with some sections containing between 40cm-50cm of water. The banks are vegetated with tall ruderal species. Aquatic vegetation comprises water mint, water forget-me-not and rushes. The ditch is assessed as being of moderate suitability to support a population of water voles albeit there is no evidence to suggest that water voles are using this section of ditch.
E35	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E36	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E37	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E38	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E39	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E40	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E41	No	Predominantly dry ditch with concrete channel. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the concrete banks of the channel, which would prevent burrowing.
E42	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.



E43	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E44	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E45	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E46	No	Predominantly dry channel becoming colonized by terrestrial species. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
E47	No	A short section of damp ditch containing a maximum water depth of 20cm. The grassy banks comprise rushes, plantain and bird's-foot trefoil. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and lack of suitable vegetation for foraging.
<b>C Site</b>		
C1	No	This water body is completely surrounded by dense scrub (comprising of hawthorn, dog rose, bramble, ivy, blackthorn and willow) resulting in there being an absence of aquatic and bankside vegetation. The water body was also virtually dry. No evidence of water vole was recorded.
C2	No	This water body is completely surrounded by an area of scrub comprising beech ( <i>Fagus sylvatica</i> ), willow, hawthorn and blackthorn, resulting in there being an absence of aquatic and bankside vegetation. The water body was also virtually dry. No evidence of water vole was recorded.
C5	No	This ditch is approximately 1-2 metres in width, with a maximum water depth between 30 - 60cm, it eventually runs dry further to the west. The channel was very silty. Vegetation in the channel includes water mint, water forget-me-not, rushes and bulrush. No evidence of water vole was recorded.
C6	No	This ditch is approximately 1-2m in width and to a maximum depth of 20cm. The banks are vegetated with a short grassy sward. Aquatic vegetation includes water mint and bulrush. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.
C7	No	A section of dry ditch, with short grass banks, parts of which are lined with concrete deeming this ditch to be unsuitable for water voles to burrow into. Aquatic vegetation comprises mostly bulrush. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and unsuitable bank substrate.
C8	No	A section of dry ditch, with short grass banks, parts of which are lined with concrete deeming this ditch to be unsuitable for water voles to burrow into. Aquatic vegetation comprises mostly bulrush. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels and unsuitable bank substrate.
C9	No	A section of ditch approximately 1-2m in width and containing between 20- 60cm of water in places. The aquatic vegetation comprises bulrush, water mint and rushes. Although the ditch was of moderate suitability to support water vole, no evidence of this species was recorded.
C10	No	A section of dry ditch up to 50cm in width, with short grassy banks. The channel comprises leaf litter, rushes and water forget-me-not. The ditch is assessed as being of low suitability to support a population of water voles on the basis of the low water levels.





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# Annex H

## Great Crested Newt Survey Results

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**Table H1 Descriptions and HSI scores for waterbodies at Graven Hill**

Water body number	HSI Score	Distance from site boundary	Water body description
<b>Graven Hill</b>			
8a	0.71 good	On-site	No access during screening survey, observations made from fence line. Small water body located within Langford Farm land holding. Water body has earth banks and contains very limited aquatic vegetation. It is situated on the edge of a grassland field and is partially surrounded by mature standard trees and dense scrub.
8b	No access	On-site	No access, water body completely surrounded by dense impenetrable scrub. Water body likely to be subject to seasonal desiccation.
9	Dry / not suitable	On-site	Seasonally wet drainage ditch situated within scrub located next to the railway line. At the time of survey, the drainage ditch contained very little flow. The drainage ditch is separated from the site by semi-improved grassland fields with scrub, hedgerows and further drainage ditches.
10	Dry / not suitable	On-site	Seasonally wet drainage ditch, situated within dense scrub, located next to the railway line. At the time of survey, the drainage ditch contained very little flow. The drainage ditch is separated from the site by semi-improved grassland fields with scrub, hedgerows and further drainage ditches.
11	0.66 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl observed but fish present. Set within an area of amenity grassland with scrub and drainage ditches within 50m.
12	0.64 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl observed but small fish present. Set within an area of amenity grassland with scrub and standard trees.
13	0.69 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl or fish observed. Set within an area of amenity grassland with a small area of scrub nearby.
13a	0.58 below average	On-site	Small, shallow, seasonal ditch containing up to 0.3m of water in places. Minimal aquatic vegetation present.
13b	0.53 below average	On-site	Small, shallow, seasonal ditch containing up to 0.3m of water in places. Minimal aquatic vegetation present.
14	0.64 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl or fish observed. Set within an area of amenity grassland with a small area of scrub nearby.
15	0.69 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. Large population of carp recorded and waterfowl observed during one of the surveys. Water body set within an area of amenity grassland with nearby seasonally wet drainage ditches and broad-leaved plantation within 100m.
16	0.47 Poor	On-site	Concrete water tank 10m x 10m. Abundant pondweed ( <i>Potamogeton</i> sp.) present. No fish or wildfowl observed. Water body set within an area of amenity grassland with nearby drainage ditches.
17	0.67	On-site	Concrete water tank 10m x 10m. Abundant pondweed present. Large population of carp recorded but no waterfowl observed. Water body set within





Water body number	HSI Score	Distance from site boundary	Water body description
<b>Graven Hill</b>			
	average		an area of amenity grassland with mature standard trees in the immediate vicinity and broad-leaved woodland and hedgerow habitat within 50m.
18	0.62 average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl or fish observed. Set within an area of amenity grassland with surrounding mature standard trees.
15a	0.9 excellent	On-site	Seasonal drainage ditch 0.5m in width and contained water to a depth of 0.3m in places. Abundant duckweed, rush species and algae.
15b	0.68 average	On-site	Seasonal drainage ditch 0.5m in width and contained water to a depth of 0.3m in places. Abundant duckweed, rush species and algae.
D1	Dry / not suitable	On-site	Section of dry drainage ditch.
D2	Dry/ not suitable	On-site	Section of dry drainage ditch.
D2a	Dry not suitable	On-site	Section of dry drainage ditch.
D3	Dry/ not suitable	On-site	Section of dry drainage ditch.
D4	Dry/ not suitable	On-site	Section of dry drainage ditch.
D5	0.52 below average	On-site	Shallow ditch located at the base of railway embankment. The bank on northern side has trees and scrub. Southern banks comprise well maintained amenity grassland. The channel contains abundant emergent vegetation.
F1	0.59 below average	On-site	Small, shallow woodland pond supporting bur-reed and yellow iris. The pond is completely over shaded by mature trees and contains an abundance of leaf litter.
D17	0.6	On-site	Waterbody situated within an area of dense scrubby plantation. Water body full of decaying leaf litter and entirely shaded. Minimal aquatic vegetation present. No fish or wildfowl observed. Abundant suitable refugia and hibernacula
D18	0.71	On-site	Large, deep water body measuring 37 x 11m. This is completely surrounded by bankside trees and as such is heavily shaded. Aquatic vegetation comprises rushes, common bulrush and yellow flag. The waterbody is quite turbid and may contain fish.
E1	Dry / not suitable	On-site	Dry seasonal ditch with surrounding scrub. Poached by cattle.
E1a	Dry/not suitable	On-site	Dry water body surrounded by scrub.
E2	Dry / not suitable	On-site	Dry seasonal ditch located within semi-improved grassland.
E3	0.45 poor	On-site	Concrete water tank 10m x 10m with no aquatic vegetation but abundant willow leaf debris. No evidence of fish or wildfowl. Water body set within an area of amenity grassland with a nearby drain and surrounding mature trees.
E9	0.62	On-site	Concrete water tank 10m x 10m with no aquatic vegetation with the exception of a small amount of rush ( <i>Juncus</i> sp). No fish or wildfowl observed. Water



Water body number	HSI Score	Distance from site boundary	Water body description
<b>Graven Hill</b>			
	average		body set within an area of amenity grassland with an area of mixed plantation located within 50m.
E10	0.81 excellent	On-site	Concrete water tank 10m x 10m with abundant aquatic vegetation mostly pond weed. No wildfowl observed but stickleback present. Water body surrounded on three sides by mixed woodland and scrub.
E11	0.64 average	On-site	Concrete water tank 10m x 10m with no aquatic vegetation but floating plastic and litter provide some artificial egg laying substrate. No wildfowl or fish observed. Water body set within an area of amenity grassland with surrounding mature standard trees.
G1	Dry/not suitable	On-site	This pond appears to have been dry for sometime indicated by the colonization of terrestrial vegetation.
SDB1	0.33 poor	Off site within St David's Barracks	Circular concrete pond 5m in diameter with raised brick perimeter. The water contained abundant algae and fish with no aquatic vegetation. The pond is surrounded by amenity grassland, tarmac roads, buildings and hard standing car parks. Screened from survey work.
SDB2	Dry / not suitable	Off site within St David's Barracks	Dry concrete ditch on assault course. Screened from survey work.
SDB3	Dry / not suitable	Off site within St David's Barracks	Dry pond located within wooded area surrounded by amenity grassland. Screened from survey work.
<b>Off-site</b>			
E15	No access	Adjacent to site boundary	Off-site water body separated from site by security fence and surrounded by scrub, preventing viewing. Connected to nearby seasonal drainage ditch assessed as replacement water body. Seasonal drainage ditch is 0.5m in width and at the time of the survey, contained water to a depth of 0.3m in places. Abundant duckweed, rush species and algae.
20	Screened from survey through map exercise	240m	Water body separated from development site by railway line and arable fields. The likelihood that GCN from these off-site waterbodies could turn up on the development site is assessed as low. Water body screened from survey work.
21	Screened from survey through map exercise	170m	Water body separated from development site by railway line and arable fields. The likelihood that GCN from these off-site waterbodies could turn up on the development site is assessed as low. Water body screened from survey work.
22	Screened from survey through map exercise	360m	Water body separated from development site by railway line and arable fields. The likelihood that GCN from these off-site waterbodies could turn up on the development site is assessed as low. Water body screened from survey work.



Water body number	HSI Score	Distance from site boundary	Water body description
<b>Graven Hill</b>			
24	Screened from survey through map exercise	340m	Water body separated from development site by railway line and arable fields. The likelihood that GCN from these off-site waterbodies could turn up on the development site is assessed as low. Water body screened from survey work.
25a	Dry / not suitable	45m	A small ornamental pond situated within an improved grassland field that is grazed by horses. This appeared to have been dry for some time.
25b	0.60 average	25m	A small circular water body with a diameter of approximately 7m. This is situated in an area of improved grassland grazed by horses, adjacent to a hedgerow. No fish were recorded albeit mallard ducks were recorded using the pond.
26a	0.6 average	250m	A large water body surrounded by mature scrub situated within an improved grassland field that is grazed by horses. Aquatic vegetation is limited. Fish may be present and mallard ducks were recorded.
26b	0.65 average	125m	A small circular water body with a diameter of approximately 5m, situated within a small hollow in a residential garden. A limited amount of aquatic vegetation is present. No fish were recorded.
27	No access	500m	Request for access to survey water body refused by landowner.
28	No access	500m	Request for access to survey water body refused by landowner.
29	No access	390m	Request for access to survey water body refused by landowner.
30	No access	320m	Request for access to survey water body refused by landowner.
31	No access	260m	Request for access to survey water body refused by landowner.
32	No access	390m	Request for access to survey water body refused by landowner.
33	No access	60m	Screened from survey work due to presence of major road which form a significant barrier to movement
34	No access	480m	Screened from survey work due to presence of major road which form a significant barrier to movement
88	No access	500m	Request for access to survey waterbodies refused by landowner
89	No access	470m	Request for access to survey waterbodies refused by landowner



**Table H2 Description of waterbodies and HSI scores at C Site**

Water body number	HSI Score	Distance from site boundary	Water body description
On-site			
1	0.57 below average	On-site	Concrete water tank 10m x 10m. No aquatic vegetation present. No waterfowl observed but stickleback fish present. Set within an area of amenity grassland with a small area of scrub nearby.
E2	0.56 below average	On-site	Concrete water tank 10 x 10. Limited aquatic vegetation present. No waterfowl observed. Situated in an area of amenity grassland with standard trees, within 5m of a hedgerow. Water reasonably turbid.
E2a	Dry / not suitable	On-site	A damp section of ditch.
E2b	Dry / not suitable	On-site	A damp section of ditch.
E4	0.35 poor	On-site	Concrete water tank 10m x 10m with no aquatic vegetation but floating plastic and litter provide some artificial egg laying substrate. No evidence of fish or wildfowl. Water body set within an area of amenity grassland with surrounding mature standard trees. Water body receives discharge from outflow pipe.
E5	0.57 below average	On-site	Concrete water tank 10m x 10m with no aquatic vegetation. No evidence of fish or wildfowl. Water body set within an area of amenity grassland with surrounding scrub. Water body receives discharge from outflow pipe.
E6	0.56 below average	On-site	Concrete water tank 10m x 10m with no aquatic vegetation but floating plastic and litter provide some artificial egg laying substrate. No wildfowl observed but fish present. Water body set within an area of amenity grassland with scrub located within 20m from the water body margins. Water body receives discharge from outflow pipe.
E7	Dry / not suitable	On-site	Large raised metal water tank set on bricks. Vertical tank sides to 1.5m in height, preventing access to any amphibian species. No aquatic vegetation present. No fish or wildfowl observed. Tank set within an area of amenity grassland with surrounding mature standard trees.
E8	0.5 Below average	On-site	Concrete water tank 10m x 10m with no aquatic vegetation but floating plastic and litter provide some artificial egg laying substrate. No wildfowl or fish observed. Water body set within an area of amenity grassland.
E13	0.45 poor	On-site	A concrete tank 10m x 10m supporting a stand of common reed ( <i>Phragmites australis</i> ). Water reasonably turbid and appears polluted. Water body situated adjacent to the railway, scrub and broad-leaved plantation.
E16	0.5 below average	On-site	Concrete water tank 10m x 10m with minimal aquatic vegetation. No wildfowl or fish observed. Water body set within an area of amenity grassland.
E16a	0.48 poor	On-site	A section of wet ditch 1-2m in width and containing water to a depth of 20cm, albeit dry in some sections. The ditch supports abundant aquatic vegetation.
D10	0.47 poor	On-site	A section of ditch measuring 1m in width and containing water to a depth of 5cm. The ditch supports an abundance of aquatic vegetation, albeit appears to be polluted with surface run-off. No fish or waterfowl recorded.
D11	0.51 below average	On-site	A section of ditch measuring 1m in width and containing water to a depth of 10cm. The ditch supports an abundance of aquatic vegetation mostly common reed. No fish or waterfowl recorded.



Water body number	HSI Score	Distance from site boundary	Water body description
D12	0.40 poor	On-site	A section of wet ditch containing abundant aquatic vegetation. Level of water variable throughout the length of the ditch. The ditch is set within an area of amenity grassland adjacent to an area of broad-leaved plantation and scrub.
D13a	0.45 poor	On-site	A section of wet ditch containing abundant aquatic vegetation. Level of water variable throughout the length of the ditch. The ditch is set within an area of amenity grassland adjacent to an area of broad-leaved plantation and scrub.
D14	0.56 below average	On-site	A section of ditch measuring 3m in width and containing water to a maximum depth of 0.5m. Abundant aquatic vegetation. Set in an area of amenity grassland and standard trees.
D15	Dry / not suitable	On-site	A dry section of ditch.
D16	Dry / not suitable	On-site	A dry section of ditch.
D17	0.60 average	On-site	A small inundated area situated within an area of dense woodland and scrub. There is virtually no aquatic vegetation. No water fowl or fish observed. The waterbody is surrounded by abundant dead wood and potential refugia.
D18	0.71 good	On-site	A water body situated in an area of dense woodland. No aquatic vegetation present, water body completely overshadowed. No waterfowl or fish observed. The water body is surrounded by abundant dead wood and potential refugia.
Off-site			
2	0.5 Below average	125m	A concrete water tank measuring 10m x 10m. No aquatic vegetation present other than abundant duckweed. No waterfowl observed but fish may be present. Water body surrounded by locked security gate, no access permitted. Water body screened from survey work as water body surrounded by the built environment and separated from the site by a busy road which forms a significant barrier to GCN accessing the site.
60a	0.56	90m	A small water body 5m x 5m containing little aquatic vegetation with the exception of algae. Water body is set within an area of grazed semi-improved grassland. Part of the water body is located adjacent to a hedgerow.
60b	0.53	Adjacent to site boundary	A water body is 15m x 4m containing limited aquatic vegetation with the exception of algae. The water body is set within an area of grazed improved grassland and flanked in part by scrub. The banks of the water body are poached by cattle.
60c	0.54	170m	A water body measuring approximately 5m x 9m, situated within an area of grazed, improved grassland, 10m from a hedgerow. There is virtually no aquatic vegetation and the banks of the water body are poached by cattle.
60d	0.36	500m	A water body measuring approximately 4m x 6m, situated within an area of improved grassland, adjacent to a hedgerow. The pond supports only a limited amount of marginal and aquatic vegetation and the banks of the water body are subject to poaching.
60		70m	No access agreed
61		70m	No access agreed
63		275m	This water body has been screened from survey work as it is separated from the development site by a road which forms a significant barrier to movement.
64		390m	This water body has been screened from survey work as it is separated from the development site by a road which forms a significant barrier to movement.



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Water body number	HSI Score	Distance from site boundary	Water body description
65		435m	This water body has been screened from survey work as it is separated from the development site by a road which forms a significant barrier to movement.
66		410m	This water body is situated at the upper limit of the distance within which GCN will travel from their breeding pond to access suitable terrestrial habitat. Furthermore, it is separated from the development site by a number of arable fields and as such the likelihood of GCN from this water body turning up within the development site is considered to be low. This water body has therefore been screened from further survey work.





Table H2 GCN survey results for Graven Hill and C site

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
Survey conditions	Dry, windy 10° C	Dry, calm, 12° C	Showers, 18° C	Dry, light breeze 12° C	Dry, breezy, 18° C	Dry, breezy, 15° C	Dry, breezy, 18° C	Dry, breezy, 21° C	Drizzle but warm, 18° C	Dry, breezy, 18° C	Dry, calm, 16° C	Dry, breezy, 17° C	Dry, calm, 12° C	Dry, breezy, 16° C
Graven Hill														
8a	Impenetrable scrub, very rowdy bullocks, further surveys abandoned													
					Egg search: none Torching: none Bottles: 3 F GCN, 1 M GCN	Egg search: none Torching: none Bottles: 2 M GCN, 2 F GCN	Egg search: GCN eggs present Torching: none Bottles: none	Torching: none Bottles: 2 M GCN, 1 F GCN	None	None				
8b														

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
9		Not suitable												
10		Not suitable												
11	Egg strips: GCN eggs present Torching: 52 M GCN, 30 F GCN Artificial refugia search: none	Torching: 67 M GCN, 51 F GCN Artificial refugia search: none					Torching: 42 M GCN, 80 F GCN Artificial refugia search: none			Torching: 75 GCN Artificial refugia: none	Torching: 20 M GCN, 22 F GCN Artificial refugia: none		Torching: 10 GCN M, 27 F GCN Artificial refugia search: none	
12	Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: none Artificial refugia search: none					Egg strips: none Torching: none Artificial refugia search: none			Egg strips: none Torching: 1 F GCN Artificial refugia search: none	Egg strips: none Torching: 2F GCN Artificial refugia search: none		Egg strips: none Torching: 1 F GCN Artificial refugia search: none	
13	Egg strips: none Torching: none	Egg strips: none Torching: none					Egg strips: none Torching: none			Egg strips: none Torching: none				

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
13a	Artificial refugia search: none	Artificial refugia search: none					Artificial refugia search: none			Artificial refugia search: none				
	Torching: none Artificial refugia search: none	Torching: none Artificial refugia search: none					Dry			Torching: none Artificial refugia search: none				
13b	Torching: none Artificial refugia search: none	Torching: none Artificial refugia search: none					Dry			Torching: none Artificial refugia search: none				
	Egg strips: none Torching: none Artificial refugia search: none						Egg strips: none Torching: none Artificial refugia			Egg strips: none Torching: none Artificial refugia		Egg strips: none Torching: none Artificial refugia		
14														

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
	Fish present						search: none			search: none		search: none		
16	Egg strips: none Torching: none Artificial refugia search: none						Egg strips: none Torching: none Artificial refugia search: none				Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: none Artificial refugia search: none		
							Torching: 5 M GCN, 5 F GCN, 1 SN Artificial refugia search: none			Torching: M GCN, 4 F GCN Artificial refugia search: none	Torching: 2 F GCN Artificial refugia search: none	Torching: 4 F GCN Artificial refugia search: none	Torching: 4 F GCN Artificial refugia search: none	
17	Egg strips: present Torching: 4 M GCN, 2 F GCN Artificial refugia search: none									Torching: 1 F GCN Artificial refugia	Torching: 4 M GCN, 1 F GCN	Torching: 1 M GCN Artificial refugia	Torching: 2M GCN, 2 F GCN Artificial	
18	Eggs strips: none Torching: 1	Egg strips: none Torching:					Egg strips: GCN eggs							

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
	M GCN Artificial refugia search: none	2 M GCN Artificial refugia search: none					present Torching: 1 M GCN, 3 F GCN Artificial refugia search: none			search: none	Artificial refugia search: none	search: none	refugia search: none	
E1		Not suitable												
E2		Not suitable												
E3	Egg strips: none Torching: 2 M GCN, 1 F GCN Artificial refugia search: none						Egg strips: none Torching: none Artificial refugia search: none			Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: none Artificial refugia search: none		Egg strips: none Torching: none Artificial refugia search: none
E9	Egg strips: none Torching:						Egg strips: none Torching:			Egg strips: none Torching:	Egg strips: none Torching:			

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
	none Artificial refugia search: none						none Artificial refugia search: none			none Artificial refugia search: none	none Artificial refugia search: none			
E10	Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: none Artificial refugia search: none					Egg strips: none Torching: none Artificial refugia search: none			Egg strips: none Torching: none Artificial refugia search: none				
E11	Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: 1 M GCN Artificial refugia search: none					Egg strips: none Torching: none Artificial refugia search: none			Egg strips: none Torching: 1 F GCN Artificial refugia search: none		Egg strips: none Torching: 1 M GCN, 1 F GCN Artificial refugia search: none		Egg strips: none Torching: none Artificial refugia search: none
E15a	Torching: 2 M GCN Artificial						Dry			Torching: none Artificial		Torching: none Artificial	Torching: 1 M GCN, 1 F	



Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
	refugia search: none									refugia search: none		refugia search: none	GCN Artificial refugia search: none	
E15b	Torching: 1F GCN Artificial refugia search: none						Dry			Torching: 2 M GCN Artificial refugia search: none		Torching: none Artificial refugia search: none	Dry	
D2		Not suitable												
D2a		Not suitable												
D3		Not suitable												
D4		Not suitable												
D5		Not suitable												
F1		Egg search: none Torching:					Egg search: none Torching:				Egg search: none Torching:		Egg search: none Torching:	

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
		none Artificial refugia search					none Artificial refugia search				none Artificial refugia search		none Artificial refugia search	
25a					Not suitable									
25b					Egg search: none Torching: none Bottles: none		Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: 1 F GCN					Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none
														Egg search: none Torching: none Bottles: none
26a					Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none						Egg search: none Torching: none Bottles: none	

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
26b					Egg search: none Torching: none Bottles: 2 F GCN	Egg search: none Torching: GCN, 1 F GCN Bottles: F GCN	Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: 1 F GCN					Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: 3 F GCN
C site														
1		Egg strips: none Torching: none Artificial refugia search: none	Egg strips: none Torching: 2 F GCN Artificial refugia search: none	Egg strips: GCN eggs present Torching: none			Torching: 1 F GCN Artificial refugia search: none		Torching: 2 F GCN Artificial refugia search: none				Torching: 1 F GCN Artificial refugia search: none	
E2		Egg strips: none Torching: none Artificial		Egg strips: none Torching: none Artificial			Egg strips: none Torching: none Artificial		Egg strips: none Torching: none Artificial					

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
		refugia		refugia			refugia		refugia					
E2a		Torching: none Artificial refugia		Torching: none Artificial refugia			Torching: none Artificial refugia		Torching: none Artificial refugia (fish seen)					
E2b		Torching: none Artificial refugia		Torching: none Artificial refugia			Torching: none Artificial refugia	Torching: none Artificial refugia						
E4		Egg strips: none Torching: none Artificial refugia: none	Egg strips: none Torching: none Artificial refugia: none				Egg strips: none Torching: none Artificial refugia		Egg strips: none Torching: none Artificial refugia					
E5	Egg strips: none Torching: 4M GCN 3 F GCN Artificial refugia:		Egg strips: none Torching: 9 M GCN, 5 F GCN Artificial				Egg strips: none Torching: 1 M GCN, 1 F GCN		Egg strips: none Torching: 4 M 8 F GCN Artificial		Egg strips: none Torching: 7 M GCN 1 F GCN		Egg strips: none Torching: 1 M GCN 2 F GCN Artificial	

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
	none		refugia: none				Artificial refugia: none		refugia: none		Artificial refugia: none		refugia: none	
E6	Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none				Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none					
E7		Not suitable							none					
E8		Egg strips: none Torching: 1 M GCN Artificial refugia: none	Egg strips: none Torching: 1 M GCN, 1 F GCN Artificial refugia: none				Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none	
E14		Not suitable												

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
E 16		Egg strips: none Torching: none Artificial refugia: none	Egg strips: none Torching: none Artificial refugia: none				Egg strips: none Torching: none Artificial refugia: none		Egg strips: none Torching: none Artificial refugia: none					
E 16 a		Torching: none Artificial refugia: none	Torching: none Artificial refugia: none				Torching: none Artificial refugia: none		Torching: none Artificial refugia: none					
D 10	Torching: none Artificial refugia: none	Torching: none Artificial refugia: none	Torching: none Artificial refugia: none	Torching: none Artificial refugia: none					Torching: none Artificial refugia: none					
D 11		Torching: none Artificial refugia: none	Torching: none Artificial refugia: none	Torching: none Artificial refugia: none					Torching: none Artificial refugia: none					
D 12		Torching: none Artificial		Torching: none Artificial				Torching: none Artificial	Torching: none Artificial					



Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
		refugia: none		refugia: none				refugia: none	refugia: none					
		Egg strips: none		Egg strips: none				Egg strips: none	Egg strips: none					
		Torching: none		Torching: none				Torching: none	Torching: none					
E13		Artificial refugia: none		Artificial refugia: none				Artificial refugia: none	Artificial refugia: none					
		Torching: none		Torching: none				Torching: none	Torching: none					
D13a		Artificial refugia: none		Artificial refugia: none				Artificial refugia: none	Artificial refugia: none					
		Torching: none		Torching: none				Torching: none	Torching: none					
D14		Artificial refugia: none		Artificial refugia: none				Artificial refugia: none	Artificial refugia: none					
		Not suitable												
D15		Not suitable												
D16		Not suitable												



Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
D17				Egg search: none Torching: 2 M GCN, 1 F GCN Refugia search: None				Egg search: none Torching: 5 M GCN, 3 F GCN Refugia search: none	Egg search: none Torching: none Refugia search: none	Egg search: none Torching: none Refugia search: none	Egg search: 1 M GCN Torching: none Refugia search: none		1 F GCN	
D18				Egg search: none Torching: none Refugia search: none				Egg search: none Torching: none Refugia search: none	n Egg search: none Torching: none Refugia search: none	Egg search: none Torching: none Refugia search: none				
60a				Egg search: none Torching: none Bottles: 1 M GCN, 5 F GCN	Egg search: none Torching: none Bottles: 1 M GCN, 5 F GCN	Egg search: None Torching: 2 F GCN Bottles: 1 M GCN, 1 F GCN			Egg search: None Torching: none Bottles: 2 M GCN, 1 F GCN	Egg search: none Torching: none Bottles: 1 M GCN, 2 F GCN		Egg search: None Torching: None Bottles: 1 M GCN	Egg search: none Torching: none Bottles: 1 M GCN	

Date of GCN surveys	04/04/2011	05/04/2011	06/04/2011	07/04/2011	18/04/2011	19/04/2011	04/05/2011	05/05/2011	10/05/2011	11/05/2011	17/05/2011	18/05/2011	19/05/2011	23/05/2011
60b					Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none			Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none				
60c					Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none			Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none				
60d									Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none		Egg search: none Torching: none Bottles: none	Egg search: none Torching: none Bottles: none	

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# Annex I

## Reptile Survey Results

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Table I1 and I2 details the weather conditions during each of the reptile surveys undertaken at Graven Hill and C Site.

**Table I1 Dates and weather conditions for Graven Hill reptile survey visits**

Survey No.	Date	Start time	End time	Site	Weather	Start temp. (°C)	End Temp. (°C)
1	17/06/10	07:15	12:00	D & E sites within Graven Hill	Fine dry and sunny.	16	16
2	22/06/10	07:30	11:15	D & E sites within Graven Hill	Fine dry and sunny.	16	17
3	05/07/10	08:00	10:15	D&E sites within Graven Hill	Fine dry and sunny.	16	17
4	14/07/10	08:30	11:00	E site within Graven Hill	Fine and sunny at times the ground was wet.	18	19
5	05/08/10	07:30	11:50	D & E sites within Graven Hill	Sunny with intermittent cloud cover.	15	18
6	17/08/10	14:00	15:45	E site within Graven Hill	Cloud 90%, sunny intervals, ground was wet after light rain. .	19	23
7	18/08/10	14:00	15:30	D site within Graven Hill	Cloud 80%, sunny intervals.	20	23
8	24/08/10	16:40	18:10	D & E sites within Graven Hill	Cloud 70%, warm, dry with sunny intervals.	20	19
9	31/08/10	16:00	17:20	D site within Graven Hill	Cloud 40% with a misty start , with sunny intervals and a clear afternoon	19	17
10	01/09/10	10:25	11:40	D site within Graven Hill	Cloud 40%, bright and clear.	18	20
11	09/09/10	10:50	12:30	D site within Graven Hill	Cloud 60%, a bright start, leading to increased cloud with sunny intervals	19	21
12	10/09/10	10:30	11:45	D site within Graven Hill	Cloud 90%, ground was wet after overnight rain, cool overcast start, leading to sunny intervals.	19	19
13	16/09/10	09:00	10:30	D site within Graven Hill	Cloud 90% cool, overcast start, leading to sunny intervals	15	18





Survey No.	Date	Start time	End time	Site	Weather	Start temp. (°C)	End Temp. (°C)
14	17/09/10	08:30:00	09:45:00	D site within Graven Hill	Cloud 20%, cool, bright, clear start, leading to increased cloud cover and sunny intervals.	12	16
15	21/09/10	10:10:00	11:40:00	D site within Graven Hill	Cloud 70%, a cool and misty start, leading to decreased cloud with sunny intervals	16	19
16	22/09/10	10:30:00	11:45:00	D site within Graven Hill	Cloud 40% a cool overcast start, leading to decreased cloud with sunny intervals.	19	21
17	30/09/10	10:50:00	11:55:00	D site within Graven Hill	Cloud 40% a cool and misty start, leading to a bright warm day with intermittent cloud	14	18
18	18/04/11	12:45:00	14:50:00	D site within Graven Hill	Cloud 60% with dry ground with sunny intervals	16	16
19	19/04/11	11:45:00	14:00:00	D site within Graven Hill	Cloud 50% sunny and dry	13	13
20	05/05/11	13.00	14.30	D site within Graven Hill	Cloud 80%	18	18
21	06/05/11	10.00	11.30	D site within Graven Hill	Cloud 100%	15	16
22	10/05/11	12.30	13.45	D site within Graven Hill	50% cloud cover and ground was wet	13	14
23	18/5/11	11.00	15.30	Graven Hill, hill top	80% cloud cover and ground was wet	13	14
24	19/5/11	11.00	15.00	Graven Hill, hill top	50% cloud cover and ground was dry	14	16
25	1/6/11	9.25	12.35	Graven Hill hill top	50% cloud cover and ground was wet	14	19
26	3/6/11	8.15	11.30	Graven Hill, hill top	90% cloud cover and ground was wet	13	20
27	6/6/11	11.30	14.25	Graven Hill, hill top	100% cloud cover and ground was wet	12	15
28	8/6/11	7.20	10.30	Graven Hill, hill top	90% cloud cover and ground was wet	11	15
29	9/6/11	11.00	15.00	Graven Hill, hill top	80% cloud cover and ground was wet	15	16
30	13/6/11	12.00	15.30	Graven Hill, hill top	70% cloud cover and ground was wet	18	20



Survey No.	Date	Start time	End time	Site	Weather	Start temp. (°C)	End Temp. (°C)
31	15/6/11	9.55	13.15	Graven Hill, hill top	100% cloud cover and ground was dry	16	18
32	17/6/11	8.25	11.45	Graven Hill, hill top	100% cloud cover and ground was wet	12	16
33	20/6/11	16.05	18.50	Graven Hill, hill top	100% cloud cover and ground was dry then wet after shower	20	15
34	21/6/11	11.40	17.10	Graven Hill, hill top	80% cloud cover and ground was wet	17	16
35	22/6/11	13.00	16.30	Graven Hill, hill top	50% cloud cover and ground was wet	20	19
36	03/08/2011	7.30	10.30	Graven Hill, hill top	80% cloud cover and ground was wet	17	24
37	15/08/2011	10.00	13.00	Graven Hill, hill top	30% cloud cover and ground was moist	17	20
38	16/08/2011	09.00	12.00	Graven Hill, hill top	Cloud 100%, ground dry	16	18
39	17/08/2011	10.00	13.00	Graven Hill, hill top	100% cloud cover and the ground was damp	17	20
40	19/08/2011	10.00	13.00	Graven Hill, hill top	30% cloud cover and the ground was damp	15	20
41	25/08/2011	10.00	13.00	Graven Hill, hill top	50% cloud cover and the ground was damp	16	20
42	31/08/2011	14.40	18.35	Graven Hill, hill top	100% cloud cover and the ground was dry	17	16

## C Site

**Table I2** Dates and weather conditions for C Site reptile survey visits

Survey No.	Date	Start time	End time	Site	Weather	Start temp. (°C)	End temp. (°C)
1	18/06/10	07:45	11:30	C	Fine dry and sunny		
2	23/06/10	07:30	09:00	C	Fine dry and sunny	16	17
3	06/07/10	07:45	10:15	C	Fine dry and sunny, slight breeze	14	19
4	04/08/10	07:30	09:15	C	Fine, a little wet in the long grass	15	17
5	18/08/10	10:30	12:00	C	overcast, cool start leading to sunny intervals	16.7	21.4



6	25/08/10	10:20	11:45	C	overcast, cool start, bright intervals	18	20
7	31/08/10	10:20	11:30	C	cool, misty start leading to clearer sunny intervals	18	21

Tables I3 and I4 provides a detailed breakdown of the reptile survey results recorded during each of the surveys.

**Table I3 Reptile survey results for Graven Hill**

Survey no.	Date	Site	Reptiles found and location
1	17/06/10	D & E site within Graven Hill	None found
2	22/06/10	D & E site within Graven Hill	None found
3	05/07/10	D & E site within Graven Hill	None found
4	14/07/10	E site within Graven Hill	None found
5	05/08/10	D & E site within Graven Hill	None found
6	17/08/10	E site within Graven Hill	None found
7	18/08/10	D site within Graven Hill	Refugia area D (tin, corner of car park): 1 x adult female common lizard (basking on top of tin)
8	24/08/10	D & E site within Graven Hill	Refugia G3: 1 x Adult Male Common lizard
9	31/08/10	D & E site within Graven Hill D	Site D: Refugia F2: 1 x adult male grass snake; Refugia F3: 1 x juvenile common lizard
10	01/09/10	D site within Graven Hill	Refugia F4: 1 x juvenile common lizard; Refugia G10: 1 x adult female common lizard; Refugia D2: 1 x adult male common lizard; Refugia A16: 1 x juvenile grass snake
11	09/09/10	D site within Graven Hill	Refugia G1: 1 x juvenile common lizard, Refugia G3: 1 x juvenile common lizard, Refugia C11: 1 x juvenile common lizard, Refugia D1: 1 x juvenile common lizard
12	10/09/10	D site within Graven Hill	Refugia F2: 2 x juvenile common lizards, Refugia F3: 1 x juvenile common lizard, Refugia G1: 1 x juvenile common lizard, Refugia G3: 1 x juvenile common lizard
13	16/09/10	D site within Graven Hill	Refugia G10: 1 x juvenile common lizard
14	17/09/10	D site within Graven Hill	None found
15	21/09/10	D site within Graven Hill	Refugia F2: 1 x adult female common lizard, Refugia F3: a x juvenile common lizard, Refugia G3: 1 x juvenile common lizard, Refugia G10: 1 x adult female common lizard, Refugia D12: 1 x adult female common lizard
16	22/09/10	D site within Graven Hill	None found
17	30/09/10	D site within Graven Hill	Refugia F5: 1 x adult female common lizard, Refugia G1: 2 x juvenile common lizards, Refugia G10: 3 x juvenile common lizards
18	18/04/11	D site within Graven Hill	None found



Survey no.	Date	Site	Reptiles found and location
19	19/04/11	D site within Graven Hill	Grass snake (sub adult).
20	05/05/11	D site within Graven Hill	Area A- 1 male common lizard, 1 grass snake, Area D- 1 female common lizard, 3 male common lizard
21	06/05/11	D site within Graven Hill	Area A- 1 common lizard, 1 grass snake, Area D- 1 common lizard, 1 grass snake
22	10/05/11	D site within Graven Hill	A 1 grass snake, A 1 female common lizard, G 1 male common lizard
23	18/05/11	Hill top within Graven Hill	None found
24	19/05/11	Hill top within Graven Hill	Location mat 21: 1 common lizard
25	01/06/11	Hill top within Graven Hill	Location mat 13: 1 juvenile grass snake
26	03/06/11	Hill top within Graven Hill	No reptiles
27	06/06/11	Hill top within Graven Hill	None found
28	08/06/11	Hill top within Graven Hill	Location G mat 80: 1 common lizard
29	09/06/11	Hill top within Graven Hill	None found
30	13/06/11	Hill top within Graven Hill	Location H mat *1: 1 common lizard, Location I mat 162: 1 common lizard
31	15/06/11	Hill top within Graven Hill	Location H mat *1: 1 common lizard, Location I mat 162: 1 common lizard
32	17/06/11	Hill top within Graven Hill	None found
33	20/06/11	Hill top within Graven Hill	Location H mat *1: 1 common lizard
34	21/06/11	Hill top within Graven Hill	Location N : 1 common lizard
35	22/06/11	Hill top within Graven Hill	Location H mat *1: 1 common lizard
36	03/08/2011	Hill top within Graven Hill	None found
37	15/08/2011	Hill top within Graven Hill	None found
38	16/08/2011	Hill top within Graven Hill	None found
39	17/08/2011	Hill top within Graven Hill	None found
40	19/08/2011	Hill top within Graven Hill	1 common lizard
41	25/08/2011	Hill top within Graven Hill	None found
42	31/08/2011	Hill top within Graven Hill	1 juvenile grass snake.



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**Table I4**      **Reptile survey results for C Site**

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<b>Survey no.</b>	<b>Date</b>	<b>Reptiles found and location</b>
1	18/6/10	None found
2	23/6/10	None found
3	06/07/10	None found
4	04/08/10	None found
5	18/08/10	None found
6	25/08/10	None found
7	31/08/10	None found

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## **Annex J**

# **Results of invertebrate surveys and definitions of rarity**

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## 9.4 DEFINITIONS OF INVERTEBRATE RARITY STATUSES

[This is taken from an internal English Nature publication. The references are cited in the EN document and can be provided on request].

### INVERTEBRATE STATUS CATEGORIES

For the purposes of evaluating invertebrate faunas and priorities for conservation action, invertebrates are attributed various rarity status categories, the meanings of which are given below. Criteria for the selection of species into Red Data Book categories one to five follow Shirt (1987), with minor modifications derived from Hyman & Parsons (1992) and Parsons (1993).

Categories RDBI (Indeterminate) and RDBK (Insufficiently Known) are based on the criteria used by Wells, Pyle and Collins (1983).

Criteria for the selection of Nationally Scarce species follow Eversham (1983) and Ball (1986).

#### Red Data Book Category 1. RDB1 - ENDANGERED

**Definition.** Taxa in danger of extinction in Great Britain and whose survival is unlikely if the causal factors continue operating.

Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so dramatically reduced that they are deemed to be in immediate danger of extinction. Also included are some taxa that are possibly extinct.

**Criteria.** Species, which are known or believed, to occur as only a single population within one 10km square of the National Grid.

Species, which only occur in habitats known to be especially vulnerable.

Species, which have shown a rapid and continuous decline over the last twenty years and are now estimated to exist in five or fewer 10km squares.

Species which are possibly extinct but have been recorded this century but which if rediscovered would need protection.

#### Red Data Book Category 2. RDB2 - VULNERABLE

**Definition.** Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating.

Included are taxa of which most or all of the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously depleted and whose ultimate security is not yet assured; and taxa with populations that are still abundant but are under threat from serious adverse factors throughout their range.



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Criteria. Species declining throughout their range.

Species in vulnerable habitats.

### **Red Data Book Category 3. RDB3 - RARE**

Definition. Taxa with small populations in Great Britain that are not at present Endangered or Vulnerable, but are at risk.

These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

Criteria. Species, which are estimated to exist in only 15 or fewer 10km, squares. This criterion may be relaxed where populations are likely to exist in over 15 10km squares but occupy small areas of especially vulnerable habitat.

### **Red Data Book Appendix. RDBApp. - EXTINCT**

Definition. Taxa which formerly had breeding populations in Great Britain but which are now believed to have died out. (Taxa not recorded since 1900)

### **Nationally Scarce (Notable) Species**

The term 'Nationally Scarce' was adopted and replaced the term 'Notable' during the compilation of the Guidelines for the Selection of Biological SSSIs. The two terms are thus interchangeable but 'Nationally Scarce' is preferable.

Ball (1986) discusses the allocation of species to Nationally Scarce categories:

*'The Invertebrate Site Register project includes the preparation of National Species Reviews which seek to identify and document uncommon species. The criteria used have been based directly on those evolved by botanists and two levels of 'National Notability' has been used. These are Notable A, for species known to occur in 30 or less 10km squares of the National Grid and Notable B for those known from 100 or less squares.*

*Although this system can be used directly with well-recorded groups like Dragonflies, Butterflies and Grasshoppers; when dealing with many other groups of insects, the level of recording is not sufficient to apply the criteria rigorously. A combination of three alternative approaches has been employed:*

- 1. The approximate number of squares in which a species may occur can be estimated by looking at the number it has been recorded from as a proportion of the total in which the whole group (e.g. its family) has been recorded.*  
*Coarser measurements such as the number of vice-counties in which a species has occurred can be used (7 or less for Notable A, 20 or less for Notable B).*
- 2. Experts can be asked to use their field experience to judge the status of species in their particular specialist group against others with a better-established status. By consulting as many people as possible and taking a consensus of their views, geographical and personal biases can be minimized.*



- 
3. *In some groups in which widespread interest and recording is a rather recent phenomenon, no attempt has yet been made to separate Notable A and Notable B species, and all Nationally Notable species are simply graded 'Notable'.*

**Nationally Scarce (Notable). N - NOTABLE**

Definition. Species, which are estimated to occur in 16 to 100 10km squares in Great Britain. The subdividing of this category into Nationally Scarce A and Nationally Scarce B has not been attempted for some species because of either the degree of recording that has been carried out in the group to which the species belongs, or because there is some other reason why it is not sensible to be so exact.

**Nationally Scarce (Notable) Category A. Na - NOTABLE A**

Definition. Taxa which do not fall within RDB categories but which are uncommon in Great Britain and thought to occur in 30 or fewer 10km squares of the National Grid or, for less well recorded groups, within 7 or fewer vice-counties.

**Nationally Scarce (Notable) Category B. Nb - NOTABLE B**

Definition. Taxa which do not fall within RDB categories but which are uncommon in Great Britain and thought to occur in between 31 and 100 10km squares of the National Grid or, for less well recorded groups, between 8 and 20 vice-counties.

**Regionally Scarce (Notable). Nr - NOTABLE**

Definition. Species which are considered to occur in 5 or less 10km squares in an area equivalent in size to a region of the old Nature Conservancy Council or larger, approximately one eighth the total area of England.

Such statuses were worked out during the compilation of the Invertebrate Site Registers. They cover various groups in Scotland, in northern England as a whole, in northeast and northwest England, in vice-county Yorkshire and in the east Midlands and East Anglia. They were worked out by local entomologists.

**LOCAL**

Definition. The term is not rigidly defined, but loosely means species confined to a particular habitat type (usually associated with better quality examples of that habitat), a particular geographic area, or species that are too widespread to warrant Nationally Scarce (Notable) status but are nevertheless infrequently encountered.

**COMMON**

Definition. Common or very widespread species, frequently recorded.





APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011														
SITE	E	E	E	E	E	E	E	E	A	A	A	A	A	D
SURVEY DATE	03/08/2010	03/08/2010	03/08/2010	03/08/2010	03/08/2010	06/08/2010	03/08/2010	03/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	05/08/2010
SAMPLE NO.	1	3	4	6	8	8	9	10	1	2	3	4	5	1
Cepaea nemoralis														
Monacha cantiana											1			
Araneus quadratus												1		
Enoplognatha ovata			1											
Misumena varia									1					1
Pisaura mirabilis			1				1							
Xysticus cristatus									1					
Dicranopalpus ramosus						2	1		1				2	
Leiobunum blackwalli														
Leiobunum rotundum						3		1						
Mitopus morio														
Paroligolophus meadei						1								
Phalangium opilio							1							
Eriophyes campestricola														
Eriophyes convolvens													1	
Eriophyes goniothorax typicus							1	1			1		1	
Eriophyes lateannulatus											1			
Eriophyes macrochelus														
Eriophyes macrorhynchus														
Eriophyes similis											1			
Armadillium vulgare														
Porcellio scaber														
Forficula auricularia						1	1	1	1			1		1
Chorthippus brunneus		3												
Chorthippus parallelus		2			2		2							
<b>Conocephalus discolor</b>														
Conocephalus dorsalis									1					2
Tetrix undulata														
Leptophyes punctatissima							1							
Meconema thalassinum								1						1
Chrysopa carnea							1	2						
Coniopteryx tineiformis														
Hemerobius lutescens						2								
Micromus variegatus						1								
Cloeon dipterum						1								
Calopteryx splendens								1						
Enallagma cyathigerum						1						1		10
Ischnura elegans														
Aeshna sp													1	
Sympetrum sanguineum														
Drepanosiphon platanoides											10+			
Graphopsocus cruciatus					1									
Aphrophora alnivora						2	1	5	1	1		3		6
Aphrophora costalis														
Cicadella viridis		1	1		1		1	1						1
Cixius nervosus									1					
Neophilaenis lineatus			1											
Philaenus spumarius		2	8		1	1	3	4	2	1	2	2		2

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011														
SITE	E	E	E	E	E	E	E	E	A	A	A	A	A	D
SURVEY DATE	03/08/2010	03/08/2010	03/08/2010	03/08/2010	03/08/2010	06/08/2010	03/08/2010	03/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	05/08/2010
SAMPLE NO.	1	3	4	6	8	8	9	10	1	2	3	4	5	1
<i>Aelia acuminata</i>										1				
<i>Anthocoris nemorum</i>						2		2						
<i>Calocoris sexguttatus</i>														
<i>Capsus ater</i>														
<i>Corizus hyoscami</i>												1		
<i>Deraeocoris lutescens</i>														
<i>Deraeocoris ruber</i>														
<i>Dolichonabis limbatus</i>								1						
<i>Dolycoris baccarum</i>									1			4	1	1
<i>Elasmostethus interstinctus</i>														
<i>Eurydema oleracea</i>									1			2		
<i>Himacerus mirmicoides</i>						1								2
<i>Leptopterna dolabrata</i>														
<i>Liocoris tripustulatus</i>														
<i>Megaloceraea recticornis</i>									1					
<i>Notostira elongata</i>			2				2		1	2		1		
<i>Palomena prasinum</i>														
<i>Pentatoma rufipes</i>														
<i>Physatocheila dumetorum</i>														
<i>Stenodema calcaratum</i>		1	1		6	1	8	4	5			2		2
<i>Stenodema laevigatum</i>													1	
<b>Stictopleurus abutilon</b>														
<i>Limnophilus auricula</i>						1								
<i>Adalia 2-punctata</i>									1					
<i>Calvia 14-guttata</i>														
<i>Chilocorus renipustulatus</i>									1					
<i>Coccinella 7-punctata</i>		1	3		1	1	1	1	1			5	1	1
<i>Exochomus 4-pustulatus</i>						1								
<i>Halyzia 16-guttata</i>														
<i>Harmonia axyridis</i>							1	1						
<b>Hippodamia variegata</b>								1						
<i>Propylea 14-punctata</i>			1		3	1	1	1	3	1				1
<i>Psyllobora 22-punctata</i>								1						
<i>Tytthaspis 16-punctata</i>			1							1				
<i>Lagria hirta</i>														
<i>Oedemera lurida</i>		2	7						1	4				2
<i>Oedemera nobilis</i>														
<i>Malachius bipustulatus</i>														
<i>Anthocomus rufus</i>									1					
<i>Axinotarsus marginalis</i>														
<i>Rhagonycha fulva</i>			1		1		1		1	1			1	
<i>Grammoptera ruficornis</i>														
<i>Stenocorus meridianus</i>														
<i>Strangalia maculata</i>														
<i>Apion frumentarium</i>												1		
<i>Oulema melanopa</i> s.l. (F)							1							
<i>Oulema melanopa</i> s.s. (M)														1
<i>Gonopteryx rhamni</i>														
<i>Pieris brassicae</i>								1						



[illegible]

[illegible]

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011														
SITE	E	E	E	E	E	E	E	E	A	A	A	A	A	D
SURVEY DATE	03/08/2010	03/08/2010	03/08/2010	03/08/2010	03/08/2010	06/08/2010	03/08/2010	03/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	05/08/2010
SAMPLE NO.	1	3	4	6	8	8	9	10	1	2	3	4	5	1
Rhaphium caliginosum														
Scellus notatus														1
Sciapus longulus														
Sybistroma obscurellum														
Teucophorus signatus														
Xanthochlorus ornatus											1			
Lonchoptera furcata		3	3		3		5	1		2				1
Lonchoptera lutea														
Baccha elongata														
Cheilosia bergenstammi								1						
Cheilosia illustrata									1					
Cheilosia impressa														6
Cheilosia pagana														
Cheilosia proxima			1									2		12
Chrysogaster cemiteriorum												1		7
Chrysogaster solstitialis			3											
Chrysotoxum bicinctum			2						1			2		3
Chrysotoxum verralli														
Dasysyrphus albostrigatus									2					2
Episyrphus balteatus		2	9		2	2	5	6	8	2	1	3	3	11
Eristalinus sepulchralis												1		
Eristalis arbustorum														
Eristalis interruptus														
Eristalis pertinax														
Eristalis tenax											1		1	
Eumerus funeralis														1
Eupeodes corollae			2				2	3		1				2
Eupeodes latifasciatus		1	2		3		4			1		4		1
Eupeodes luniger		1	2		2		3		1			4		4
Ferdinandea cuprea														
Helophilus pendulus			1				1	1						
Leucozona laternaria														
Leucozona lucorum											1			
Melangyna compositarum						1								
Melangyna umbellatarum								1						1
Melanostoma mellinum		16	36		3	2	4	2	8	10		2	1	22
Melanostoma scalare			1					1						2
Meliscaeva cinctella														
Neoascia podagrica		2												
Paragus haemorrhous										1		7		11
Pipiza bimaculata														
Pipizella viduata		2					1	3	4	2		7		16
<b>Pipizella virens</b>														
Platycheirus albimanus		3	9						1					
Platycheirus angustatus									1					
Platycheirus clypeatus		10	8		5		1	2	5	5		3		17
Platycheirus granditarsa					1									
Platycheirus occultus		3	3		3		4							
Platycheirus rosarum									1					

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011														
SITE	E	E	E	E	E	E	E	E	A	A	A	A	A	D
SURVEY DATE	03/08/2010	03/08/2010	03/08/2010	03/08/2010	03/08/2010	06/08/2010	03/08/2010	03/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	05/08/2010
SAMPLE NO.	1	3	4	6	8	8	9	10	1	2	3	4	5	1
Platycheirus scambus												1		
Platycheirus scutatus								1						
Rhingia campestris							1							
Ripponensia splendens		2	1									1		
Scaeva pyrastris			1						1	1		5	1	2
Sphaerophoria interrupta			2											
Sphaerophoria scripta		1	2		1				1	2		4		5
Sphaerophoria taeniata					1		1		5	1		3		1
Syritta pipiens		3	3		1		3		4	1		3	1	2
Syrphus ribesii		3	5			1	2	2	7	1		11	1	17
Syrphus vitripennis		5	1		2	3	1	3	9	1		5	1	18
Volucella pellucens													1	
Xanthogramma pedissequum														
Thecophora atra			1				1							1
Anomoia purmunda					1		1							
Campiglossa malaris		1								3				2
Cerajocera tussilaginis														
Chaetorellia jacaee														1
Chaetostomella cylindrica									1					
Ictericia westermanni		1	4						1	2				1
Sphenella marginata		1												
Tephritis cometa												1		
Tephritis formosa					3	1	4	3				1		
Tephritis hyoscamiyi														
Terellia ruficauda							2							
Urophora cardui		2					2	1	1		1	1		
Urophora stylata														
Xyphosia miliaria							1		1			1		1
Herina germinationis		1	5			1			2	1				
Herina longistylata		9	12		8		1		2	1		8		14
Seioptera vibrans														
Loxocera albiseta		1												
Palloptera anderssoni														
Palloptera campta														
Calliopum aeneum														
Calliopum simillimum						6							1	
Cnemacantha muscaria														
Homoneura thalhammeri														
Meiosimyza affinis								2						
Meiosimyza decipiens								1						
Meiosimyza platycephala														
Meiosimyza rorida						4					8		3	
Meiosimyza subfasciata									1					
Minettia fasciata			2			6	3	11	3	5		3	1	13
Minettia longipennis											2		2	
Minettia plumicornis												3		
Minettia tabidiventris								2					1	1

[illegible]

[illegible]

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011														
SITE	E	E	E	E	E	E	E	E	A	A	A	A	A	D
SURVEY DATE	03/08/2010	03/08/2010	03/08/2010	03/08/2010	03/08/2010	06/08/2010	03/08/2010	03/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	04/08/2010	05/08/2010
SAMPLE NO.	1	3	4	6	8	8	9	10	1	2	3	4	5	1
Crossocerus cetratus		1												
Crossocerus podagricus														
Ectemnius continuus								1						
Mellinus arvensis		1												
Myrmosa atra														
<b>Oxybelus argentatus</b>			2											
Passaloecus singularis														
Pemphredon inornata														
Pemphredon clypealis														
Spilomena troglodytes														
Spilomena sp								1						
Trypoxylon attenuatum														2
Trypoxylum clavicerum														
Trypoxylon figulus		1												
Hoplitis spinulosa														
Hylaeus annularis														
Hylaeus brevicornis														
Hylaeus communis														
Lasioglossum albipes		1			1		4			6		1		
Lasioglossum leucopus		8												2
Lasioglossum morio		8					1							18
<b>Nomada fucata</b>														
Nomada integra														
Bombus campestris														
Bombus hypnorum														
Bombus lapidarius			1		1				1			1		
Bombus lucorum														
<b>Bombus muscorum</b>								1						
Bombus pascuorum		1							1					
Bombus rupestris														
Bombus terrestris			1						1					



APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Cepaea nemoralis			1								1				
Monacha cantiana			1												
Araneus quadratus															
Enoplognatha ovata										1		1			
Misumena varia									1						
Pisaura mirabilis															
Xysticus cristatus															
Dicranopalpus ramosus			2				1				1				
Leiobunum blackwalli			1							3					
Leiobunum rotundum															
Mitopus morio										1					
Paroligolophus meadei															
Phalangium opilio			1												
Eriophyes campestricola			1	1						1		1			
Eriophyes convolvens											1				
Eriophyes goniothorax typicus		1		1						1					
Eriophyes lateannulatus			1												
Eriophyes macrochelus										1		1			
Eriophyes macrorhynchus										1		1			
Eriophyes similis			1	1						1		1			
Armadillium vulgare				1							1				
Porcellio scaber											1				
Forficula auricularia					1	3				1		1			
Chorthippus brunneus	1		1												
Chorthippus parallelus															
<b>Conocephalus discolor</b>	<b>1</b>														
Conocephalus dorsalis															
Tetrix undulata													1		
Leptophyes punctatissima			1	1			1		1		1				
Meconema thalassinum				1											
Chrysopa carnea			8			1	2		1		1	6			
Coniopteryx tineiformis							2								
Hemerobius lutescens															
Micromus variegatus								1							
Cloeon dipterum			1				2								
Calopteryx splendens															1
Enallagma cyathigerum			6								1				
Ischnura elegans	1														
Aeshna sp														1	
Sympetrum sanguineum		1										1	1		
Drepanosiphon platanoides											1				
Graphopsocus cruciatus							1								
Aphrophora alnivora			4			1	2		1	1		1			
Aphrophora costalis								1							
Cicadella viridis					1										
Cixius nervosus															
Neophilaenis lineatus					1										
Philaenus spumarius	1		3				2		1		2	1			

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
<i>Aelia acuminata</i>															
<i>Anthocoris nemorum</i>					1	1	5		2	3					
<i>Calocoris sexguttatus</i>										3	1				
<i>Capsus ater</i>															
<i>Corizus hyoscami</i>															
<i>Deraeocoris lutescens</i>							6								
<i>Deraeocoris ruber</i>											1				
<i>Dolichonabis limbatus</i>			3												
<i>Dolycoris baccarum</i>															
<i>Elasmostethus interstinctus</i>							1								
<i>Eurydema oleracea</i>						1									
<i>Himacerus mirmicoides</i>			1								1	2			
<i>Leptopterna dolabrata</i>									1			3			
<i>Liocoris tripustulatus</i>							1	4							
<i>Megaloceraea recticornis</i>									3						
<i>Notostira elongata</i>															
<i>Palomena prasinum</i>						1	1		1						
<i>Pentatoma rufipes</i>							1	1	1		1	2			
<i>Physatocheila dumetorum</i>						1									
<i>Stenodema calcaratum</i>					10	2									
<i>Stenodema laevigatum</i>															
<b><i>Stictopleurus abutilon</i></b>			1												
<i>Limnephilus auricula</i>											1				
<i>Adalia 2-punctata</i>								1							
<i>Calvia 14-guttata</i>							1								
<i>Chilocorus renipustulatus</i>															
<i>Coccinella 7-punctata</i>		1	1		1	1		1	1	1	1	1			
<i>Exochomus 4-pustulatus</i>															
<i>Halyzia 16-guttata</i>											1				
<i>Harmonia axyridis</i>					1	1	3		2	1					
<b><i>Hippodamia variegata</i></b>															
<i>Propylea 14-punctata</i>					4	1	1	1		1	1	1			
<i>Psyllobora 22-punctata</i>															
<i>Tytthaspis 16-punctata</i>															
<i>Lagria hirta</i>			1												
<i>Oedemera lurida</i>	1										1				
<i>Oedemera nobilis</i>									1			1			
<i>Malachius bipustulatus</i>									2						
<i>Anthocomus rufus</i>					4										
<i>Axinotarsus marginalis</i>									1		1				
<i>Rhagonycha fulva</i>	2								2	1		2			
<i>Grammoptera ruficornis</i>										2	2	1			
<i>Stenocorus meridianus</i>										1					
<i>Strangalia maculata</i>												5			
<i>Apion frumentarium</i>															
<i>Oulema melanopa</i> s.l. (F)															
<i>Oulema melanopa</i> s.s. (M)															
<i>Gonopteryx rhamni</i>											1				
<i>Pieris brassicae</i>			1			1			1			1	1		1

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011												
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APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Beris vallata											2	6			
Chloromyia formosa									3			1			
Chorisops tibialis															
Microchrysa flavicornis			1				1								
Nemotelus notatus										1					
Oxycera rara															
Pachygaster atra									4						
Pachygaster leachii							6								
Sargus bipunctatus			1												
Machimus atricapillus															
Chrysopilus asiliformis									9	1	1				
Rhagio lineola							1								
Rhagio tringarius							1								
Chrysops relictus															
Haematopota pluvialis										1	1	1			
Hybomitra bimaculata											1				
Crossopalpus humilis															
Crossopalpus nigrifella															
Drapetis assimilis															
Drapetis parilis															
Drapetis simulans											1				
Elaphropeza ephippiata						1	5	1			5	1			
Tachypeza arrogans										1					
Platypalpus minutus s.l. (F)						1	1								
Platypalpus minutus s.s. (M)						1									
Platypalpus pallidiventris	1				1	7					7	2			
Hybos culiciformis							1								
Hybos femoratus	1						1								
Leptopeza flavipes									1	2	1				
Ocydromia glabricula			2							9	4				
Coptophlebia albinervis									1						
Empis livida									1	1		1			
Empis lutea										3	5				
Empis nigripes									1						
Hilara thoracica										1					
Argyra leucocephala															
Campsicnemus curvipes										1	1				
Chrysotus blepharosceles											1				
Chrysotus gramineus			3				11		5		1	3			
Chrysotus neglectus							1			1	2				
Dolichopus festivus			1			3			4		1				
Dolichopus griseipennis					1						1				
Dolichopus latelimbatus							1								
Dolichopus trivialis															
Dolichopus unguulatus										2					
Dolichopus wahlbergi										1					
Hercostomus celer							1								
Micromorphus albipes															
Poecilobothrus nobilitatus							4		3						

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011												
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APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Platycheirus scambus															
Platycheirus scutatus									2			1			
Rhingia campestris									1						
Ripponensia splendens															
Scaeva pyrastris	2	1			1		1	2							
Sphaerophoria interrupta															
Sphaerophoria scripta			3								1				
Sphaerophoria taeniata								1							
Syrirta pipiens	1		1		1	1		1	3			1			
Syrphus ribesii	3				2	1	1	1							
Syrphus vitripennis	2		2			8	4	2			3				
Volucella pellucens									1	1		1			
Xanthogramma pedissequum											1				
Thecophora atra															
Anomoia purmunda															
Campiglossa malaris			2						1						
Cerajocera tussilaginis										5	11				
Chaetorellia jacaeeae															
Chaetostomella cylindrica															
Ictericia westermanni															
Sphenella marginata															
Tephritis cometa															
Tephritis formosa	1		1			1	1								
Tephritis hyoscamiyi					1										
Terellia ruficauda									2			3			
Urophora cardui				1		1									
Urophora stylata									1						
Xyphosia miliaria			3						7		1	4			
Herina germinationis	2						1								
Herina longistylata	6								1						
Seioptera vibrans							1								
Loxocera albiseta															
Palloptera anderssoni							3								
Palloptera campta							3								
Calliopum aeneum							1								
Calliopum simillimum											1				
Cnemocantha muscaria												1			
Homoneura thalhammeri							1								
Meiosimyza affinis															
Meiosimyza decipiens															
Meiosimyza platycephala			1								1				
Meiosimyza rorida			1					1		12	4				
Meiosimyza subfasciata									1						
Minettia fasciata			3			9	2		11		1				
Minettia longipennis			1						1	1	1				
Minettia plumicornis															
Minettia tabdiventris															
Pseudolycia pallidiventris s.l. (F)															
Sapromyza sordida						1									

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Sapromyzosoma quadricincta									1						
Sapromyzosoma quadripunctata	1														
Tricholauxania praeusta			1				5	2	1	6	4				
<b>Colobaea bifasciella</b>															
Coremacera marginata															
Hydromya dorsalis															
Limnia unguicornis															
Pherbellia cinerella				1											
Pherbellia dubia										1	1				
Pherbellia schoenherri	1														
Pherbina coryleti				1	1										
Renocera pallida															
Tetanura pallidiventrtris											1				
<b>Tetanocera punctifrons</b>								1							
Trypetoptera punctulata															
Geomyza balachowskyi/hackmanni (F)				1											
Geomyza nartshukae															
Opomyza florum			2	8	2		1	8	19	3	2				
Opomyza germinationis			3	3		1	2	1	13	4					
Opomyza petrei				1											
Sepsis cynipsea				1	1	1		1							
Sepsis fulgens															
Sepsis orthocnemis	1														
Anthomyza gracilis	1														
Paranthomyza nitida											1				
Cerodontha denticornis	1										1				
Cerodontha fulvipes							1								
Phytomyza cirsii		1								1		1			
Phytomyza ilicis		1										1			
Phytomyza lappae										1					
Phytomyza pastinacae/sphondylii										1					
Cryptonevra flavitarsis				2	1										
Dicraeus vagans								1							
Elachiptera cornuta				1			1								
Elachiptera megaspis															
Lasiosina cinctipes															
Oscinella maura															
Oscinimorpha minutissima	1														
Rhopalopterum anthracina															
Thaumatomyia notata									5		2	1			
<b>Trachysiphonella scutellata</b>															
Tricimba cincta					3										
Asteia concinna															
Clusiodes albimana										1					
<b>Leiomyza birkheadi</b>							2								
Meonura flavifacies									1						
<b>Meonura minutissima</b>											1				
Meonura vagans										1	1				
Neuroctena anilis							2				1				



APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Scaptomyza pallida											1				
Disomyza incurva															
Philygria vitipennis											1				
Psilopa nana	1														
Scathophaga stercorea			1					2	1	1	1	1			
Heteronychia depressifrons										1					
Sarcophaga carnaria			1						1						
Sarcophaga subvicina			1						1						
Sarcophaga variegata															
Melanomya nana							1	2			3				
Nyctia halterata									3	4					
Hylemyia nigrimana			1		1				6	7	2				
Hylemyia variata									1			1			
Coenosia agromyzina															
Coenosia mollicula									1						
Coenosia tigrina	1														
Graphomya maculata															
Haematobia irritans															
Hydrotaea irritans															
Lispe tentaculata															
Morellia aenescens	2														
Morellia simplex															
Musca autumnalis	2		1			1			1						
Muscina levida											1				
Polietes lardarius										1					
Pseudocoenosia solitaria															
Piezura graminicola															
Eriothrrix rufomaculatus			5			1		2			3	6			
<b>Mintho rufiventris</b>															
Ocytata pallipes	1								1						
<b>Phasia barbifrons</b>															
Phasia pusilla	1														
Phasia obesa															
Solieria sp						1									
Tachina fera		1	1		1					1					
Diplolepis rosae															
Barylypa insidiator											1				
Gravenhorstia cerinops															
Lissonota lineolaris										1					
Ophion mocsaryi															
Gasteruption jaculator											1				
Formica fusca															
Lasius flavus	1			1		1									
Lasius niger s.s.															
Anoplius nigerrimus					1										
Vespula germanica															
Vespula vulgaris									2		1	2			
Ancistrocerus gazella								2							
<b>Symmorphus connexus</b>									1						

APPENDIX 2: TERRESTRIAL INVERTEBRATES RECORDED FROM MOD SITES AT BICESTER: 2010-2011															
SITE	D	D	D	D	C	C	C	C	GravenHill	GravenHill	GravenHill	GravenHill	Site C	Site D	Site E
SURVEY DATE	05/08/2010	05/08/2010	05/08/2010	05/08/2010	05/08/2010	06/08/2010	06/08/2010	06/08/2010	07/07/2011	07/07/2011	07/07/2011	09/07/2011	10/07/2011	09/07/2011	09/07/2011
SAMPLE NO.	4	5	6	8	2	3	4	5	1	2	3	4			
Crossocerus cetratus															
Crossocerus podagricus											3				
Ectemnius continuus										1	2				
Mellinus arvensis															
Myrmosa atra			1												
<b>Oxybelus argentatus</b>															
Passaloecus singularis						1									
Pemphredon inornata					1										
Pemphredon clypealis											2				
Spilomena troglodytes										1					
Spilomena sp						1									
Trypoxylon attenuatum			1												
Trypoxylum clavicerum										1					
Trypoxylon figulus															
Hoplitis spinulosa	1		1												
Hylaeus annularis															
Hylaeus brevicornis															
Hylaeus communis										2	7	4			
Lasioglossum albipes															
Lasioglossum leucopus															
Lasioglossum morio	4		6												
<b>Nomada fucata</b>											1				
Nomada integra											1				
Bombus campestris											1				
Bombus hypnorum												1			
Bombus lapidarius	1								2			1			
Bombus lucorum											1				
<b>Bombus muscorum</b>															
Bombus pascuorum	1	1							3			1			
Bombus rupestris									4						
Bombus terrestris		1						3	1		1	1			

# Appendix K

## Water Resources Baseline Information

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## K.1 Water Quality Information

**Table K.6 Water Quality for Langford Brook/River Ray**

Reach	U/S NGR	D/S NGR	Reach Length (km)	Chemistry	Biology	Nitrates	Phosphates
Stratton Audley to Bicester STW (Langford Brook)	461600 225190	457800 221100	6.6	C	B	5	3
Bicester STW to River Ray (Langford Brook)	457800 221100	457000 216780	5.4	C	B	6	5
River Ray - Grendon Underwood STW to Langford Brook	468000 221100	457000 216780	16.8	D	-	3	5
River Ray - Langford Brook to Gallos Brook	457000 216780	453000 213890	6.6	D	B	5	5

**Key**

Chemistry and biology grades classification: A (very good), B (good), C (fairly good), D (fair), E (poor), F (bad)

Nutrient Grade classification: 1 (Very low), 2 (low), 3 (Moderately low), 4 (Moderate), 5 (High), 6 (Very high)

U/S NGR – upstream national grid reference, D/S NGR – downstream national grid reference

Source: The Environment Agency, 2008

**Table K.7 Abstractions located near Graven Hill**

Distance from site (m)	Direction	NGR	Licence Number	Type of Abstraction
<b>Groundwater Abstraction Licences</b>				
407	NW	457400, 220800	28/39/14/0295	General Farming & Domestic
515	W	457200, 220600	28/39/14/0329	General Farming & Domestic
626	NE	460200, 221100	28/39/14/0035	General Farming & Domestic
647	NE	460300, 221000	28/39/14/0035	General Farming & Domestic
667	NW	457100, 220800	28/39/14/0300	Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services
683	NW	457990, 222000	28/39/14/0349	Pollution Remediation



Distance from site (m)	Direction	NGR	Licence Number	Type of Abstraction
703	NE	460300, 221100	28/39/14/0035	General Farming & Domestic
<b>Surface Water Abstraction Licences</b>				
317	SW	457560, 219140	28/39/14/0350	Make-Up Or Top Up Water
<b>Potable Water Abstractions</b>				
667	NW	457100, 220800	28/39/14/0300	Groundwater for: Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services
1912	S	457800, 217950	28/39/14/0318	Groundwater for: Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services
1915	S	457820, 217940	28/39/14/0318	Groundwater for: Drinking, Cooking, Sanitary, Washing, (Small Garden) - Commercial/Industrial/Public Services

Source: GroundSure EnviroInsight reports (Emapsite, 2011)

**Table K.8 Licensed Discharge Consents near Graven Hill**

Distance from site	Direction	NGR	Permit Number	Type of Discharge
0	n/a	458000, 220500	TEMP.1422	To the Langford Brook - Sewage Discharges - Pumping Station - Water Company
0	n/a	458800, 219700	TEMP.1421	To the Langford Brook - Sewage Discharges - Pumping Station - Water Company
0	n/a	458600, 221100	TEMP.1423	To the Langford Brook - Sewage Discharges - Pumping Station - Water Company
0	n/a	459550, 220850	CATM.2741	To the River Ray - Trade Discharges - Site Drainage
0	n/a	459600, 220600	TEMP.1433	To the River Ray - Sewage Discharges - Pumping Station - Water Company
0	n/a	459300, 219700	TEMP.1420	To the River Ray - Sewage Discharges - Pumping Station - Water Company
190	E	459850, 220460	CATM.3354	To the Langford Brook - Sewage Discharges - Final/treated (Not water company)
192	NW	457980, 221270	CAWM.0807	To the Langford Brook - Sewage Discharges - Sewer Storm Overflow - Water company
207	NW	458800, 221500	TEMP.1419	To the Langford Brook - Sewage Discharges - Pumping Station - Water Company
252	NW	457860, 221200	CNTD.0023	To the Langford Brook - Sewage Discharges - Final/treated Effluent - Water Company



Distance from site	Direction	NGR	Permit Number	Type of Discharge
263	N	458300, 221650	CNTW.0555	To the Langford Brook - Miscellaneous Discharges - Surface Water
265	SW	457561, 220315	CAWM.1163	To the Langford Brook - Sewage Discharges - Final/treated Effluent - Not Water Company
265	SW	457561, 220315	CAWM.1163	To the Langford Brook - Sewage Discharges - Final/treated Effluent - Not Water Company
272	NW	457850, 221220	CNTD.0023	To the Langford Brook - Sewage Discharges - Final/treated Effluent - Water Company
289	SW	457548, 220294	CAWM.1163	To the Gagle Brook - Sewage Discharges - Final/treated (Effluent - Not Water Company

Source: GroundSure EnviroInsight reports (Emapsite, 2011)

**Table K.9 Licensed Discharge Consents near C Site**

Distance from site	Direction	NGR	Permit Number	Type of Discharge
0	n/a	460900, 217700	TEMP.1431	To the River Ray - Sewage Discharges - Pumping Station - Water Company
0	n/a	460600, 217000	TEMP.1430	To the River Ray - Sewage Discharges - Pumping Station - Water Company
0	n/a	460900, 217900	TEMP.1432	To the River Ray - Sewage Discharges - Pumping Station - Water Company
39	NE	461100, 217900	TEMP.0345	To the River Ray - Sewage Discharges - Pumping Station - Water Company
76	NE	461200, 217800	TEMP.1417	To the River Ray - Sewage Discharges - Pumping Station - Water Company

Source: GroundSure EnviroInsight reports (Emapsite, 2011)

**Table K.5 WFD classification of the reaches of watercourse adjacent to the Graven Hill**

River	Ecological status	Reason	At risk from
Oxfordshire Ray (upstream of A41 to Cherwell)	Poor	Fish	Ammonia; Agricultural sources of phosphorous; Phosphorous (from other sources); Combined source sanitary nutrients; & Diffuse Pollution.
Langford Brook (Bicester to Ray including Gagle Brook)	Moderate	General physico-chemical status	Ammonia; Phosphorous (from other sources); Combined source sanitary nutrients.





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River	Ecological status	Reason	At risk from
Langford Brook (Source to downstream of A41)	Moderate	General physico-chemical status	Ammonia; Combined source sanitary nutrients. (EA).

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## K.2 Flood Risk Assessments (Graven Hill and C Site)







**Defence  
Infrastructure  
Organisation**

Future Defence Storage and Redistribution Programme,  
Redevelopment of MOD Bicester  
C Site: Flood Risk Assessment

Appendix to ES  
September 2011



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**Report for**

Ms Ellen O'Grady  
Senior Planning Officer  
Professional and Technical Services  
DIO Operations North  
Kingston Road  
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**Approved by**

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# Defence Infrastructure Organisation

## Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester

C Site: Flood Risk Assessment  
(Appendix K to BIC/OPA/DOC/10)

September 2011

AMEC Environment & Infrastructure  
UK Limited



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# 1. Introduction

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## 1.1 Purpose of this Report

- 1.1.1 This Flood Risk Assessment (FRA) has been prepared to support the proposed re-development of C Site at MOD Bicester, which is owned and operated by the Ministry of Defence (MOD). The site is located south-east of Bicester, and west of the village of Upper Arncott. The site is centred at grid reference SP 6088 1769. The site is located south of the A41 which connects Bicester and Aylesbury to the east.
- 1.1.2 This is a Level 2 FRA which has been prepared in line with requirements of Planning Policy Statement 25: Development and Flood Risk (DCLG, 2010).

## 1.2 Data Collation and Consultation

- 1.2.1 A flood risk data request was made to the Environment Agency on 18 June 2010, and information was received on 02 and 04 August 2010.
- 1.2.2 A site visit was made on 13 July 2010 by Anne Kemlo, accompanied by a member of MOD staff, Peter Brunton, from the Estate Management Team.
- 1.2.3 Information has been taken from the following reports:
- Bicester Establishment Development Plan Report, February 2008, Defence Infrastructure Organisation (DIO)<sup>1</sup>;
  - Emap Site Reports, dated January 2010, issued in support of the Land Quality Assessment work completed by AMEC Environment and Infrastructure Ltd. (AMEC E&I)<sup>2</sup> in relation to the site; and
  - Preliminary Design and Access Statement for Graven Hill, AMEC for the DIO, March 2010.

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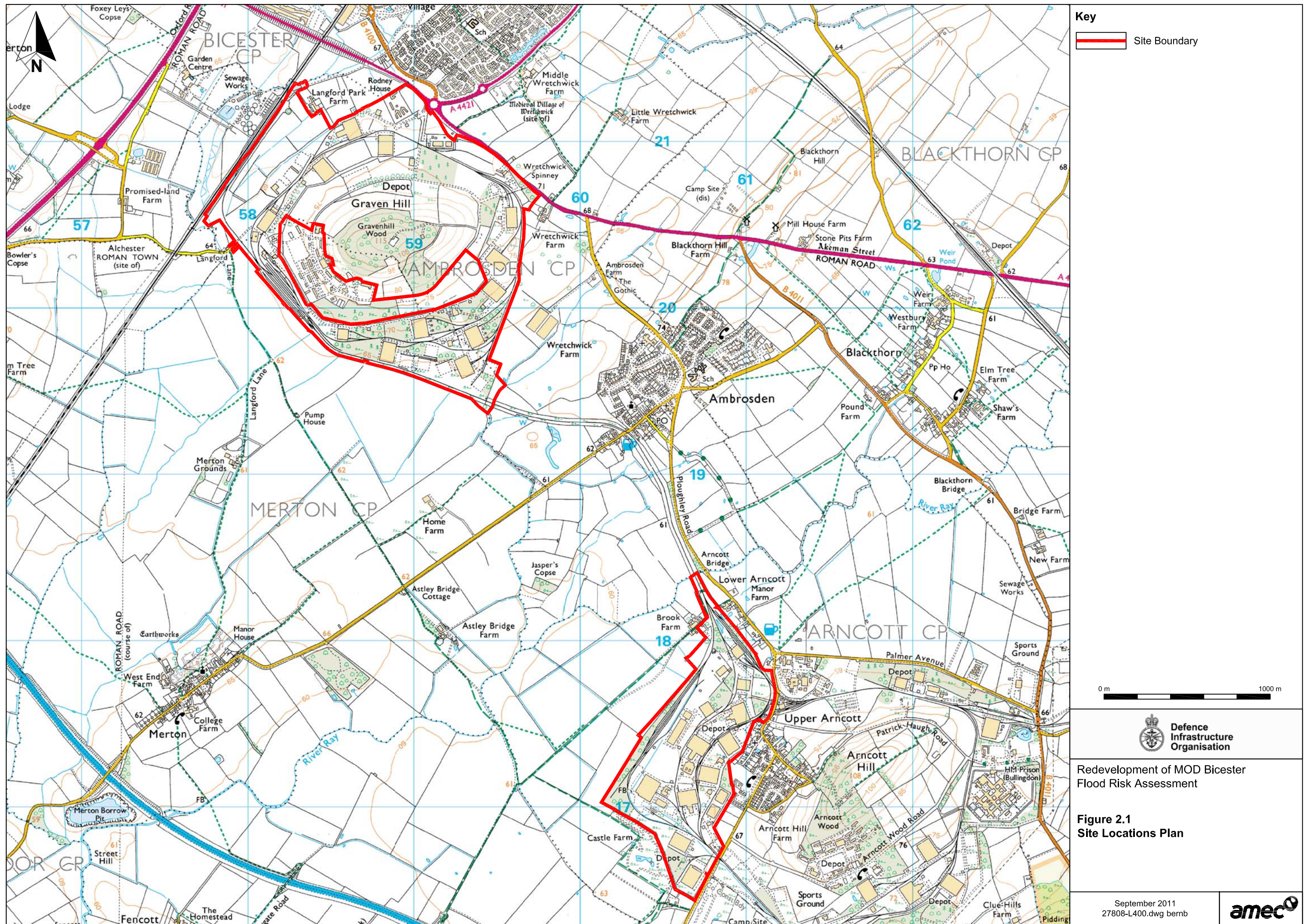
<sup>1</sup> The Defence Infrastructure Organisation was formed on 1 April 2011 when the former Defence Estates was brought together with other property and infrastructure functions in the MOD to form a single organisation.

<sup>2</sup> Following its acquisition by AMEC, Entec UK Ltd was integrated into AMEC Environment and Infrastructure in July 2011, all references are now to AMEC E&I.











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## 2. Description of Site

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### 2.1 Site Location

- 2.1.1 MOD Bicester is located to the south-east of Bicester and approximately 30km north-east of Oxford. It comprises a number of sites which are located within a distance of about 11km of each other, south of the A41 and north of the M40. The sites that are being considered for development C Site, at Arncott and Graven Hill, west of Ambrosden. The location of the sites is shown in Figure 2.1.
- 2.1.2 MOD Bicester was established during the period 1939-45 and its primary purpose is for storage and maintenance of equipment and supplies, which are then transported from the site for use in the UK and abroad.
- 2.1.3 This report considers C site, which covers 83.3 hectares (ha). In terms of the drainage proposals, the total area of the site affected by the redevelopment proposals is 35.3ha.

### 2.2 Existing Site Layout

- 2.2.1 C Site is bounded to the east by Arncott village and to the north (beyond Ploughley Road), south and west by open agricultural land. Within the site there are a number of buildings, many of which are large storage sheds; other buildings include offices and workshops, as well as those used for amenity purposes. There are large areas of hardstanding usually adjacent to the buildings on site which are used for vehicle parking, equipment storage and maintenance. A large proportion of the site comprises grassed areas, with some areas of woodland and other vegetation.
- 2.2.2 There are also several MOD railway tracks which route through the site in a north-south alignment and connect the site with D and E Sites to the north-west and other MOD sites to the east.

#### Details of Existing Site Layout

- 2.2.3 Buildings and other land use footprint information has been provided by the DIO and is summarised in Table 2.1, overpage.
- 2.2.4 The existing drainage catchments have been delineated Catchment A in the north and Catchment B in the centre of C Site. These are shown later at Figure 4.2. The remainder of C Site, (corresponding to Catchment C) will remain unchanged.
- 2.2.5 Overall the future drainage system will provide a net betterment, as the captured run-off will be subject to current standards for surface water run-off attenuation, and eventual discharge to the same receiving ditchcourse.



**Table 2.1 Areas of Building Footprint and Hardstanding**

<b>Asset Type</b>	<b>Total Area</b>
<b>Catchment A - Existing buildings and hardstanding plus access roads, Total Impermeable Area</b>	<b>2.3ha</b>
<b>Catchment B - Existing buildings and hardstanding plus access roads, Total Impermeable Area:</b>	<b>9.3ha</b>
<b>Existing Impermeable in Area to south of Catchment B</b>	<b>0.6ha*</b>
<b>Total Area (catchment A + B)</b>	<b>35.3ha</b>
<b>Catchment A Area</b>	<b>13.5ha</b>
<b>Catchment B Area</b>	<b>21.8ha</b>
<b>Area south of catchment B</b>	<b>1.9ha</b>
Catchment A: % impermeable	17%
Catchment B: % impermeable	43%
Area South of Catchment B: % impermeable	32%
<b>Total area of site (red line boundary), includes area that will not be redeveloped</b>	<b>83.3ha</b>

\*limited development here at present, but will include new car parking areas in future.

- 2.2.6 Therefore, approximately 11.6ha (33%) of the section of C Site to be redeveloped (catchments A and B) currently comprises impermeable surfaces. Impermeable areas affect the volume and rate of surface water running off the site (see Chapter 5).

## 2.3 Hydrology and Surface Water Features

- 2.3.1 C Site is located within the River Ray catchment. The River Ray flows in a westerly direction and is located (at its closest point) adjacent to northern most part of C Site. South of the Site, two small watercourses flow southwards to a series of drainage channels on Otmoor. More detail is provided on Figure 4.2.
- 2.3.2 Average annual rainfall (1961-90) for the Ray catchment at SP 601 172 is 622mm/year<sup>3</sup> lower than the average rainfall for England of 828mm/year (1961-1990, Met Office).
- 2.3.3 The site visit identified that there are a number of surface drainage channels and ditches at the site, as well as man made open water ponds; as shown on OS 1:25k mapping.

<sup>3</sup> Flood Estimation Handbook CDRom V3.





## 2.4 Topography

- 2.4.1 C Site is characterised by flat topography, which varies between 60m and 70m AOD. To the north of the site land slopes gently downwards to reach 60m AOD. To the south-east of the site land rises more steeply to the top of Arncott Hill at a height of 108m AOD, approximately 500m east of the site.
- 2.4.2 A detailed topographic survey was carried out in July 2010 (see Appendix C). Figure 4.2 shows the general elevations on and around the site, and indicates the site is elevated above the extents of EA Flood Zones 3 and 2. This indicates that the highest part of the site is on the eastern side in the centre of the site, at elevation of up to 69m AOD. The site slopes from here to the north-west and south-west, to an elevation of 61m AOD in the north part of the site and 63m AOD along the south-west boundary of the site.

## 2.5 Hydrogeology and Soils

- 2.5.1 C Site overlies Middle Oxford Clay (southern part of the site) and Lower Oxford Clay (northern part of the site)<sup>4</sup>. This implies impermeable ground conditions, but areas of made ground will have different characteristics.
- 2.5.2 Soils at the site have a Soil Index<sup>5</sup> of 0.45 - clayey, or loamy over clayey soils, with an impermeable layer at shallow depth.
- 2.5.3 Online soils information<sup>6</sup> shows C Site is on slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.
- 2.5.4 The September 2010 Phase 2 Land Quality Assessment (LQA) states with regards to C Site hydrogeology that:

*“The anticipated geological sequence consists of alluvium deposits (clay, silt, sand and gravel) overlying solid geology consisting of the Stewartby Member (mudstone) and Peterborough Member (mudstone) of the Oxford Clay Formation.*

*The majority of Site C is underlain by Unproductive Strata (Negligibly Permeable).*

*As the site is mainly underlain by an Unproductive Strata (Oxford Clay Formation) which would be considered to present a low sensitivity with a moderate sensitivity assessed for the Secondary (Minor) Aquifer (Alluvium) situated in the north part of Site A. The site is not within a SPZ”.*

<sup>4</sup> British Geological Survey England and Wales mapping Sheet 237, Thame, Solid and Drift Edition

<sup>5</sup> Flood Studies Report (FSR) Winter Rainfall Acceptance Potential (WRAP) map

<sup>6</sup> LANDIS soils database, see: <http://www.landis.org.uk/services/soilscapes.cfm>



- 2.5.5 Site investigations (trial pits) undertaken in August 2010 confirmed the clay geology beneath the site.
- 2.5.6 Environment Agency (EA) groundwater mapping shows that no part of the site is underlain by aquifers of either primary or secondary significance, and no part of the site is within a groundwater source protection zone.
- 2.5.7 An infiltration test was carried out using the BRE-365 method on the 24 August 2010, and found no drop in the trial pit water level over 225 minutes. Infiltration rates are therefore negligible at the site.

## 2.6 Water Quality and Sensitivity of Downstream Watercourses

- 2.6.1 Water quality monitoring is carried out on the River Ray between Grendon Underwood and the confluence with the Langford Brook. The latest data from the EA is for 2009 and is shown below in Table 2.2.

**Table 2.2 Water Quality for River Ray between Grendon Underwood and the Langford Brook, 2009**

Reach	U/S NGR	D/S NGR	Reach Length (km)	Chemistry	Biology	Nitrates	Phosphates
River Ray - Grendon Underwood STW to Langford Brook	468000, 221100	457000, 216780	16.8	D	N/A	3	5

Key:

Chemistry and biology grades classification: A (very good), B (good), C (fairly good), D (fair), E (poor), F (bad)

Nutrient Grade classification: 1 (Very low), 2 (low), 3 (Moderately low), 4 (Moderate), 5 (High), 6 (Very high)

- 2.6.2 The chemical and biological water quality in the River Ray at this location is fair to good, with moderately low levels of nitrate, and high levels of phosphate which may be affected by the STW, although high levels of nutrients may occur naturally and are not necessarily bad for the environment. The water quality and sensitivity of receiving watercourses to pollution will influence the level of surface water treatment required as part of the proposed development.

## 2.7 Proposed Development

- 2.7.1 The proposed development on C Site consists of a large storage building with associated car parking and landscaping. There is a proposed open vehicle storage area to the north of the building and a new Road Rail Transfer Area to the west. The Site will remain in use by the MOD.



2.7.2 The master plan is provided in Appendix A and comprises the following areas:

- main building footprint;
- road-rail transfer area;
- carpark, roads and hardstanding;
- existing retained buildings; and
- landscaping.

2.7.3 Based on the proposed master plan, a total future impermeable area of 66% of the site (23.3ha) has been calculated. The current total impermeable area within Catchments A and B (the redevelopment area) is 13.6ha (38%). Therefore, the redevelopment will result in an increase in the impermeable area at the site of 9.7ha compared to the existing development - a 74% increase, as shown in Table 2.3, below.

**Table 2.3 Comparison of Impermeable Areas - Existing and Proposed Developments**

Scenario	Area (ha)	%
Estimate impermeable area - current development	11.6	33%
Estimate impermeable area - proposed development	23.3	66%
Total site area	35.3	-
Percentage change in impermeable area	$(100/33)*66 = 200\% - \text{i.e. a 100\% increase}$	

2.7.4 Detailed calculations have been undertaken, and are shown in Chapter 5 (Managing Surface Water Run-off).





## 3. Planning Context

### 3.1 Planning Policy Statement 25

- 3.1.1 Planning Policy Statement 25 (PPS 25): Development and Flood Risk (DCLG, 2010), and supporting Practice Guide (DCLG, 2009) guide the design of flood risk management measures in new developments. A FRA is required for all sites of 1ha or more regardless of which Flood Risk Zones a site is located in. C site is greater than 1ha in area so a FRA is required.
- 3.1.2 The FRA must assess the risk to the site from all sources of flooding including surface water run-off, and demonstrate that the development will be made safe from flood risk, without increasing flood risk elsewhere in the catchment, and where possible reducing overall flood risk.

#### Sequential Test

- 3.1.3 PPS 25 sets out requirements for flood risk to be considered at a strategic planning stage by regional and local planning authorities, for example in the development of Regional and Strategic Flood Risk Assessments. A sequential approach must be applied when allocating sites for future development, such that future development is steered away from areas of flood risk, i.e. from Flood Zone 3 and 2 to Flood Zone 1, where possible. Only where there are no appropriate sites for development in Zone 1 should sites in Zone 2 be considered and sites in Zone 3 should only be considered if there are no appropriate sites available in Zone 2.
- 3.1.4 Regional and local planning authorities are required to produce Strategic Flood Risk Assessments (SFRA), which should apply the Sequential Test at a regional level and help to inform Local Development Frameworks in allocating land for development types. A Level 1 SFRA for Cherwell and West Oxfordshire was published by Cherwell District Council (CDC), West Oxfordshire District Council (WODC) and Oxfordshire County Council (OCC) in April 2009.
- 3.1.5 The proposed development site is within Flood Zone 1 with the exception of a very small area of land close to the northern end of the site and adjacent to the River Ray. However, as shown in the masterplan (Appendix A) no development will take place within this area. Therefore, the proposals are in line with the requirements of the PPS25 Sequential approach.

#### Exception Test

- 3.1.6 PPS 25 sets out which land use types are compatible in different Flood Risk Zones, and the instances in which an Exception Test must be passed in the FRA (see Table 3.1).



**Table 3.1 Flood Risk Vulnerability from PPS 25: Development and Flood Risk**

<b>Flood Risk Vulnerability Classification</b>	<b>Essential Infrastructure</b>	<b>Water Compatible</b>	<b>Highly Vulnerable</b>	<b>More Vulnerable</b>	<b>Less Vulnerable</b>
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	x	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	x	x	x

Key:

✓ Development is appropriate

x Development should not be permitted

Source: Table D.3 of PPS25

- 3.1.7 The proposed development is in Zone 1 with the exception of a very small area of land at the northern boundary of the site adjacent to the River Ray which is in Flood Zone 3. No development will take place within Zone 3 or 2. The development which will take place in Zone 1 will be employment uses which are classified as 'Less Vulnerable' (from Table D.2 of PPS 25) and is therefore development appropriate to Zone 1. Therefore, no Exception Test is required.

## 3.2 Strategic Flood Risk Assessment

- 3.2.1 The SFRA<sup>7</sup> notes that: *"In general, the fluvial flood risk across the study area is high with large extensive floodplains being a substantial feature of the rural landscape. Urban locations within the study area [i.e. the Cherwell District Area] that are potentially affected by fluvial flooding in Cherwell include Bicester [amongst others]."*
- 3.2.2 The mapping included in the SFRA<sup>8</sup> indicates that at Arncott there is a surface watercourse on the north-west boundary of C Site, which is not shown on 1:50 Ordnance Survey (OS) mapping. There are two further small water bodies marked as part of the Flood Zone 2 marked within the Site boundary. Flood Zone 3 does extend onto a small area of the site at the north boundary.

<sup>7</sup> Cherwell District Council, West Oxfordshire District Council and Oxfordshire County Council, April 2009, The Cherwell and West Oxfordshire Level 1 Strategic Flood Risk Assessment (SFRA).

<sup>8</sup> SFRA (Appendix B) (<http://www.cherwell.gov.uk/index.cfm?articleid=4356>) (map at page B-16).



- 3.2.3 It should be noted that where no modelled climate change levels were available from the EA the SFRA used the Flood Zone 2 boundary as a proxy for Flood Zone 3 with climate change, until more detailed data becomes available.

### Sewer Flooding

- 3.2.4 Instances of sewer flooding reported to CDC as a consequence of the 2007 summer flooding<sup>9</sup> indicates that no historical flooding records or information for the site. The SFRA<sup>10</sup> also indicates there are no incidents of total sewer flooding at the Site.

### Surface Water Flooding

- 3.2.5 The SFRA states that the settlement of Arncott, amongst others, is located on low lying impervious ground where there may be limited infiltration and therefore the Site may be at increased risk of flooding from overland flow.

### Groundwater Flooding

- 3.2.6 The underlying geology of the area is predominantly clay, which is impermeable and therefore no significant groundwater is expected at the site. There are no recorded incidents of groundwater flooding<sup>11</sup> for C Site.

### Sustainable Drainage

- 3.2.7 Attenuation type systems<sup>12</sup> will be the most appropriate form of Sustainable Drainage Systems (SUDS) in the area to the south-east of Bicester, due to impermeable ground conditions (as indicated by the negligible infiltration rates recorded during soakaway testing).

## 3.3 Cherwell District Council Local Plan

- 3.3.1 The Draft Core Strategy<sup>13</sup> includes the following policy (A.62) on sustainable flood risk management.

*We do not consider that a local policy on sustainable flood risk management is necessary as it would duplicate the guidance in Planning Policy Statement 25: Development and Flood Risk (PPS25), its recently updated practice guidance, and South East Plan policy NRM4: Sustainable Flood Risk Management. The Council will manage and reduce flood risk*

<sup>9</sup> SFRA, Appendix B

<sup>10</sup> SFRA, Figure A-3, Thames Water DG5 Total Sewer Flooding

<sup>11</sup> SFRA, Appendices B, C and D

<sup>12</sup> SFRA, Mapping in Appendix I

<sup>13</sup> Cherwell District Council, February 2010, Draft Core Strategy





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*in the district through using a sequential approach; locating vulnerable developments in areas at lower risk of flooding. We will only permit development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding. In addition to safeguarding floodplains from development, we will seek opportunities to restore natural river flows and floodplains, increasing their amenity and biodiversity value.*

3.3.2 The following policy on SUDS is included:

*Policy SD 6                      Sustainable Drainage Systems (SUDS)*

*The use of sustainable drainage systems (SUDS) for the management of surface water run off generated by developments will be encouraged. Site specific Flood Risk Assessments should be used to determine how SUDS can be used on particular sites and to design appropriate systems.*



## 4. Flood Risk

### 4.1 Fluvial Flood Risk

- 4.1.1 Figure 4.1 indicates that most of C Site is in Flood Zone 1 i.e. outside Flood Risk Zone 3 and 2<sup>14</sup>, with the exception of a very small area at the north-western most part of the site adjacent to the River Ray at Arncott Bridge. However, comparison of the flood extent with the detailed topographic survey indicates that the area marked as Flood Zone 3 and 2 is actually the existing railway embankment and bridge over the River Ray. This is elevated above the river and flood levels, and will not be altered by the development proposals, remaining as it is at present. Therefore the site is not at risk from the 0.1% annual exceedance probability (AEP) flood, (i.e. the flood event which is expected to occur every 1,000 years on average).
- 4.1.2 The EA has confirmed that there are no modelled flood levels available for the River Ray at this location. The impact of climate change over the lifetime of the proposed development may increase the extent of the 1% AEP flood in the area to the north of the site. However, this increase in extent would be limited. The reason for this is that Flood Zone 2, since it reflects the 0.1% AEP event, can be used as a surrogate for the less severe 1% AEP (Flood Zone 3) + climate change extent, and this does not extend much further onto the site. The site topographic survey indicates that most of the site is elevated well above 61.4m AOD, i.e. above the levels on the River Ray floodplain (below 61m AOD).
- 4.1.3 In addition to main river flood risk there are a number of drainage channels or ditches on the site which might pose a minor flood risk locally.
- 4.1.4 Figure 4.2 shows the site and local hydrology in more detail. The location of the vast majority of the site in Flood Zone 1 can be clearly seen.
- 4.1.5 Finished Floor Levels will be constructed at least 300mm above the design flood level. This has been based on the 0.1% AEP extent, as this effectively incorporates an allowance for climate change. By comparing the edge of Flood Zone 2 (0.1% AEP flood event), with the topographic survey, this level has been estimated at 61.40m AOD. Allowing a further freeboard of 300mm this gives a minimum Finished Floor Level of 61.70m AOD. This is well below the c. 64m floor level assumed for the master plan.
- 4.1.6 Based on the final masterplan and outline FRA it may be necessary to undertake further assessment of the flood risk posed to the redevelopment by the drainage ditch network on site. This would potentially include hydraulic modelling<sup>15</sup>. The scope of

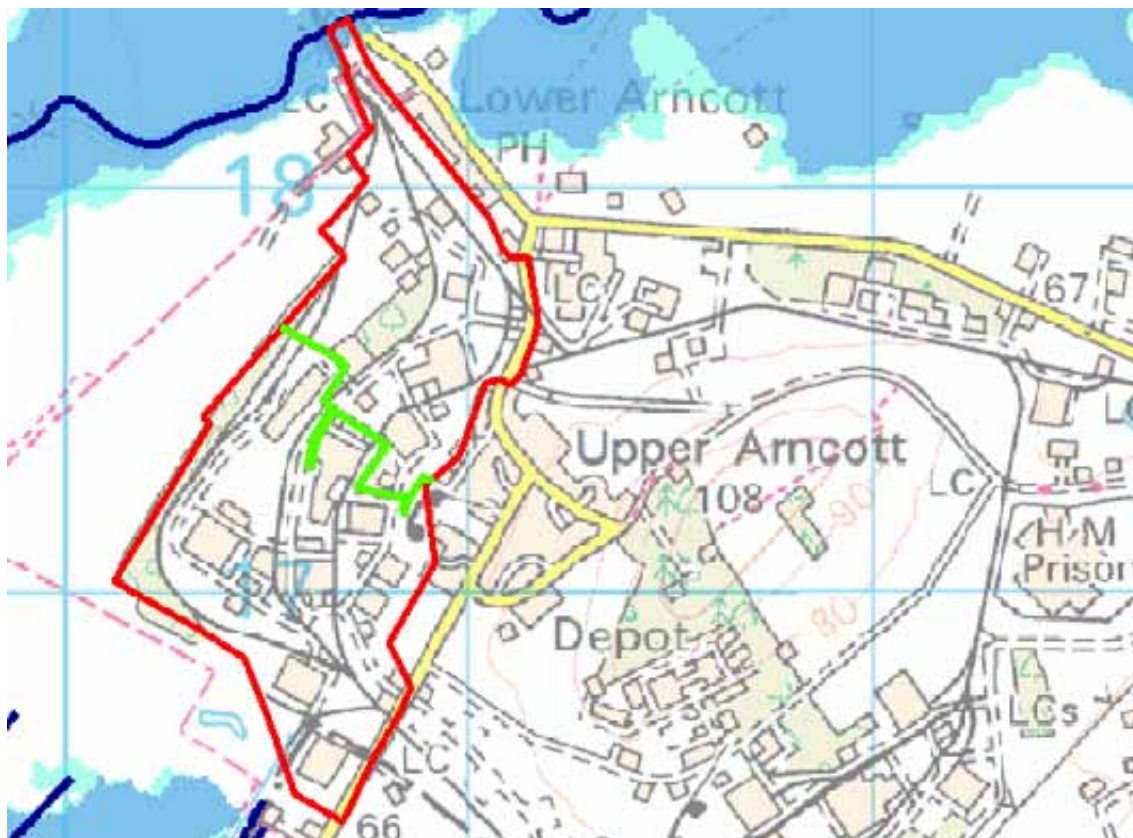
<sup>14</sup> Environment Agency Indicative flood risk mapping ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)).

<sup>15</sup> Telecon. Ian Norris, Thames West Development and Flood Risk Team, 02 August 2010.



any further work would need to be confirmed with the EA following submission of the FRA.

**Figure 4.1 Environment Agency Flood Risk Mapping C Site**



**Notes:**

Dark blue shading: flooding from rivers or the sea, without defences.

Pale blue shading: flooding from the extreme flood.

Red line is the planning application boundary.

Green line: area to north of green line is actually being redeveloped and is therefore assessed in this FRA.

Dark blue line: designated as Main River by the Environment Agency.

## 4.2 Groundwater Flood Risk

- 4.2.1 The geology at the site is impermeable which indicates that groundwater flooding is unlikely. The SFRA reported no incidences of historic groundwater flooding, and the EA did not report any in their response to AMEC's flood data request. Infiltration tests undertaken in August 2010 indicated that infiltration rates were negligible, suggesting that the soil/geology is not capable of holding/transmitting significant quantities of water, and therefore posing a risk via groundwater flooding.

## **4.3 Flood Risk from Sewers and Infrastructure**

- 4.3.1 The SFRA did not identify any specific flood risk issues from sewers or infrastructure. Ordnance Survey mapping does not show any water infrastructure (e.g. canals, reservoir, etc.) in the vicinity of the site which might pose a flood risk in the case of failure.
- 4.3.2 The site's existing surface water drainage system suffers from a lack of connectivity between the on site ditches and no systematic provision of conveyance capacity (i.e. pipes draining contributing catchment areas route water to the ditches faster than it can drain out). As a result several low-lying areas of the site experience temporary surface water flooding when the present surface water drainage ditches cannot convey surface water run-off to the adjacent receiving watercourses fast enough.
- 4.3.3 The site's future drainage system will be designed to modern standards (see chapter 5), and as such will be designed to appropriately convey and attenuate the expected volumes of site run-off. The drainage system phasing should be designed, such that new infrastructure is in place when new development commences in each area of the site. The condition of the existing drainage system, and flood risk posed by this is therefore not considered a constraint.

## **4.4 Flood Risk from Surface Water Run-off**

- 4.4.1 Surface water run-off from rainfall can create flood risk when flows do not infiltrate to ground and drainage systems are inundated. In new developments where impermeable areas are increased the potential for infiltration and attenuation is reduced and run-off rates from the site will increase if no mitigation is included in the development design. This can cause increased flooding in the catchment downstream, and/or the drainage system to which the flow discharges.
- 4.4.2 PPS 25 requires that surface run off from rainfall must be managed so that flow rates from the new development are no more than, and ideally less than, those from the current site, with an appropriate allowance for climate change. This ensures that water discharged from site does not contribute to increased flood risk in the surrounding areas.

## **4.5 Flood Risk from Surface Water Run-on**

- 4.5.1 Surface water run-on can occur when rainfall flows onto the site from higher ground adjacent to it, and this may have the potential to cause flood risk on site. In cases where surface water is managed on surrounding land, e.g. by adequate drainage including agricultural and road drainage as appropriate, then the risk of run-on is reduced. Topography and the underlying geology can both influence the likelihood of water running onto a site.
- 4.5.2 At C Site, land elevations rise to the east, towards Upper Arncott so potentially run-on would enter the site from land to the east. There is a roadway bordering the site at this location and the village of Upper Arncott is situated between the western slope of

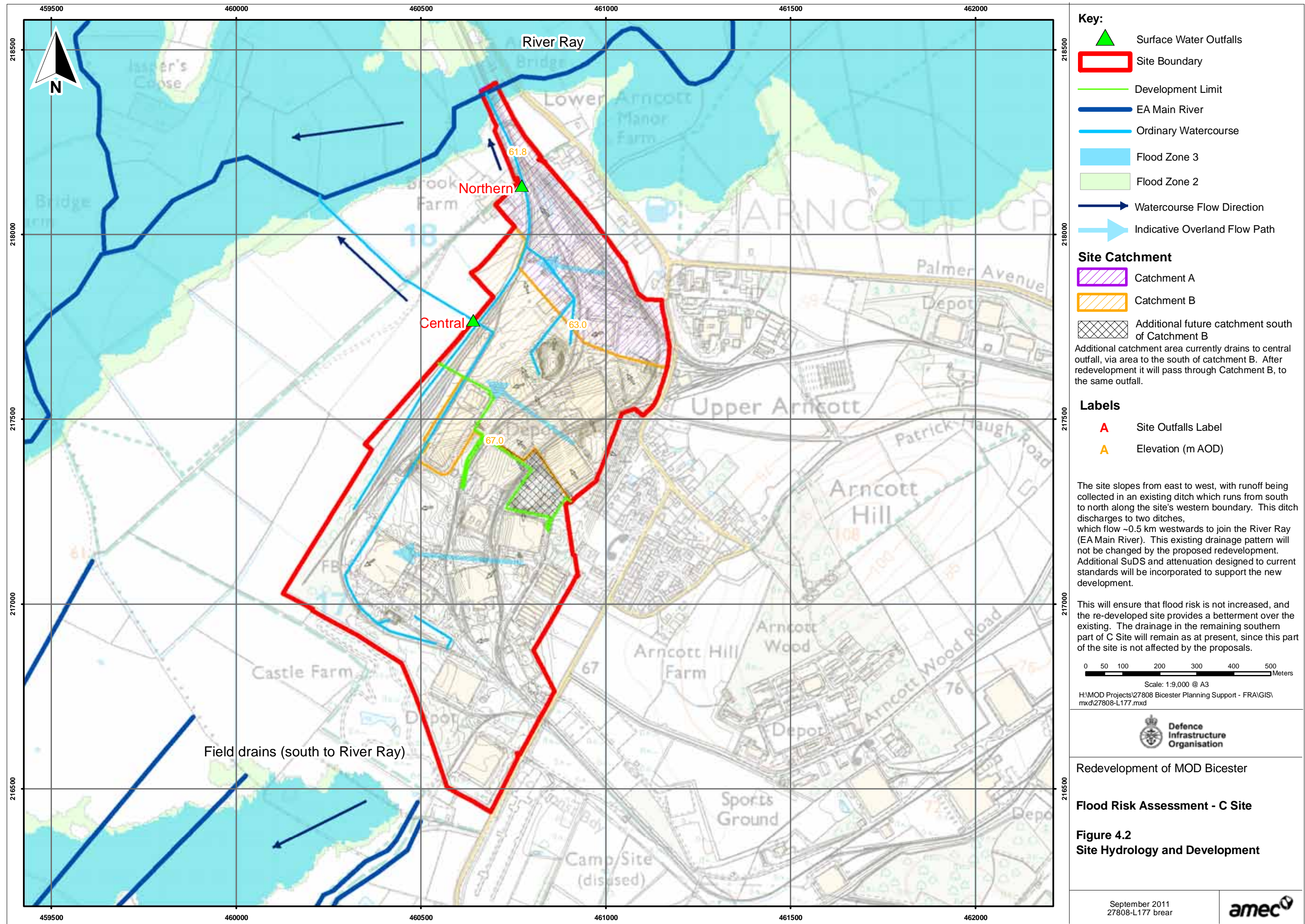


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Arcott Hill and the site. Given the small size of the Arnott Hill catchment draining towards the site (0.5km<sup>2</sup>), and the roads/properties between the hill and the site, the generation of significant quantities of surface water run-off, and their transmission to the site is considered unlikely.









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## 5. Managing Surface Water Run-off - Sustainable Drainage

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### 5.1 PPS 25 Requirements

- 5.1.1 PPS 25 requires that surface water run-off from a new development is managed so that flows from the development do not exceed existing rates, for events up to and including the 100 year rainfall event, with an appropriate allowance for climate change over the lifetime of the development. Since the site is currently developed this would mean that peak flow from the site will have to be no greater than the current brownfield run-off rates.
- 5.1.2 PPS 25 requires that all new development incorporates SUDS measures to manage surface water run-off from the site. Guidance to PPS 25 (updated in December 2009) states that SUDs should seek to manage drainage close to source, storing water for later use and discharging to ground if appropriate as a preferred option,. Alternatively drainage should be discharged to watercourses and only to drains or sewers as a least preferred option.
- 5.1.3 SUDS seek to mimic natural drainage processes to slow flow rates, thereby reducing flood risk downstream. They can also provide water quality improvements where water is stored for example in ponds, or filtered through natural media, for example grassed swales. A third benefit of using SUDS is providing wildlife and landscape enhancements, for example with reedbeds or ponds, and grassed areas for example swales, detention basins etc.

### 5.2 EA and OCC Requirements

- 5.2.1 Consultation with the EA<sup>16</sup> has confirmed that design run-off rates should be no more than existing rates from the site, and should ideally be limited to greenfield rates. However, the EA recognise that this may not be feasible in all situations, and will look for 'betterment' with discharge rates reduced as far as possible towards greenfield. The calculations have therefore allowed for a 20% reduction below the existing brownfield run-off levels. This 20% reduction reflects the figure agreed in consultation with the EA and OCC.

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<sup>16</sup> Telephone call with Ian Norris, Flood Risk and Development Control, Thames West Area Environment Agency (02 August 2010).





## 5.3 Construction Industry Research and Information Association Guidance

5.3.1 Construction Industry Research and Information Association (CIRIA) SUDS guidance (CIRIA, 2007) recommends that SUDS are managed using a management train approach which involves the following:

- source control: run-off is managed close to its source with for example rainwater harvesting, green roofs and soakaways if ground conditions allow, and pervious pavements;
- site control: flow from several local catchments is routed via swales or french drains towards linked infiltration or surface water storage components, e.g. pond or detention basin; and
- regional control: run-off management systems from several separate sites are integrated.

5.3.2 The CIRIA guide gives indicative number of SUDS components required for water quality improvement before flow is discharged from the site, depending on where the water is drained from and where it is being drained to. This is indicated below in Table 5.1. So for C Site, assuming the receiving watercourse is of medium sensitivity to water quality impacts, up to three components would be required for the development which will comprise employment uses and external areas of storage, loading/unloading and parking.

**Table 5.1 SUDS Water Quality Treatment Requirements**

	Receiving Water Sensitivity			
		Low	Medium	High
Run-off Catchment Characteristic	Roofs only	1	1	1
	Residential roads, parking areas, commercial zones	2	2	3
	Refuse collection/industrial areas/loading bays/lorry parks/highways	3	3	4

Source: CIRIA SUDS Manual Table 5.6

## 5.4 Determining Attenuation Requirements

5.4.1 The catchment flows have been in WinDES® using the Modified Rational Method. Rainfall values were generated using the Flood Studies Report method. Further



details are provided in the Drainage Strategy, document ref. BIC/OPA/DOC/17 (AMEC, August 2011).

- 5.4.2 For QBAR (mean annual flood) it has been recommended that a rate of 5 l/s/ha is used for existing run-off rates, in line with OCC requirements. Future run-off rates will be attenuated to the equivalent of 80% of this.
- 5.4.3 The key parameters for both methods are summarised in Table 5.2 along with the input data and flow results for each catchment area.

**Table 5.2 Existing Site Run-off Rates**

Parameter	Catchment A	Catchment B	Total
Total site area	13.5ha	21.8ha	35.3ha
Impermeable area	2.3ha (17%)	9.3ha (43%)	11.6ha (33%)
SAAR (mm)	622	622	-
Soil Index (from Wallingford WRAP Map)	0.45	0.45	-
FSR Region	6	6	-
<b>Flow Results</b>			
QBAR	69 l/s or approx 5 l/s/ha	162 l/s or approx 7 l/s/ha	-
1:1yr Flow	59 l/s or approx 4 l/s/ha	138 l/s or approx 6 l/s/ha	197 l/s
1:30yr Flow	146 l/s or approx 11 l/s/ha	312 l/s or approx 14 l/s/ha	458 l/s
1:100yr Flow	192 l/s or approx 14 l/s/ha	385 l/s or approx 18 l/s/ha	577 l/s

### Attenuation Requirements

- 5.4.4 The proposed development will result in an increase in impermeable areas, as discussed in Section 2.7. Impermeable areas at the existing site (hardstanding, buildings, etc.) amount to an estimated 11.6ha (33% impermeable), whereas the proposed development is estimated to include 23.3ha of impermeable surface (66% impermeable). Therefore, additional storage will be required to attenuate run-off, a) from the increase in impermeable area, and b) due to the need to provide additional attenuation to reduce overall run-off rates by 20%.
- 5.4.5 It is assumed that the proposed development would have a lifetime of 60 years and a climate change factor of 20% on rainfall (as specified in Appendix B of PPS 25).
- 5.4.6 WinDES® was used to estimate attenuation volumes at the development site in order to provide the required flow attenuation rates, with an allowance for climate change. This calculation determines the total storage requirement for the site. Results are



shown in Table 5.3 below. Catchment A has been expanded to include a large part of existing Catchment B, will be unchanged.

**Table 5.3 Storage Required to ensure Run-off is Attenuated to 20% Below Existing Rates**

Parameter	Catchment A	Catchment B
Return Period (yrs)	1 in 1, 1 in 30 and 1 in 100 + 20% climate change	
Profile Type	Summer and Winter	
Storm Duration (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440	
M5-60 (mm)	20.0	
Ratio R	0.4	
Volumetric Run-off Coefficient	0.75 (summer) and 0.85 (winter)	
Percentage Impermeable	0.66 (i.e. 66%)	

**Notes**

1) Descriptions for each variable is as follows:

- a. Return Period - The return period is used when a rainfall profile is being used in lieu of a statistically generated rainfall profile. It allows the mean annual flood values to be calculated in relation to the expected frequency.
- b. Storm Duration - Typical values used to represent common storm profiles.
- c. M5-60 - Rainfall depth equal to a 1 in 5yr return period lasting 60 minutes.
- d. Ratio R - Ratio of the rainfall depths from the 60 minute storm to the 2 day storm.
- e. Volumetric Run-off - Proportion of catchment rainfall that enters the system.

Percentage Impermeable - Percentage of total area entered into model as being impermeable

	Flow Results		
	Catchment A (Future Area: 26.7ha)	Catchment B (Future Area: 8.6ha)	Total Future Flows
1:1yr Flow	146 l/s (4 l/s/ha)	43 l/s (6 l/s/ha)	189 l/s <b>(96% of existing)</b>
1:30yr Flow	253 l/s (7 l/s/ha)	95 l/s (14 l/s/ha)	348 l/s <b>(76% of existing)</b>
1:100yr Flow with 20% CC allowance	275 l/s (10 l/s/ha)	120 l/s (18 l/s/ha)	395 l/s <b>(68% of existing)</b>
<b>Attenuation Storage Required</b>			
Required Storage (m <sup>3</sup> )	2,500m <sup>3</sup>	0,500m <sup>3</sup>	3,000m <sup>3</sup>

5.4.7 The calculations show that in order to attenuate surface water run-off from the future development to around 80% of existing run-off rates a volume of 3,000m<sup>3</sup> would be required. The average reduction in run-off over the three return periods specified in Table 5.3 being 80%. Further details of the assessment can be found in the Drainage Strategy document (as referred earlier).



## 5.5 SUDS Strategy

- 5.5.1 SUDS make use of surface based components which are incorporated into natural landscaping, such as attenuation ponds and swales, filter strips and permeable paving. Soakaways and other infiltration techniques may also be appropriate if hydrogeological conditions permit. SUDS aim to mimic natural drainage patterns at the site, slowing flow rates close to source, and allowing water quality improvements as run-off flows through filtering media.
- 5.5.2 Source control measures could include rainwater harvesting. Soakaways are not considered appropriate as an infiltration test carried out (to the BRE-365 standard) on site (24 August 2010), measured no infiltration over the trial pit observation period, indicating that infiltration is not a viable SUDS option on this site.
- 5.5.3 The site-wide drainage scheme will comprise a series of roadside grass swales or ditches which allow water to drain down towards the lowest elevation in the site. Flow will be slowed down as it passes through these swales, which will incorporate check dams to further slow flow rates. Water quality will also be improved as a result of standing time and natural filtration processes. There may be a number of attenuation components in each sub-catchment, such as ponds or grassed depressions (detention basins) which will temporarily store water and further attenuate flow rates as the water flows off-site. Attenuation ponds will be constructed which will potentially collect drainage from several sub-catchments. Ponds can provide a permanently wet feature which contributes to the ecology and green infrastructure of the site and surrounding landscape. Alternatively they can operate so that they only store water during and after extreme rainfall events.
- 5.5.4 The indicative SUDS layout is shown on the masterplan in Appendix A.
- 5.5.5 More detailed design of the SUDS measures will be developed during the reserved matters stage of the planning application when more detail about the development layout will be available, in order to determine more accurate volumes of attenuation. The exact final volume of attenuation required across the site will be submitted for agreement with the EA at the detailed planning stage.
- 5.5.6 PPS 25 presents a hierarchy of discharge options. Infiltration is the preferred option, but has been shown to be unfeasible at this site. Therefore, the second option, (attenuated) discharge to a nearby watercourse is to be pursued for this site.
- 5.5.7 Any run-off from the site will discharge to the River Ray located to the north of the site, via existing ditch courses.
- 5.5.8 Sustainable drainage has been considered at an early stage in the masterplanning process, so that as far as practicable drainage measures can be incorporated into the development design alongside roads in a generally down gradient direction. Space within the development will be allocated for swales, ponds and other surface drainage features. Arrangements for the long term management of the drainage system will be developed as part of the Section 106 agreement for the outlined planning application. At this stage it is assumed that a private management company would adopt the SUDS.





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## 6. Summary and Conclusions

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- 6.1.1 This FRA has identified that the vast majority of C Site lies within Flood Zone 1 and that fluvial flood risk from main rivers to the area of proposed development is minimal. There is a small area within Flood Zone 3 (1% AEP) associated with the River Ray and located adjacent to the north-western tip of the Site. There is no development planned for this part of the development site.
- 6.1.2 The drainage strategy will employ a modern system that will control surface water flows, resulting in an improvement over existing conditions. As such, downstream flooding issues on the River Ray will not be exacerbated. While the principles of the drainage strategy have been agreed with the EA, the drainage system design will need further refinement at detailed design stage.
- 6.1.3 Geology and soils across the site are impermeable and therefore it is unlikely that there is a risk of groundwater flooding.
- 6.1.4 No water infrastructure (such as canals or reservoirs) has been identified close to the site which would result in flood risk if failure of this infrastructure occurred.
- 6.1.5 Finished Floor Levels will be constructed at least 300mm above the design flood level. This has been based on the 0.1% AEP extent, as this effectively incorporates an allowance for climate change. By comparing the edge of Flood Zone 2 (0.1% AEP flood event), with the topographic survey, this level has been estimated at 61.40m AOD. Allowing a further freeboard of 300mm this gives a minimum Finished Floor Level of 61.70m AOD. This is well below the c. 64m floor level assumed for the master plan.
- 6.1.6 Surface water run-off will be managed through the implementation of SUDS which are likely to include swales, attenuation ponds, and detention basins, in a number of sub-catchments throughout the development allowing run-off to discharge from the site at the northern boundary, into the River Ray. A discharge consent from the EA will be required.
- 6.1.7 Calculations show that a storage volume of 3,000m<sup>3</sup> will be required on site for attenuation of run-off to greenfield rates. Although impermeable area will increase, the proposed development will reduce the total run-off rate compared to existing, as run-off will be attenuated to greenfield rates. As at present there is no formal attenuation of surface water run-off rates, this represents a significant betterment.
- 6.1.8 A review of flood risk policy shows that this FRA and its findings support the requirements of PPS 25 and demonstrates that the proposed development at C Site is appropriate and complies with flood risk requirements.







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## 7. References

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- CDC, 2010 Cherwell Local Plan (Draft Core Strategy), Cherwell District Council, February 2010
- DCLG, 2010 Planning Policy Statement 25: Development and Flood Risk, Department for Communities and Local Government, March 2010.
- CDC, 2009 Level 1 Strategic Flood Risk Assessment for Cherwell and West Oxfordshire, Cherwell District Council, West Oxfordshire District Council and Oxfordshire County Council, April 2009.
- DCLG, 2009 Practice Guide to PPS 25, Department for Communities and Local Government, December 2009.
- CIRIA, 2007 The SUDS Manual (C697), Construction Industry Research and Information Association, February 2007.
- SEARA, 2006 South East Plan - A Clear Vision for the South East, South East England Regional Assembly, March 2006.





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# Annex A

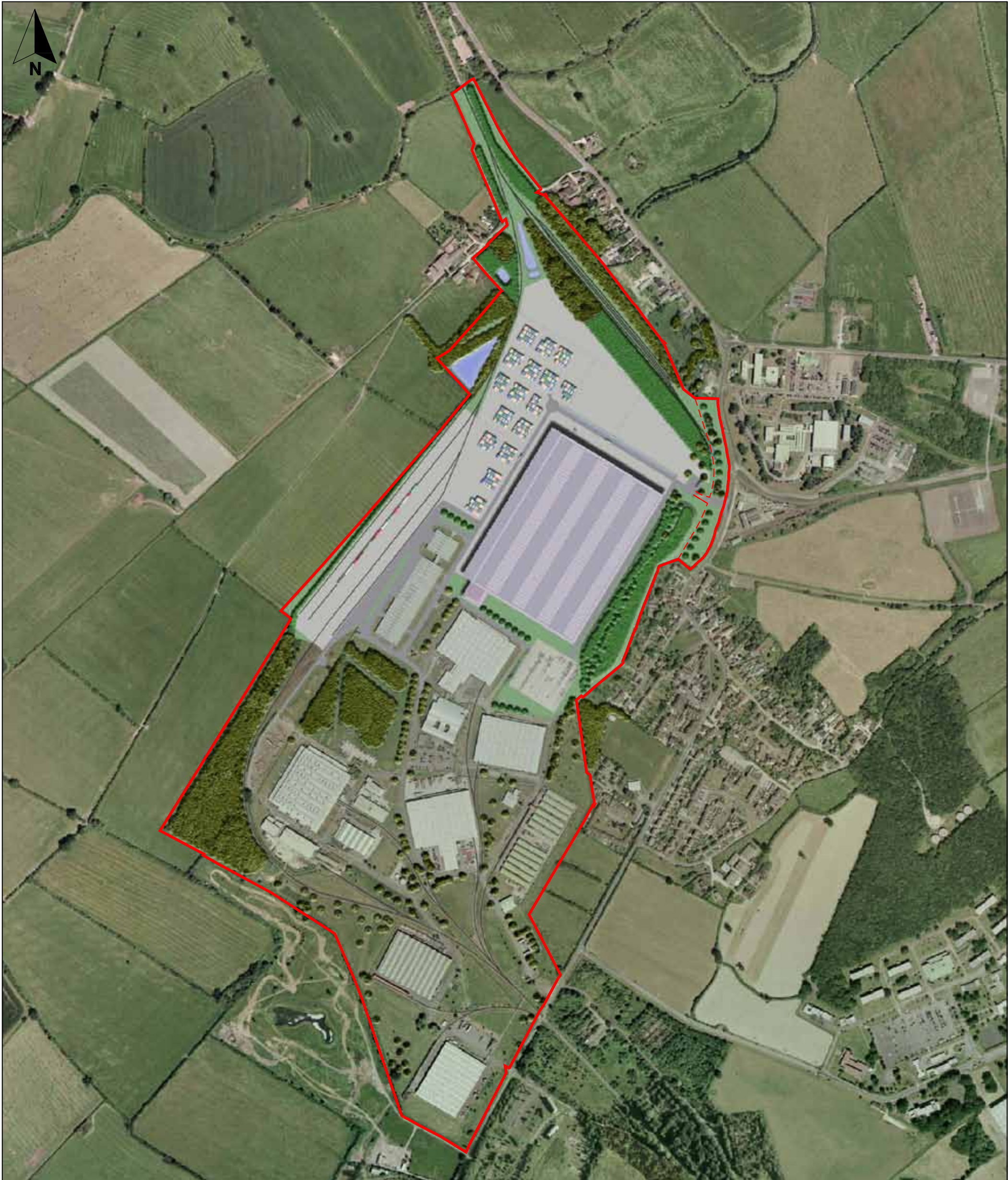
## Current Masterplan Layout for C Site

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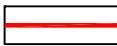








Key

 Site boundary (83.3ha)



Redevelopment of MOD Bicester  
Flood Risk Assessment

**Figure A1**  
**C Site Illustrative Masterplan**

0 m  500 m

September 2011  
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# **Annex B**

## **Flood Mapping Provided by the Environment Agency**

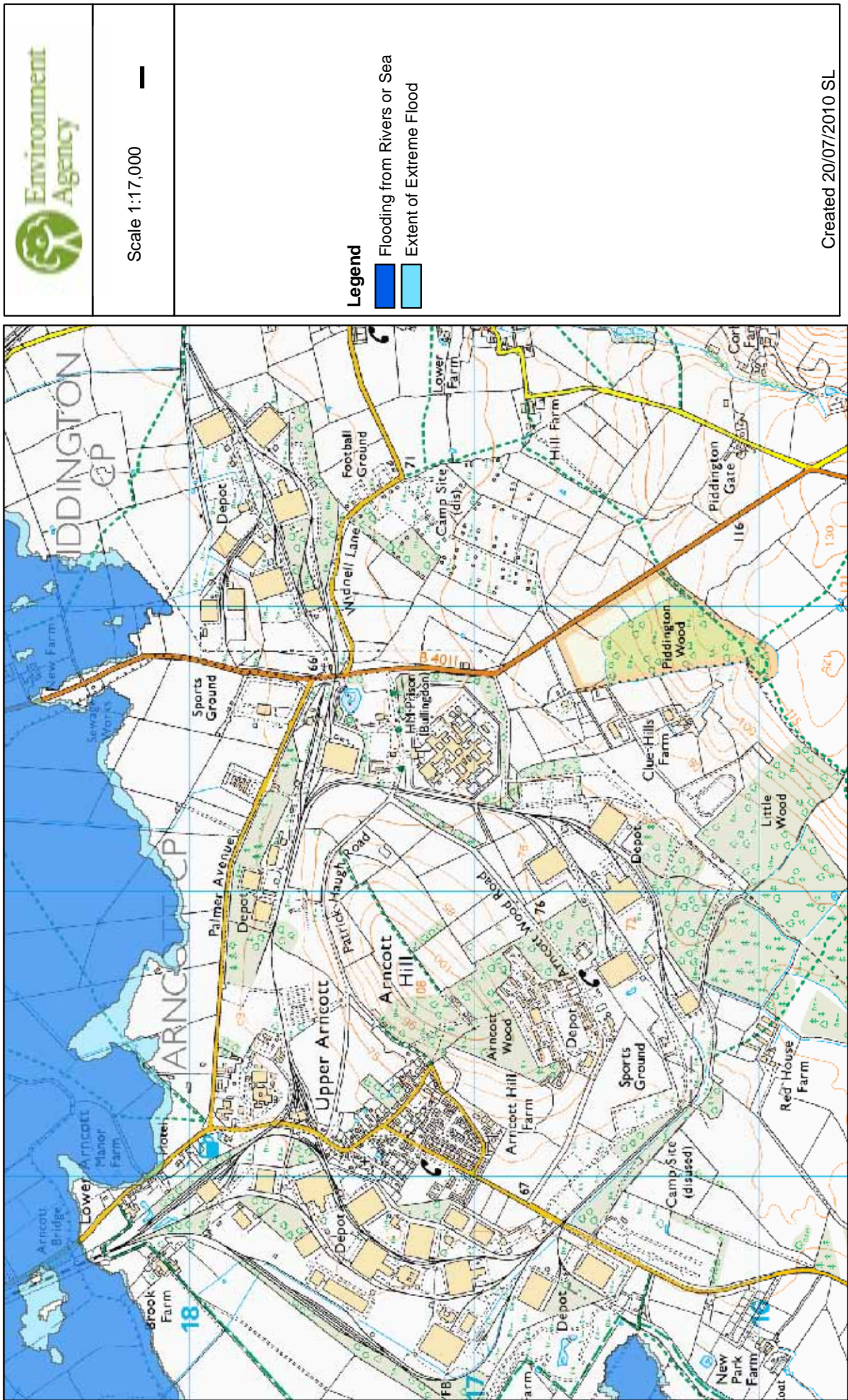
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**Basic FRA/FCA Map centred on Arncliffe Hill, Bicester**  
**[Ref:14\_075\_014\_001]**





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# Annex C

## Topographic Survey

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Please see data on CD.









**Defence  
Infrastructure  
Organisation**

Future Defence Storage and Redistribution Programme,  
Redevelopment of MOD Bicester  
Graven Hill: Flood Risk Assessment

Appendix to ES  
September 2011



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# Defence Infrastructure Organisation

## Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester

- Graven Hill Site: Flood Risk Assessment  
(Appendix K to BIC/OPA/DOC/10)

September 2011

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# 1. Introduction

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## 1.1 Purpose of this Report

- 1.1.1 This Flood Risk Assessment (FRA) has been prepared to support the proposed re-development of the Graven Hill site, at MOD Bicester. The site is located to the south of Bicester, west of the village of Ambrosden and south of the A41 between Bicester and Aylesbury to the east centred at grid reference SP 58847 20404.
- 1.1.2 This is a Level 2 FRA which has been prepared in line with requirements of Planning Policy Statement 25 (PPS 25): Development and Flood Risk (DCLG, 2010).

## 1.2 Data Collation and Consultation

- 1.2.1 A flood risk data request was made to the Environment Agency (EA) on 18th June 2010 and information was received on 02 and 04 August 2010.
- 1.2.2 A site visit was made on 13 July 2010 by Anne Kemlo, accompanied by a member of MOD staff, Peter Brunton, from the Estate Management Team.
- 1.2.3 Information has been taken from the following reports:
- Bicester Establishment Development Plan Report, February 2008, Defence Infrastructure Organisation (DIO)<sup>1</sup>;
  - Emap Site Reports, dated January 2010, issued in support of the Land Quality Assessment work completed by AMEC Environment and Infrastructure Ltd. (AMEC E&I)<sup>2</sup> in relation to the site; and
  - Preliminary Design and Access Statement for Graven Hill, AMEC for the DIO, March 2010.

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<sup>1</sup> The Defence Infrastructure Organisation was formed on 1 April 2011 when the former Defence Estates was brought together with other property and infrastructure functions in the MOD to form a single organisation.

<sup>2</sup> Following its acquisition by AMEC, Entec UK Ltd was integrated into AMEC Environment and Infrastructure in July 2011, all references are now to AMEC E&I.





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## 2. Description of Site

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### 2.1 Site Location

- 2.1.1 MOD Bicester is located to the south-east of Bicester and approximately 30km north-east of Oxford. It comprises a number of sites which are located within a distance of about 11km of each other; south and east of the A41 and north of the M40. The sites which are being considered for redevelopment comprise C Site, at Arncott and Graven Hill, west of Ambrosden. The location of the sites is shown in Figure 2.1.
- 2.1.2 MOD Bicester was established during the period 1939-45 and its primary purpose is for storage and maintenance of equipment and supplies, which are then transported from the site for use in the UK and abroad.
- 2.1.3 This report considers the Graven Hill site, which extends to 207ha. However, for the purpose of the FRA, the entire MOD owned area at Graven Hill has been addressed, a total of 237.1ha. This includes St David's Barracks, which lies adjacent to the proposed development at the Graven Hill Site.

### 2.2 Existing Site Layout

- 2.2.1 The Graven Hill site contains twelve large storage warehouses, most with road and rail access, intermittently spaced around E Site (broadly in the north-west) and D Site (which broadly corresponds to the south-east). The central, upper part of the Site consists of agricultural land and woodland. .
- 2.2.2 Both D and E Sites contain other buildings including offices, workshops, as well as buildings used for amenity uses. There are large areas of hardstanding, adjacent to the buildings used for vehicle parking, equipment storage and maintenance. Bicester International Freight Terminal is located in the north-eastern part the Graven Hill site, and in total comprises approximately 6ha of railway sidings, container stacking areas, loading, transfer and circulation areas.
- 2.2.3 There is a road network running through the site, but a large proportion of the site comprises grassed areas, with some areas of woodland and other vegetation.
- 2.2.4 The MOD railway line joins the Oxford - Bicester railway close to the western boundary of E site. Railway lines then route around the outer edges of E site along the eastern boundary and provide a link through D Site and Bicester International Freight Terminal as well as linking to C and then A Site.
- 2.2.5 St David's Barracks and a potential future barracks expansion area falls outside of the area proposed for redevelopment.



## Details of Existing Site Layout

2.2.6 Buildings and other land use information has been provided by the DIO and is summarised in Table 2.1. The Site has been delineated into the existing drainage catchments (on site) and the receiving natural catchments (the adjacent watercourses). These catchments are shown on Figure 4.2.

**Table 2.1 Existing Impermeable Areas**

Parameter	Catchment Reference							
	A	B	C	D	E	F	Other open/ landscaping Areas	Graven Hill* summit
Total catchment area	70.7ha	11.7ha	19.7ha	5.5ha	60.8ha	23.6ha	18.5ha	26.6ha
Impermeable area	21.7ha (33%)	1.7ha (14%)	4.5ha (23%)	1.54ha (24%)	14.9ha (22%)	13.0ha (55%)	N/A	N/A

\*These areas are not assessed as they will not be affected by the proposals. The areas are largely greenfield, being covered in grass/woodland with some rail tracks, and at Graven Hill summit a small access road.

2.2.7 Table 2.1 shows that in total approximately 57ha or 24% of the site (including St David's Barracks) currently comprises impermeable surfaces. Impermeable areas affect the volume and rate of surface water run-off from the site (see Chapter 5).

2.2.8 Table 2.2, below, details the existing outfalls, the locations of which are shown later on Figure 4.2.

**Table 2.2 Surface Water Outfall Locations**

Outfall Reference	Pipe Diameter or Ditch Cross Sectional Area	Receiving Watercourse	General Condition (Poor/Average/Good)	Comments and Observations
Outfall A (SW1)	Ditch: 2m <sup>2</sup>	Langford Brook	Good	Discharge consent CATM.2739 was revoked in August 2006.  3No. 150mm diameter pipes located near to outfall, acting as a flow restriction.
Outfall B (SW2)	Unknown (Not surveyed)	Langford Brook	Poor	Overgrown vegetation considered to be unintentionally restricting the outflow. The water level observed during the site visit was at the top of ditch.
Outfall C (SW3)	Pipe: Unknown	Tributary to the River Ray	Unknown	Discharge consent CATM.2741 has no end date and is valid indefinitely. Could not access site during visit to assess outfall location.





Outfall Reference	Pipe Diameter or Ditch Cross Sectional Area	Receiving Watercourse	General Condition (Poor/Average/Good)	Comments and Observations
Outfall D (SW4)	Ditch: 1.65m <sup>2</sup>	Tributary to the River Ray	Average	Heavy reeds considered to be unintentionally restricting the outflow.
Outfall E (SW5)	Ditch: 2.19m <sup>2</sup>	Tributary to the River Ray	Poor	Overgrown vegetation considered to be unintentionally restricting the outflow.
Outfall F (SW6)	Unknown (not surveyed)	Tributary to the Langford Brook	Unknown	Ditch location is assumed to be associated with St David's barracks.

#### Notes

- 1.) Data collected from site visit undertaken by AMEC in March 2011.
- 2.) Ditch cross sectional area based on approximate width at base, width at top of embankment and approximate depth measured from topographical survey.

## 2.3 Hydrology and Surface Water Features

- 2.3.1 The Graven Hill site is located within the River Ray catchment. Local drainage networks broadly flow from north to south. The Langford Brook is located to the west of E Site and flows south to join the River Ray approximately 3km to the south-west of D Site. Various tributaries/ditches tributary to the Langford Brook are present immediately to the west of E site as well as the Langford Brook itself running along 125m of E Site's boundary. This watercourse is then culverted under the adjacent railway. To the east of D Site, another tributary of the River Ray flows southwards. The upper, central part of the Graven Hill site reaches c. 113m AOD and has no water courses. Figure 4.2 shows further details of the site hydrology.
- 2.3.2 Average annual rainfall (1961-90) for the Ray catchment is 627mm/year at the centre of the combined sites<sup>3</sup>. This is lower than the average rainfall for England of 828mm/year (1961-1990, Met Office).
- 2.3.3 The site visit carried out for this assessment identified that there are a number of surface drainage channels and ditches at the site, as well as man made open water ponds. There are three outfall points on the southern boundaries of D and E Sites, taking water from the ditches across the lower elevations on site (see outfalls SW1, SW6 and SW5 on Figure 4.2). Outfall SW1 drains directly to the Langford Brook, whilst outfall SW6 drains in the direction of Langford Brook via various ditchcourses, and outfall SW5 drains to the River Ray via an un-named tributary. A further outfall (SW2) to the Langford Brook is located in the north-west of the site, and two outfalls in the northeast (SW3 and SW4) drain towards another un-named tributary of the River Ray.

<sup>3</sup> Flood Estimation Handbook FEH CDRom V3



## 2.4 Topography

- 2.4.1 The elevation of the overall sites varies from 113m AOD at the top of Graven Hill, down to approximately 65m AOD on the outer boundaries of the planning application area. Slopes around Graven Hill are particularly steep, with slopes immediately beneath the summit having a gradient of 10%. However, slopes are limited to between 0% and 3% over the rest of the site, including D and E Sites where levels drop from 75m to around 60m AOD.
- 2.4.2 A detailed topography survey was carried out in July and November 2010 (see Appendix C, and detail on Figures 4.3, 4.4 and 4.5). Figure 4.2 shows the general elevations of the site, and indicates that ground elevations fall from the centre of the site in all directions towards the watercourses around the site, particularly the Langford Brook to the west and a small tributary to the River Ray in the east.

## 2.5 Hydrogeology and Soils

- 2.5.1 D Site overlies Oxford Clay, specifically the Peterborough Mudstone Member. This indicates that the underlying geology is impermeable; however the site is marked as landscaped ground with extensive areas of cut and fill. No drift geology is indicated at D site.
- 2.5.2 E Site also mostly overlies Oxford Clay, with the north-west part of the site, close to the railway, overlying the Kellaways formation (the Kellaways Sand Member composed of siltstone, fine grained sand and sandstone and sandy mudstone)<sup>4</sup>. No drift is indicated except for an area immediately adjacent to the watercourse in the north-west corner of the site where the Kellaways sand is overlain by alluvium. The clay bedrock implies impermeable geology, while the sandstone is likely to be more permeable with local groundwater. The drift may also be more permeable and may contain perched groundwater, while areas of made ground will have different permeability characteristics.
- 2.5.3 The soils underlying the site have a Soil Index of 0.45<sup>5</sup>. These are clayey, or loamy over clayey soils, with an impermeable layer at shallow depth. Online soils information<sup>6</sup> shows that the site overlies slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils, with the western and southern part of E site, on loamy soils with naturally high groundwater.
- 2.5.4 EA groundwater mapping shows that a small area adjacent to the north-west boundary of the Graven Hill site is classified as a Secondary A Aquifer (associated with bedrock geology). Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important

<sup>4</sup> British Geological Survey map 219 Solid and Drift Buckingham

<sup>5</sup> Flood Studies Report (FSR) Winter Rainfall Acceptance Potential (WRAP) map

<sup>6</sup> LANDIS soils database, see: <http://www.landis.org.uk/services/soilscapes.cfm>



source of base flow to rivers. A very small area of the site along the southern boundary close to the railway is classified as having superficial geology which is a Secondary A aquifer. The areas of secondary aquifer are shown on Figures 2.2 and 2.3.

- 2.5.5 The BRE-365 method was used to assess infiltration rates. An infiltration test was carried out on E Site on the 24 August 2010, and found no drop in the trial pit water level over 270 minutes. An infiltration test was carried out on D Site on the 25 August 2010, and found no drop in the trial pit water level over 182 minutes. Infiltration rates are therefore considered as negligible for the whole of Graven Hill.
- 2.5.6 The site is not on a groundwater source protection zone.

**Figure 2.2 EA Solid Geology Aquifer Mapping**



Note: orange shading = area of Secondary A aquifer

**Figure 2.3 EA Superficial Geology Aquifer Mapping**



Note: orange shading = area of Secondary A aquifer

## 2.6 Water Quality and Sensitivity of Downstream Watercourses

- 2.6.1 The EA carries out water quality monitoring of Langford Brook upstream of the Sewage Treatment Works (STW) immediately west of E site to the confluence with the River Ray downstream, a distance of 12km. There is also monitoring on the River Ray in the reach downstream of the confluence with the Langford Brook. The STW discharges into the Langford Brook. The latest data from the EA is for 2008 and shown below in Table 2.3.

**Table 2.3 Water Quality for Langford Brook**

Reach	U/S NGR	D/S NGR	Reach Length (km)	Chemistry	Biology	Nitrates	Phosphates
Stratton Audley to Bicester STW (Langford Brook)	461600 225190	457800 221100	6.6	C	B	5	3

Reach	U/S NGR	D/S NGR	Reach Length (km)	Chemistry	Biology	Nitrates	Phosphates
Bicester STW to River Ray (Langford Brook)	457800 221100	457000 216780	5.4	C	B	6	5
River Ray - Grendon Underwood STW to Langford Brook	468000 221100	457000 216780	16.8	D	-	3	5
River Ray - Langford Brook to Gallos Brook	457000 216780	453000 213890	6.6	D	B	5	5

#### Key

Chemistry and biology grades classification: A (very good), B (good), C (fairly good), D (fair), E (poor), F (bad)

Nutrient Grade classification: 1 (Very low), 2 (low), 3 (Moderately low), 4 (Moderate), 5 (High), 6 (Very high)

- 2.6.2 The chemical and biological water quality in the Langford Brook is moderate to good, with high levels of nutrients (Phosphate (P) and Nitrates (N)) downstream of the STW. The chemical water quality of the River Ray is fair also with high levels of nutrients (P and N) associated with an upstream STW. High levels of nutrients may occur naturally and are not necessarily bad for the environment. The water quality and sensitivity of receiving watercourses to pollution will influence the level of surface water treatment required within the redeveloped site.

## 2.7 Proposed Development

- 2.7.1 The proposed re-development at the Site will broadly comprise residential units and community facilities in the northern part of the Site and employment uses (B1, B2 and B8) in the southern part of the Site. The woodland within Graven Hill will not be redeveloped. The current masterplan (see Appendix A) indicates that the planning application area is c. 207ha. With the addition of St David's Barracks, the area of which has been included in the FRA, the overall area is 237ha.
- 2.7.2 The masterplan shows the following split of land-use across the combined sites:
- Building footprints - 18% landtake;
  - Main access roads and hardstanding - 21% landtake;
  - Landscaping (open space, woodland and gardens) - 61% landtake.
- 2.7.3 Therefore the estimated potential impermeable area comprises 39% of the total area to be developed (93ha). It is assumed that the remaining part of the site (144ha) will be permeable, i.e. grass, woodland or other natural landscape.



- 2.7.4 This represents an increase in the impermeable area at the site of 35ha compared to the existing development, a 60% increase, as shown in Table 2.4.

**Table 2.4 Comparison of Impermeable Areas - Existing and Proposed Developments**

Scenario	Area (ha)	%
Estimate impermeable area - current development	58	25.3
Estimate impermeable area - proposed development	93	39.2
Total Site Area	237.1	-
Percentage Change	$(100/58)*93 = 160\% - \text{i.e. a 60\% increase}$	



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## 3. Planning Context

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### 3.1 Planning Policy Statement 25

- 3.1.1 Planning Policy Statement 25 (PPS 25): Development and Flood Risk (DCLG, 2010) and supporting Practice Guide (DCLG, 2009) guide the design of flood risk management measures in new developments. A FRA is required for all sites of 1ha or more regardless of which Flood Risk Zones a site is located in. The Graven Hill site is greater than 1ha in area so a FRA is required.
- 3.1.2 The FRA must assess the risk to the site from all sources of flooding including surface water run-off, and demonstrate that the development will be made safe from flood risk, without increasing flood risk elsewhere in the catchment, and where possible reducing overall flood risk.

#### Sequential Test

- 3.1.3 PPS 25 sets out requirements for flood risk to be considered at a strategic planning stage by regional and local planning authorities, for example in the development of Regional and Strategic Flood Risk Assessments. A sequential approach must be applied when allocating sites for future development, such that future development is steered away from areas of flood risk, i.e. from Flood Zone 3 and 2 to Flood Zone 1, where possible. Only where there are no appropriate sites for development in Zone 1 should sites in Zone 2 be considered and sites in Zone 3 should only be considered if there are no appropriate sites available in Zone 2.
- 3.1.4 Regional and local planning authorities are required to produce Strategic Flood Risk Assessments (SFRA) which should apply the Sequential Test at a regional level and help to inform Local Development Frameworks in allocating land for development types. A Level 1 SFRA for Cherwell and West Oxfordshire was published by Cherwell District Council (CDC), West Oxfordshire District Council (WODC) and Oxfordshire County Council (OCC) in April 2009.
- 3.1.5 The proposed development site is in Flood Zone 1 so the proposed development is in line with the requirements of the PPS 25 Sequential approach.

#### Exception Test

- 3.1.6 PPS 25 sets out which land use types are compatible in different Flood Risk Zones, and the instances in which an Exception Test must be passed in the FRA (see Table 3.1).





**Table 3.1 Flood Risk Vulnerability from PPS 25: Development and Flood Risk**

<b>Flood Risk Vulnerability Classification</b>	<b>Essential infrastructure</b>	<b>Water Compatible</b>	<b>Highly Vulnerable</b>	<b>More Vulnerable</b>	<b>Less Vulnerable</b>
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	x	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	x	x	x

**Key**

✓ Development is appropriate

x Development should not be permitted

Source: Table D.3 of PPS 25

- 3.1.7 Residential development and schools are classed as 'More Vulnerable' where as employment uses are classed as 'Less Vulnerable' (from Table D.2 of PPS 25). As the proposed development is in Zone 1 all land use vulnerability types are appropriate and therefore no Exception Test is required. Indicative flood risk mapping published by the EA on their website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)) shows that the majority of the site is within Flood Zone 1.

## 3.2 Strategic Flood Risk Assessment

### Fluvial Flooding

- 3.2.1 The SFRA<sup>7</sup> notes that: *"In general, the fluvial flood risk across the study area is high with large extensive floodplains being a substantial feature of the rural landscape. Urban locations within the study area [i.e. the Cherwell District Area] that are potentially affected by fluvial flooding in Cherwell include Bicester [amongst others]"*.
- 3.2.2 The mapping included in the SFRA<sup>8</sup> shows the extent of flooding for the Flood Zone 3 with climate change projections. The mapping for the Ambrosden settlement does not extend as far north as Graven Hill (D Site and E Site). However, it is clear from the mapping that projections for flooding within the River Ray Flood Zone 3 with climate change do not extend to the site.

<sup>7</sup> Cherwell District Council, West Oxfordshire District Council and Oxfordshire County Council, April 2009, The Cherwell and West Oxfordshire Level 1 Strategic Flood Risk Assessment (SFRA)

<sup>8</sup> SFRA (Appendix B) (<http://www.cherwell.gov.uk/index.cfm?articleid=4356>).



### Sewer Flooding

- 3.2.3 Instances of sewer flooding reported to CDC following the 2007 summer flooding<sup>9</sup> indicate a low incidence (1 to 2 incidents reported in the last 10 years) of total sewer flooding in the area around the site. However, this data is reported by postcode area, i.e. low resolution, so these reported incidents may not be located at D Site or E Site.

### Surface Water Flooding

- 3.2.4 Ambrosden and Arncott are located on low lying impervious ground where there may be limited infiltration, and surface water drains via a system of low-gradient small ditches and watercourses, the area may therefore be at risk from surface water flooding.

### Groundwater Flooding

- 3.2.5 The underlying geology of the area is predominantly clay which is impermeable and therefore no significant groundwater is expected at the site. However, the SFRA notes that in the locality of Bicester there are outcrops of shale which are more permeable. No recorded incidents of groundwater flooding are indicated for the site<sup>10</sup>. Infiltration tests carried out on site in August 2010 have confirmed that infiltration rates are negligible.

### Sustainable Drainage

- 3.2.6 The SFRA<sup>11</sup> provides a high level review of the types of (SUDS) that may be appropriate for the study area. Attenuation type systems are likely to be the most appropriate form of SUDS in the area to the south-east of Bicester, due to impermeable ground conditions.

## 3.3 Cherwell District Council Local Plan

- 3.3.1 The Draft Core Strategy<sup>12</sup> includes the following policy (A.62) on sustainable flood risk management.

*We do not consider that a local policy on sustainable flood risk management is necessary as it would duplicate the guidance in Planning Policy Statement 25: Development and Flood Risk (PPS 25), its recently updated practice guidance, and South East Plan policy NRM4: Sustainable Flood Risk Management. The Council will manage and reduce flood risk in the district through using a sequential approach; locating vulnerable*

<sup>9</sup> Appendix B of the SFRA. (Figure A-3 Thames Water DG5 Total Sewer Flooding).

<sup>10</sup> Appendices B, C and D of the SFRA.

<sup>11</sup> Appendix I of the SFRA.

<sup>12</sup> Cherwell District Council, February 2010, Draft Core Strategy.



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*developments in areas at lower risk of flooding. We will only permit development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding. In addition to safeguarding floodplains from development, we will seek opportunities to restore natural river flows and floodplains, increasing their amenity and biodiversity value.*

3.3.2 The following policy on SUDS is included:

***Policy SD 6                      Sustainable Drainage Systems (SUDS)***

*The use of sustainable drainage systems (SUDS) for the management of surface water run off generated by developments will be encouraged. Site specific Flood Risk Assessments should be used to determine how SUDS can be used on particular sites and to design appropriate systems.*

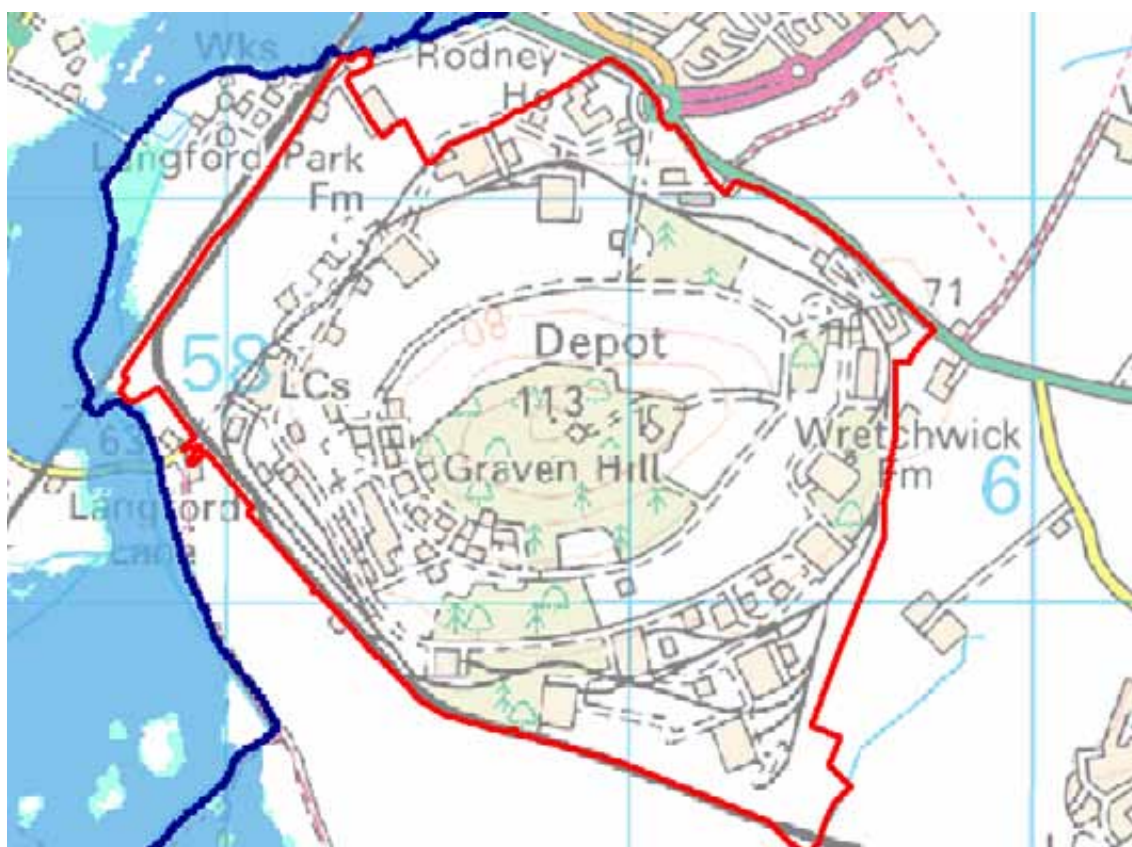


## 4. Flood Risk

### 4.1 Fluvial Flood Risk

- 4.1.1 Almost the entire site is within Flood Zone 1 which means that it is not at risk from the 0.1% Annual Exceedance Probability (AEP) flood, (i.e. the flood which is expected to occur every 1000 years on average). The map is shown at Figure 4.1 and in more detail on mapping provided by the EA at Appendix B.

Figure 4.1 Environment Agency Flood Risk Mapping



Dark blue shading: flooding from rivers or the sea, without defences

Pale blue shading: flooding from the extreme flood

Red: approximate location of development site

Dark blue line: designated as main river by the Environment Agency

- 4.1.2 In the north-west corner of the site where the boundary is adjacent to the Langford Brook, the mapping indicates that both flood zone 3 and 2 may extend into the site (to the south of the Brook) by a very small distance. The site boundary borders the watercourse for a distance of approximately 125m, and the mapping indicates that the flood zone may extend onto the site but covers less than 0.1ha. The site boundary in the extreme west of the site also abuts the edge of the Flood Zone 3 and 2, (0.005ha being in Flood Zone 3 and 2). No new development is proposed at these two locations, and they will remain as woodland/public open space; all new development will be located in Flood Zone 1, therefore the Exception Test is not required.
- 4.1.3 Modelled level data, including for climate change impact on the 1% AEP (1 in 100 year) flood event, has been provided for the site by the EA. Figure 4.2 shows the extent of the 1% AEP 100 year event with climate change from the Langford Brook at the north-west corner of the Site. From Figure 4.2 it can be seen that the parts of the site in or adjacent to EA Flood Zones 3 and 2 are extremely small areas. The areas, in the north-west and south-west corner of the Site are shown in more detail on Figures 4.3 and 4.4 (with detailed topographical survey levels). The south-east corner of the site is also relatively low lying, and is adjacent to a tributary of the River Ray flowing south from Wretchwick Farm. This area is shown on Figure 4.5.
- 4.1.4 Other than flood risk from the main river network (Langford Brook) there are various ordinary watercourses and drainage ditches close to the site boundary. These watercourses are shown on Figures 4.2 to 4.5, alongside their respective catchments. There are limited watercourses on site, mainly drainage ditches around the lower portions of the Site, particularly in the west. However, as shown in Figure 4.2 these are located away from the development areas.
- 4.1.5 Based on the final masterplan, and further discussion with the EA, it may be necessary to make further assessment of the risk posed by these watercourses, including hydraulic modelling<sup>13</sup>. The present assessment suggests that the development areas on the site are not prone to flooding from the Langford Brook, but there may be a limited risk associated with the watercourses adjacent to the south-east corner of the site where an area is reserved as a potential site for an Energy Centre.
- 4.1.6 For areas in the west, near the Langford Brook, Finished Floor Levels will be constructed at least 300mm above the design flood level. The 0.1% AEP extent has been used, as this effectively incorporates an allowance for climate change. Based on the flood level provided by the EA for the 0.1% AEP flood event at the railway crossing over the Langford Brook (at GR: SP 58265 21342), the design flood level for the western half of the site, adjacent to the Langford Brook has been taken as 65.70m AOD. Allowing a freeboard of 300mm this gives a minimum Finished Floor Level of 66.00m AOD.
- 4.1.7 For areas in the south-east (see Figure 4.5), near the tributary ditches flowing south to the River Ray, Finished Floor Levels will again be constructed at least 300mm above the design flood level. However, no details of flood levels associated with this small

<sup>13</sup> Telecon. Ian Norris, Thames West Development and Flood Risk Team, Environment Agency 02 August 2010.



watercourse (catchment area 1.8km<sup>2</sup> at the railway crossing) are available. Based on the topographic survey, the lowest elevation in the area is 62.45m AOD (at SP 59404 19514) on the edge of the existing south eastern most concrete pad. This has been taken as the design flood level for this corner of the site. With 300mm this gives a figure of: 62.75m AOD. These pad areas are accessed by roads at a higher elevation within the site. No development is proposed of the lower lying wooded area immediately to the south/east of this area along the site boundary. LiDAR data indicates that the low-lying farmland along this ditchcourse to the east is situated between 61.4m AOD and 62m AOD. It is recommended that the condition of the culvert taking this ditch under the railway line is investigated. Presuming this culvert is in good condition, the application of the 300mm freeboard to give a design level of 62.75m AOD is therefore considered to be appropriate.

- 4.1.8 For areas in the north-east, Finished Floor Levels will again be constructed at least 300mm above the design flood level. However, no details of flood levels associated with the drainage ditches in this area are available. Based on the topographic survey, the lowest elevation in the area is 69.00m AOD (at SP 59547 20829). This has been taken as the design flood level for this corner of the site. With 300mm this gives a figure of 69.30m AOD. The catchment area draining to ditches in this area is limited to run-off from the C Site and D Site drainage sub-catchments (total area 0.25km<sup>2</sup>), therefore given the limited catchment draining to these watercourses, this 300mm freeboard is considered acceptable.

## 4.2 Groundwater Flood Risk

- 4.2.1 In areas of secondary aquifer (see Figures 2.3 and 2.4) there is likely to be some local groundwater under the site. The bedrock geology is predominantly clay, which implies that there is no risk of groundwater flooding across the majority of the Site. The areas of secondary aquifer in the north-west part of the Site (associated with bedrock geology) may give rise to some flood risk during and following periods of prolonged rainfall due to groundwater rising above ground level. However, this area of the Site is identified in the indicative land use plan (Appendix A) for use as public open space and allotments, rather than built development therefore minimising any risk associated with potential groundwater flooding. There is also a small area of drift geology identified as secondary aquifer along the south-east boundary of the Site which could also give rise to flood risk. The masterplan shows that this area would be redeveloped for employment uses which are lower risk than housing development.
- 4.2.2 Infiltration tests carried out on the 24/25 August 2010 indicated that infiltration rates are negligible. This indicates that the ground beneath the site is not capable of holding significant quantities of water, and therefore the risk from groundwater flooding is minimal.
- 4.2.3 The SFRA reported no historic groundwater flooding in the overall area, and the EA did not report any in their response to AMEC's flood risk data request.



## 4.3 Flood Risk from Sewers and Infrastructure

- 4.3.1 The SFRA did not identify any specific flood risk issues from sewers or infrastructure. Ordnance Survey mapping does not show any water infrastructure (e.g. canals, reservoirs, etc.) in the vicinity of the site which might pose a flood risk in the case of failure.
- 4.3.2 The Site's existing surface water drainage system suffers from a lack of connectivity between the on-site ditches and no systematic provision of conveyance capacity (i.e. pipes draining contributing catchment areas route water to the ditches faster than it can drain out). As a result several low-lying areas of the site experience temporary surface water flooding when the present surface water drainage ditches cannot convey surface water run-off to the adjacent receiving watercourses fast enough.
- 4.3.3 The site's future drainage system will be designed to modern standards (see chapter 5), and as such will be designed to appropriately convey and attenuate the expected volumes of site run-off. The drainage system phasing should be designed, such that new infrastructure is in place when new development commences in each area of the site. The condition of the existing drainage system, and flood risk posed by this is therefore not considered a constraint.

## 4.4 Flood Risk from Surface Water Run-off

- 4.4.1 Surface water run-off from rainfall can create flood risk when flows do not infiltrate to ground and drainage systems are inundated. In new developments where impermeable areas are planned or increased, infiltration is reduced and run-off rates from the site will be increased if no mitigation is included in the development design. This can cause increased flooding in the catchment downstream, and/or the drainage system which the flow discharges to.
- 4.4.2 PPS 25 requires that surface run-off from rainfall must be managed so that flow rates from the new development are no more than, and ideally less than, those from the current site, with an appropriate allowance for climate change. This ensures that water discharged from site does not contribute to increased flood risk in the surrounding areas.
- 4.4.3 Peter Brunton (Estate Management Team, MOD Bicester) commented that E Site in particular tends to flood after heavy rainfall, adding that site ditches fill with water and take several days to drain away, and occasionally flood above banks.
- 4.4.4 Surface water run-off could occur when rainfall flows from the higher ground of Graven Hill, to the developed areas surrounding it; this may have the potential to cause flood risk on site. In cases where surface water is managed on surrounding land, e.g. by adequate drainage including agricultural and road drainage as appropriate, then the risk of run-off is reduced. Topography and the underlying geology can both influence the likelihood of water running onto a site.
- 4.4.5 At this site, land elevations are highest in the centre (summit of Graven Hill), with land sloping away in all directions. Run-off could potentially affect the adjacent parts





of the site. However, given the small size of the Graven Hill catchment in any flow path direction ('slices' of approximately  $0.1\text{km}^2$ ), and the roads/properties between the Hill and development on the Site, the generation of significant quantities of surface water run-off, and their transmission to the Site is considered unlikely.

## **4.5 Flood Risk from Surface Run-on**

- 4.5.1 The site is not at risk from surface water run-on, since it is elevated higher than the surrounding land, being effectively situated on the flanks of Graven Hill. Run-off from Graven Hill may affect the site (see Section 4.4) or fluvial flooding (see Section 4.1).





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## 5. Managing Surface Water Run-off - Sustainable Drainage

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### 5.1 PPS 25 Requirements

- 5.1.1 PPS 25 requires that surface water run-off from a new development is managed so that flows from the site do not exceed existing rates, for events up to and including the 100 year rainfall event, with an appropriate allowance for climate change over the lifetime of the development. Since the site is currently developed this would mean that peak flow from the site will have to be no greater than the current brownfield run-off rates.
- 5.1.2 PPS 25 requires that all new development incorporates SUDS to manage surface water run-off for the site. Guidance to PPS 25 (updated in December 2009) states that SUDs should seek to manage drainage close to source, storing water for later use and discharging to ground if appropriate as a preferred option. Alternatively, drainage should be discharged to watercourses and only to drains or sewers as a least preferred option.
- 5.1.3 SUDS seek to mimic natural drainage processes to slow flow rates, thereby reducing flood risk downstream. They can also provide water quality improvements where water is stored for example in ponds, or filtered through natural media, for example grassed swales. A third benefit of using SUDS is providing wildlife and landscape enhancements, for example with reedbeds or ponds, and grassed areas for example swales, detention basins, etc.

### 5.2 EA and OCC requirements

- 5.2.1 Consultation with the EA<sup>14</sup> has confirmed that design run-off rates should be no more than existing rates from the site, and should ideally be limited to greenfield rates. However, the EA recognise that this may not be feasible in all situations, and will look for 'betterment' with discharge rates reduced as far as possible towards greenfield.
- 5.2.2 Discussions with OCC confirm that they would like to use a run-off rate of 5 l/s/ha across the whole site. Greenfield rates (5 l/s/ha) have therefore been used in the drainage assessment.

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<sup>14</sup> Telephone call with Ian Norris, Flood Risk and Development Control, Thames West Area Environment Agency (02 August 2010).



## 5.3 Construction Industry Research and Information Association Guidance

5.3.1 The Construction Industry Research and Information Association (CIRIA) SUDS guidance (CIRIA, 2007) recommends that SUDS are managed using a management train approach which involves the following:

- source control: run-off is managed close to its source with for example rainwater harvesting, green roofs and soakaways if ground conditions allow, and pervious pavements;
- site control: flow from several local catchments is routed via swales or french drains towards linked infiltration or surface water storage components, e.g. pond or detention basin; and
- regional control: run-off management systems from several separate sites are integrated.

5.3.2 The CIRIA guide gives indicative number of SUDS components required for water quality improvement before flow is discharged from the site, depending on where the water is drained from. This is indicated below, in Table 5.1. So for the Site, assuming the receiving watercourse is of medium sensitivity to water quality impacts, up to three components would be required in more industrial areas of the development for example areas of employment and commercial uses.

**Table 5.1 SUDS Water Quality Treatment Requirements (from CIRIA SUDS Manual Table 5.6)**

		Receiving Water Sensitivity		
Run-off Catchment Characteristic		Low	Medium	High
	Roofs only	1	1	1
	Residential roads, parking areas, commercial zones	2	2	3
	Refuse collection/industrial areas/loading bays/lorry parks/highways	3	3	4

## 5.4 Determining Attenuation Requirements

5.4.1 The catchment flows have been in WinDES® using the Modified Rational Method. Rainfall values were generated using the FSR method. Further details are provided in the Drainage Strategy document (AMEC, August 2011).



5.4.2 The key parameters for both methods are summarised below in Table 5.2, along with the input data and flow results for each catchment area.

**Table 5.2 Greenfield Run-off Rates**

Parameter	Catchment Reference					
	A	B	C	D	E <sup>#</sup>	F*
Total site area	70.66ha	11.7ha	19.7ha	5.53ha	60.77ha	23.6ha
Impermeable area	24.4ha (35%)	1.7ha (14%)	4.5ha (23%)	1.54ha (28%)	13.0ha (21%)	13.0ha (55%)
SAAR (mm)	622	622	622	622	622	622
Soil Index (from Wallingford WRAP Map)	0.45	0.45	0.45	0.45	0.45	0.45
FSR Region	6	6	6	6	6	6
<b>Flow Results</b>						
QBAR	453 l/s (6 l/s/ha)	57 l/s (5 l/s/ha)	110 l/s (6 l/s/ha)	33 l/s (6 l/s/ha)	323 l/s (5 l/s/ha)	204 l/s (9 l/s/ha)
1:1yr Flow	385 l/s	48 l/s	94 l/s	28 l/s	274 l/s	174 l/s
1:30yr Flow	897 l/s	122 l/s	228 l/s	67 l/s	672 l/s	379 l/s
1:100yr Flow	1127 l/s	163 l/s	294 l/s	86 l/s	874 l/s	456 l/s

**Notes**

- 1.) # Catchment E includes for a large area of St David's barracks entering the Site D drainage system
- 2.) \* Catchment F covers the SLAM development area and as such the flows leaving this catchment are considered to be controlled at a greenfield run-off rate equal to the site average of approximately green field run-off rate. This flow is considered to discharge through a dedicated outfall and as such does not enter the D/E Site drainage system

5.4.3 Although the average QBAR run-off rate is in the order of 6 l/s/ha, it is recommended that a rate of 5 l/s/ha is used for controlling all run-off from the proposed development, in line with OCC requirements.

### Attenuation Requirements

5.4.4 The proposed development will result in an increase in impermeable areas, as discussed in section 2.7. Existing impermeable areas at the site (hardstanding, buildings, etc.) amount to an estimated 57ha, whereas the proposed development is estimated to include 93ha of impermeable surface. Therefore, additional storage will be required to attenuate run-off, a) from the increase in impermeable area, and b) due to the need to attenuate to greenfield rates.



- 5.4.5 As residential development is proposed for part of the Graven Hill site, a development lifetime of 100 years is assumed. A climate change factor of 30% for residential sites is used, from Appendix B of PPS 25, this and the other modelling parameters are shown in Table 5.3.
- 5.4.6 WinDES® was used to estimate attenuation volumes at the proposed development site in order to attenuate flows to greenfield rates, with an allowance for climate change. The drainage will be routed through several sub-catchments. These calculations determine the total storage requirements for the Site. Catchment F is excluded, as this will not be included in the development proposals - it contains existing St David's Barracks (which will remain as is) and the potential future barracks expansion area. Results are shown in Tables 5.3 and 5.4 below.

**Table 5.3 Network Global Variables and Simulation Parameters**

Model Parameters	Value
Return Period (yrs)	1in 1, 1in 30 and 1in 100 + 30% climate change
Profile Type	Summer and Winter
Storm Duration (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
M5-60 (mm)	20.0
Ratio R	0.4
Volumetric Run-off Coefficient	0.75 (summer) and 0.85 (winter)
Percentage Impermeable	Varies for each catchment
Notes	
<p>1) Descriptions for each variable is as follows:</p> <ul style="list-style-type: none"> <li>a. Return Period - The return period is used when a rainfall profile is being used in lieu of a statistically generated rainfall profile. It allows the mean annual flood values to be calculated in relation to the expected frequency.</li> <li>b. Storm Duration - Typical values used to represent common storm profiles.</li> <li>c. M5-60 - Rainfall depth equal to a 1 in 5yr return period lasting 60 minutes.</li> <li>d. Ratio R - Ratio of the rainfall depths from the 60 minute storm to the 2 day storm.</li> <li>e. Volumetric Run-off - Proportion of catchment rainfall that enters the system.</li> <li>f. Percentage Impermeable - Percentage of total area entered into model as being impermeable.</li> </ul>	



**Table 5.4 Comparison of Surface Water Flows**

<b>Catchment</b>	<b>Existing Run-off Flow at outfall</b>	<b>Proposed Flow at outfall</b>	<b>% Betterment in Flows achieved</b>
Catchment A	1:1yr = 400 l/s	1:1yr = 308 l/s	92 l/s less or 23% less
	1:30yr = 947 l/s	1:30yr = 460 l/s	487 l/s less or 52% less
	1:100yr = 1203 l/s	1:100yr + 30% climate change = 527 l/s	676 l/s less or 56% less
Catchment B	1:1yr = 48 l/s	1:1yr = 28 l/s	20 l/s or 42% less
	1:30yr = 122 l/s	1:30yr = 74 l/s	48 l/s or 40% less
	1:100yr = 163 l/s	1:100yr + 30% climate change = 123 l/s	40 l/s or 25% less
Catchment C	1:1yr = 94 l/s	1:1yr = 70 l/s	24 l/s or 25% less
	1:30yr = 228 l/s	1:30yr = 139 l/s	89 l/s or 40% less
	1:100yr = 294 l/s	1:100yr + 30% climate change = 234 l/s	60 l/s or 20% less
Catchment D	1:1yr = 28 l/s	1:1yr = 24 l/s	4 l/s or 15% less
	1:30yr = 67 l/s	1:30yr = 52 l/s	15 l/s or 22% less
	1:100yr = 86 l/s	1:100yr + 30% climate change = 63 l/s	23 l/s or 27% less
Catchment E	1:1yr = 274 l/s	1:1yr = 254 l/s	20 l/s or 7% less
	1:30yr = 672 l/s	1:30yr = 531 l/s	141 l/s or 21% less
	1:100yr = 874 l/s	1:100yr + 30% climate change = 635 l/s	239 l/s or 27% less
Catchment F	1:1yr = 174 l/s	1:1yr = Assumed to be 174 l/s	Assumed to be equal
	1:30yr = 379 l/s	1:30yr = Assumed to be 379 l/s	
	1:100yr = 456 l/s	1:100yr = Assumed to be 456 l/s	

**Notes**

- 1) \* Catchment F covers the SLAM development area and as such the flows leaving this catchment are considered to be controlled at a green field run-off rate equal to the site average of approximately 6 l/s/ha. This flow is considered to discharge through a dedicated outfall and as such does not enter the D/E Site drainage system.

5.4.7 The calculations show that in order to attenuate flows to greenfield rates a volume of 8,485m<sup>3</sup> would be needed, as shown in Table 5.5.





**Table 5.5 Estimated Attenuation Volumes for Strategic Ponds**

Catchment	Storage Type	Strategic Attenuation Volume Required
Catchment A	Online Pond	4000m <sup>3</sup>
	Online Pond	500m <sup>3</sup>
Catchment B	Online Pond	935m <sup>3</sup>
Catchment C	Online Pond	350m <sup>3</sup>
Catchment D	Online Pond	100m <sup>3</sup>
Catchment E	Online Pond	1,000m <sup>3</sup>
	Online Pond	1,600m <sup>3</sup>

**Notes**

- 1) The design of the ponds assumes that a permanent wet well will also be provided to help with improving the amenity value. However, the wet well will not contribute to the attenuation volume required.
- 2) Catchment F has not been included in the proposed drainage design as it is considered that the flows are controlled within St David's Barracks and discharge directly to an independent outfall.

## 5.5 SUDS Strategy

- 5.5.1 SUDS makes use of surface based components, which are incorporated into natural landscaping, such as attenuation ponds and swales, filter strips and permeable paving. Soakaways and other infiltration techniques may also be appropriate if hydrogeological conditions permit. SUDS aim to mimic natural drainage patterns at the site, slowing flow rates close to source, and allowing water quality improvements as run-off flows through filtering media.
- 5.5.2 Source control measures could include rainwater harvesting and where appropriate soakaways which collect and store water from roofs of houses and other buildings. Infiltration tests undertaken on site on 24/25 August 2010, have indicated that infiltration is not a viable means of surface water disposal on this site. Infiltration rates were found to be negligible.
- 5.5.3 The site-wide drainage scheme will comprise a series of roadside grass swales or ditches which drain water towards the lowest points of the site. Flow will be slowed as it passes through these swales, which may incorporate check dams to further slow flow rates. Water quality will also be improved as a result of standing time and natural filtration processes. There may be a number of attenuation components in each sub-catchment within the site, such as ponds or grassed depressions (detention basins) which will temporarily store water and further attenuate flow rates as the water flows off-site. Attenuation ponds will be constructed which will potentially collect drainage from several sub-catchments throughout the site. Ponds can provide a



permanently wet feature which contributes to the ecology and green infrastructure of the site and surrounding landscape. Alternatively, they can operate so that they only store water during and after extreme rainfall events.

- 5.5.4 More detailed design of the SUDS measures will be developed during the reserved matters stage of the planning application when more detail about the development layouts will be available, in order to determine more accurate volumes of attenuation for each development unit (a unit being an individual employment building and its associated car parking/hardstanding).
- 5.5.5 PPS 25 presents a hierarchy of discharge options. Infiltration is the preferred option, but has been shown to be unfeasible at this site. Therefore, the second option, (attenuated) discharge to a nearby watercourse is to be pursued for this site.
- 5.5.6 Discharge from the northern part of the site is likely to be to the Langford Brook to the west of the site, a tributary of the River Ray and from the southern part of the site to the tributary of the River Ray to the south-east of the site.
- 5.5.7 Sustainable drainage has been incorporated at an early stage in the masterplanning process. For example, the layout of the development will be arranged so that drainage measures can be incorporated into the proposed development alongside roads in a generally down gradient direction. Space within the proposed development will be allocated for swales, ponds and other surface drainage features. Arrangements for the long term management of the drainage system will be developed as part of the Section 106 agreement for the outlined planning application at this stage it is assumed that a private management company would adopt the SUDS.





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## 6. Summary and Conclusions

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- 6.1.1 This FRA has identified that the large majority of the Graven Hill site lies within Flood Zone 1 and that fluvial flood risk from main rivers to the area of proposed development is minimal. There is a small area close to the Langford Brook in the north-west part of the site where climate change may cause the flood plain to extend onto the site by less than 15m.
- 6.1.2 The drainage strategy will employ a modern system that will control surface water flows, resulting in an improvement over existing conditions. As such, downstream flooding issues on the River Ray will not be exacerbated. While the principles of the drainage strategy have been agreed with the EA, the drainage system design will need further refinement at detailed design stage.
- 6.1.3 Based on the final masterplan, and further discussion with the EA, it may be necessary to make further assessment of the risk posed by the smaller adjacent watercourses, including hydraulic modelling. The present assessment suggests that the proposed development areas on the site are not prone to flooding from the Langford Brook, but there may be a limited risk associated with the watercourses adjacent to the south-east corner of the site where the CHP unit is proposed.
- 6.1.4 Geology and soils across the majority of the Site are impermeable which means that there is limited risk of groundwater flooding. There is some sandstone and alluvium in the far north-west part of the Site where localised groundwater flooding may be a risk. However, this area is outside of the area where new development is proposed (compare Figures 2.3 and 2.4 with the masterplan in Appendix A). Trial infiltration pits undertaken on site in August 2010 have shown that infiltration rates are negligible, with stiff clay being encountered in both pits tested on this site. As infiltration rates were found to be negligible, the tests confirmed that the ground can hold limited quantities of water. Groundwater flooding is therefore considered unlikely. However, under the masterplan this area will be developed as allotments and public open space rather than built development, in line with PPS 25.
- 6.1.5 No water infrastructure (such as canals or reservoirs) has been identified close to the Site which would result in flood risk if failure of this infrastructure occurred.
- 6.1.6 Sections 4.1.6, 4.1.7 and 4.1.8 provide detailed recommendations on Finished Floor Levels for the lower parts of the Site. Due to the situation of the Site, differing finished floor levels are recommended in the west, south-east and north-east of the site. For some areas these levels may need to be confirmed by further modelling of the local watercourses.
- 6.1.7 Surface water run-off will be managed through the implementation of SUDS which will include swales, attenuation ponds, and detention basins, distributed within a number of sub-catchments throughout the development which will drain to the surface water network and into the Langford Brook to the west of the Site or the watercourse at the south-east corner of the site boundary. Infiltration tests have confirmed that



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infiltration rates are negligible on the Site, and that therefore this is not a viable SUDS technique at this location.

- 6.1.8 Calculations showed that a storage volume of 8,485m<sup>3</sup> will be required on site for attenuation of run-off to greenfield rates. Although impermeable area will increase, the proposed development will reduce the total run-off rate compared to existing, as run-off will be attenuated to greenfield rates. As at present there is no formal attenuation of surface water run-off rates, this represents a significant betterment.
- 6.1.9 A review of flood risk policy shows that this FRA and its findings support the requirements of PPS 25 and demonstrates that the proposed development is appropriate and complies with flood risk requirements.



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## 7. References

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- CDC, 2010      Cherwell Local Plan (Draft Core Strategy), Cherwell District Council, February 2010
- DCLG, 2010      Planning Policy Statement 25: Development and Flood Risk, Department for Communities and Local Government, March 2010.
- CDC, 2009      Level 1 Strategic Flood Risk Assessment for Cherwell and West Oxfordshire, Cherwell District Council, West Oxfordshire District Council and Oxfordshire County Council, April 2009.
- DCLG, 2009      Practice Guide to PPS 25, Department for Communities and Local Government, December 2009.
- CIRIA, 2007      The SuDS Manual (C697), Construction Industry Research and Information Association, February 2007.
- SEARA, 2006      South East Plan - A Clear Vision for the South East, South East England Regional Assembly, March 2006.







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# Annex A

## Current Masterplan Layout

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Redevelopment of MOD Bicester  
Flood Risk Assessment

**Figure A1**  
**Graven Hill Illustrative Masterplan**

September 2011  
27808-L442.dwg. bernb





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# **Annex B**

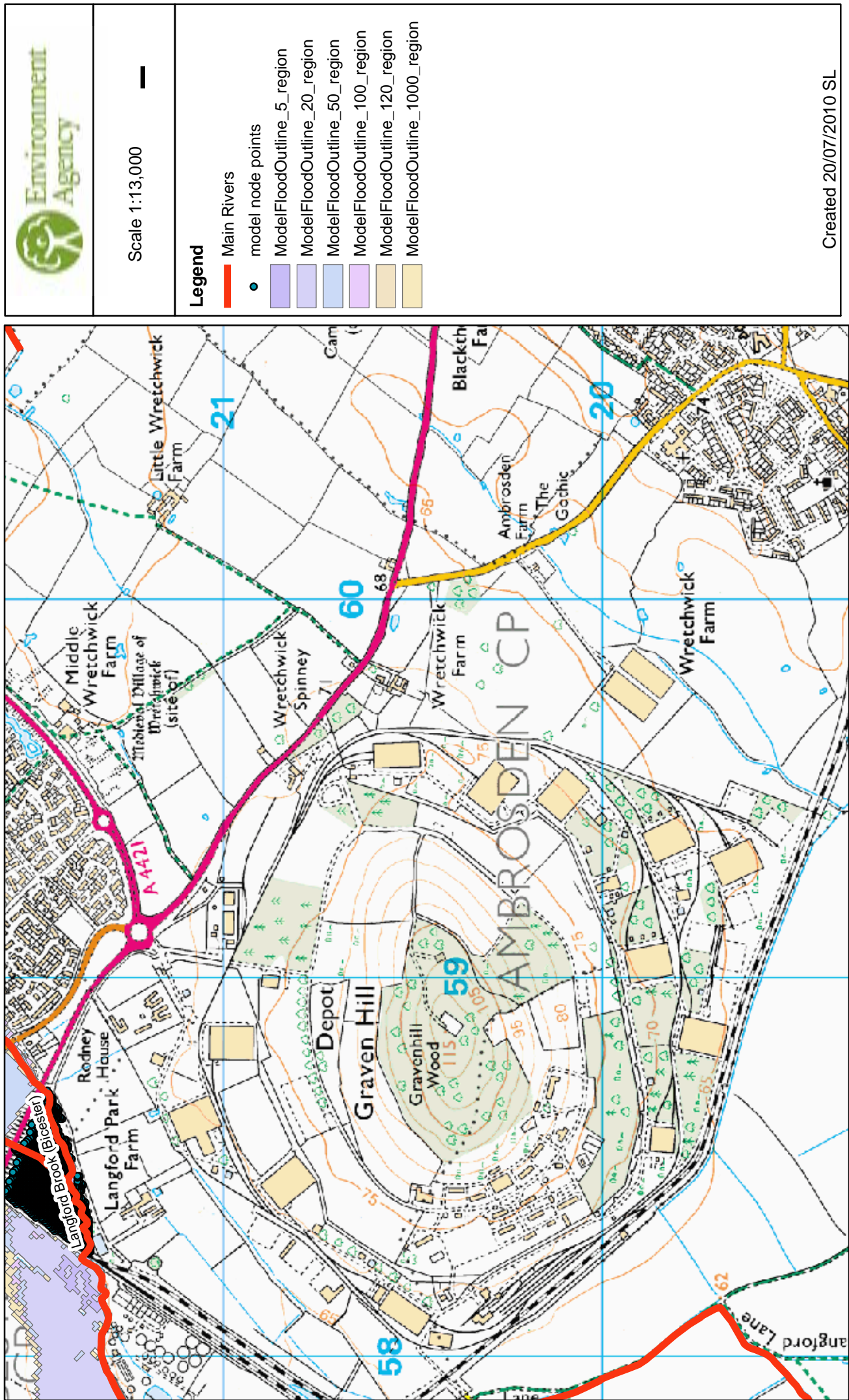
## **Flood Mapping Provided by the Environment Agency**

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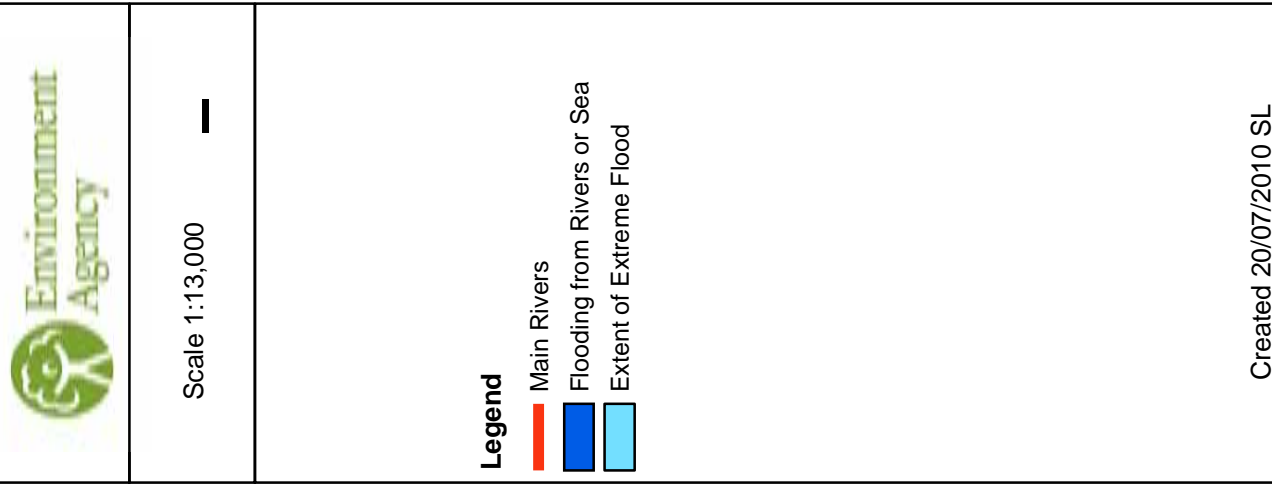
Basic FRA/FCA Map centred on Graven Hill, Bicester  
[Ref:14\_075\_014\_001]







[Ref:14\_075\_014\_001]

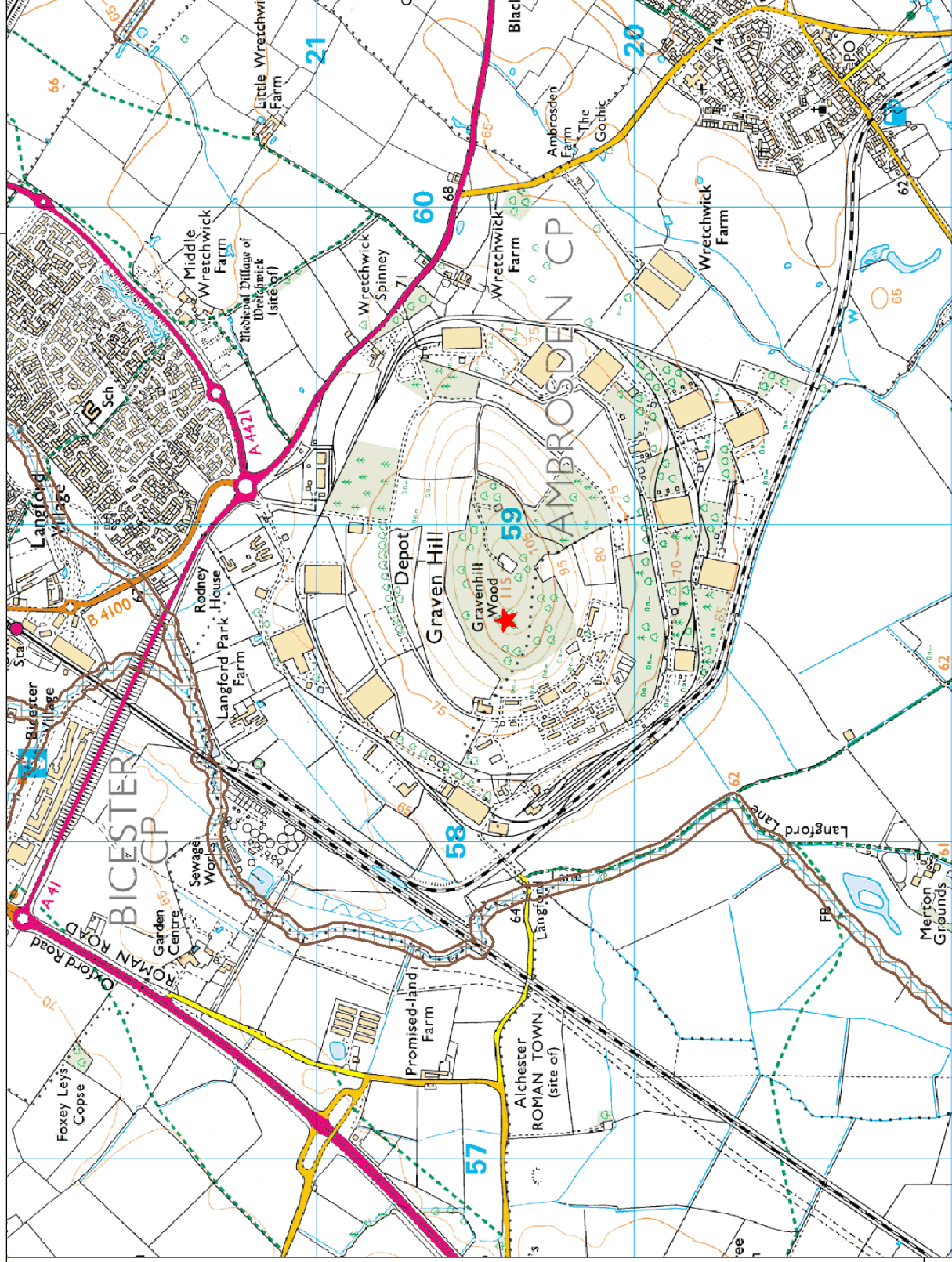






# WIR33378 Bank Top tool centred on Graven Hill 4.8.10

**Legend**  
 Bank Top ePlanning Tool



0 175 350 525 m.





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# Annex C

## Topographic Survey

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Please see data on CD.



