

Wimpole

RADIO-TRACKING REPORT

For and on behalf of

East West Railway Company

Revision 2

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1.0 EXECUTIVE SUMMARY

- 1.1 A scheme involving the construction of phase 3 of the Cambridge to Oxford railway from Bedford to Cambridge is subject to an Environmental Assessment. This report summarises the radio-tracking study undertaken in 2020.
- 1.2 The radio-tracking study had the following objectives:
- Trapping and radio-tracking up to 15 barbastelle bats post maternity to locate roosts and roost areas for barbastelle bats;
 - Try to determine if there are separate maternity colonies or a single colony with sub-groups to help assess the likely impacts of the proposals in the event that sub-groups are identified which could be fragmented;
 - Trapping and radio-tracking up to 5 serotine bats post maternity to determine whether there are any maternity roosts close to the proposed scheme of this species;
 - Determine core foraging areas and commuting routes for these two species specifically to assess whether the proposals will result in fragmentation or loss of core foraging habitat for bats from the maternity colony/colonies.
- 1.3 In the licence application, it was also requested that the licence should include radio-tracking serotine, if trapped. The aim of tracking these species would be to find the maternity roost(s) of these species (thought to be off-site) and determine the extent of their foraging areas within the zone of influence of the proposals.
- 1.4 A total of 77 bats were caught during four nights of trapping (17th, 18th, 20th and 22nd August 2020). Trapping locations were in two areas, Wimpole Estate including the Belts and Eversden Woods) and woodlands to the west (Hayley Wood and Waresley Wood). Trapping and radio-tracking was disrupted by bad weather (as highlighted in paragraph 3.3.5) conditions including high winds and lightning which resulted in some surveys being cancelled and others to be restricted as woodlands could not be entered in high winds.
- 1.5 A total of 12 barbastelles were radio-tagged. Two tags either failed or the bats moved out of the survey area as no records were made of these bats after being released (bat 4 and 10). A third bat (bat 3) was heard only sporadically during the day time in woodland to the south of Hayley Wood.
- 1.6 A total of 21 roost trees and a further three approximate roosts have been recorded. A single building roost has also been found.
- 1.7 No serotine bats were caught.

2.0 INTRODUCTION

2.1 Project Background and Purpose

- 2.1.1 East West Rail is a major transport infrastructure project that will establish a strategic railway connecting East Anglia with Central, Southern and Western England. It will link Oxford and Cambridge and eventually on to Norwich and Ipswich.
- 2.1.2 The railway is being planned and built in three sections; Western, Central and Eastern sections. The first phase of the Western section between Oxford and Bicester has been completed and planning for the next stage of the western section between Bicester and Bedford is well advanced. The next section is the Central section between Bedford and Cambridge which has been through a public consultation process from which a preferred route corridor has been selected.
- 2.1.3 Work is currently on-going to select the detailed route alignment of the central section within the preferred route corridor. The preferred route corridor passes at its nearest point approximately 3 km to the north of Eversden and Wimpole Woods Special Area of Conservation (SAC) (EU Code: UK0030331), which has been designated for its colony of barbastelle bats, one of the UK's rarest bat species for which site protection is required through the designation of SAC's.
- 2.1.4 Past radio tracking studies have shown that bats from the SAC are travelling up to 10.5km from the roost across and within the preferred route corridor and thus it is essential to inform the detailed design of the railway, mitigation measures and the environmental impact assessment that up to date information on the use of the preferred route corridor by barbastelle bats is gathered over the 2020 season and also the 2021 season before planning consent is applied for.
- 2.1.5 Bat surveys at Wimpole have been undertaken over many years, the site is a SAC for its population of barbastelle bats. Bat surveys including trapping and tracking in 2001/2002 by the Cambridgeshire and Bedfordshire Bat Groups and others recorded breeding barbastelle bats in trees within the estate and found bats flying quite widely to a variety of foraging areas to the north and east of Wimpole.
- 2.1.6 Further radio-tracking in 2004 recorded foraging areas similar to that in 2002 but with another area to the west also used for foraging.
- 2.1.7 Through discussion with stakeholders, concerns have been raised about impacts of the proposed new railway on serotine bat which are known to roost at Wimpole. Serotine is a rare bat in Cambridgeshire and as with barbastelle it is considered serotine are at risk if they regularly use land within the preferred route corridor.

2.1.8 The proposals for the 2020 radio-tracking surveys included:

- Trapping and radio-tracking up to 15 barbastelle bats post maternity to locate roosts and roost areas for barbastelle bats;
- Try to determine if there are separate maternity colonies or a single colony with sub-groups to help assess the likely impacts of the proposals in the event that sub-groups are identified which could be fragmented;
- Trapping and radio-tracking up to 5 serotine bats post maternity to determine whether there are any maternity roosts close to the proposed scheme of this species;
- Determine core foraging areas and commuting routes for these two species specifically to assess whether the proposals will result in fragmentation or loss of core foraging habitat for bats from the maternity colony/colonies.
- Locate roosts for serotine bats.

2.1.9 There are four key risks to be addressed in relation to barbastelles (and other bat assemblages that might be present and potentially impacted by the Proposed Scheme):

- Severance and/or loss of flight paths;
- Collision risk;
- Loss of roosts; and
- Loss of foraging habitat.

3.0 METHODOLOGY

3.1 Trapping and Tagging

3.1.1 A licence for the trapping and radio-tracking study was granted to [REDACTED]. The project was undertaken following the conditions set out in this project licence.

3.1.2 The licence allowed for the tagging of 15 barbastelle (excluding juveniles) and five serotine bats using Salts Latex Adhesive Solution 833005. The licence also included the ringing of the same number of bats. Ringing followed guidance set out in the Bat Workers Manual (2004).

Trapping

3.1.3 The capture of bats was undertaken by experienced and licensed bat consultants and follows guidance set out by Natural England's guidance (2013) and details set out in the Bat Workers Manual 3rd Edition (2004) and used both harp traps and mist nests. The trapping was undertaken between 17th and 22nd August 2020 in suitable weather conditions (sunset temperature 10°C or above, no rain or strong winds). Five woodland sites were chosen for trapping; Hayley Woods SSSI, Waresley Wood SSSI Northern Belts, Eversden Wood, and Eastern Belts that are located within the Eversden and Wimpole Woods SAC. Repeat trapping was undertaken at Hayley Wood and Eversden Wood. The selection of trapping locations was determined by known presence of barbastelle and successful past trapping in the Eversden and Wimpole Woods SAC and early barbastelle activity in Hayley Wood and Waresley Wood during woodland transects undertaken in July 2020 by BSG Ecology on behalf of East West Rail Ltd.

3.1.4 Biometric data were recorded from all bats caught including gender, forearm length and weight. Every bat was also examined to ascertain its breeding status, where possible. Only bats which were in healthy condition and of suitable weight were considered for tracking/ringing. Bats were tagged with radio-transmitters provided by Holihill. Tags weighed 0.47g, 0.35g or 0.28g, and the licence granted from Natural England allowed tags to be used on bats up to a maximum of 5% body weight.

3.1.5 To aid in trapping, acoustic lures (Sussex Autobat) were used during the trapping exercise. The lures played either a synthesised barbastelle social call and were used near to harp traps on a number of evenings specifically to attract those subject bats.

Tracking

3.1.6 Night time tracking of bats was undertaken between dusk and dawn or until they were lost by surveyors. Bats were also tracked by surveyors during the day who attempted to find their roosting locations.

- 3.1.7 Between two and eight surveyors were used to radio-track the bats, using both close-tracking and synchronised triangulation techniques to produce joint bearings. Surveyors used long-range MITEK radio-sets and mobile phones to allow contact to be maintained while synchronised joint bearings were taken. A series of safe observation points for the radio-tracking surveyors were pre-planned to allow for safe working and to provide the best receiver locations for joint bearings to be taken.
- 3.1.8 Bats were radio-tracked using Australis and Sika radio-tracking scanning receivers with Yagi rigid directional aerials to track bats on foot. Whip omni-directional antennas were employed when searching for bats by vehicle. Hand-held sighting compasses were used to take bearings and both detailed maps and handheld GPS units were used to provide locations for both surveyors and bats. More detail on the specifics of tracking is included in **Appendix 2**.

Personnel

- 3.1.9 The key night-time radio-tracking surveyors used were experienced in multi-bat tracking studies for development and road schemes, each having a minimum of seven years' experience of similar, sustained trapping and tracking survey. Experienced day-time surveyors were used to track bats back to day roosts. The main accredited agents used were: [REDACTED]
[REDACTED]
[REDACTED] were used as accredited agents during the trapping and for radio-tracking. All radio-trackers were experienced in such work.

Data Analysis

- 3.1.10 Detailed description of the analysis used for this tracking project are outlined in **Appendix 3**, however a summary is provided here. For each tagged bat, the triangulation points obtained have allowed habitat areas to be identified. Detailed statistical analysis relating to variation in home ranges (an area over which an animal or group of animals regularly travels in search of food or mates, and which may overlap with those of neighbouring animals or groups of the same species) or core areas (the area where the animal spends the majority of its time) has not been undertaken as the same level of survey effort was not carried out for each bat. Wherever sufficient information has been gathered, analysis of home ranges has been undertaken.
- 3.1.11 The data presented in this report are based on all available triangulation points. In addition, where a bat was known to be present in a given location at a given time, a data point was also generated. Where a bat was closely radio-tracked (for example, a bat foraging for a sustained period within a specific area), a triangulation point was generated for the approximate centre of the foraging area.

- 3.1.12 Bat fixes were transferred to digital geo-referenced maps using AutoCAD and coordinates for triangulation points were determined; the extent of bat activity for each bat was plotted independently and the data were carefully scrutinised and any obviously false bearings were discarded. The coordinates of the plotted triangulation points were then transferred into Ranges 7 software (Anatrack) and analysed to produce minimum convex polygons¹ (MCPs), neighbour linkage² (or clusters) and kernel contours³. These are all methods of showing home ranges. Where roosts were found, the roost sites were included within the home ranges. The analysis was carried out using 95% of the locations closest to the home range centre (for polygons produced by MCP analysis) or the 95% nearest to each other for the contour analysis (the cluster and kernel contours).
- 3.1.13 Within each data set, the trapping locations were specified as the focal sites and all coordinates from the night-time tracking and roost locations were inputted as location qualifying variables (LQVs) within Ranges (LQV's are time, activity, habitat, values associated with the x,y coordinates). The activities of the bats were assigned a numerical value for their activity, either roosting, flying or night-roosting for analysis within Ranges. Typically a focal site might consist of a static, repeatedly-used location such as a den or nest, but in the case of bats where roosts change regularly, the trapping location is the most appropriate focal point to use.

3.2 Emergence surveys of barbastelle roost trees

- 3.2.1 During the surveys, evening emergence surveys of tree roosts R4 in The Belts and R7 in Hayley Woods were undertaken on 19th and 26th August. Emergence surveys commenced at sunset and latest until approximately an hour after sunset or until the roost feature could no longer be seen. Emergence surveys were undertaken by two surveyors who were positioned where they had clear sight of potential roost features in each tree.

3.3 Survey Limitations

Covid-19 Pandemic

- 3.3.1 The Covid-19 pandemic resulted in a number of issues with respect to radio-tracking bats. These fall into two categories:
- 1) protecting the surveyors from the potential risks of catching and spreading Covid-19, and
 - 2) protecting bats as it is considered possible that the virus could potentially be passed between humans and bats.

¹ The MCP enables the creation of a boundary around all fixes using the smallest possible convex polygon. This is commonly used but may overestimate the size of home ranges.

² A type of multivariate analysis that uses records or measurements of a number of characteristics or features to group individuals into clusters or classes, so that individuals within each cluster/class are as alike each other as possible and as unlike individuals in other clusters/classes as possible.

³ Kernel methods quantitatively determine areas which are intensively used by animals by converting position coordinates into lines or areas with varying probabilities of use and present these graphically.

- 3.3.2 As a result a number of precautions were observed following the most up to date Defra advice at the time which was advice provided by Defra on 28th May 2020. Details of the specific precautions are set out in **Appendix 1** but the main constraint was the inability to work in a team and being restricted to having specific bubbles to avoid cross contamination. Prior to the radio-tracking work starting 11 surveyors were tested for Covid-19 and all were negative for the virus. Post radio-tracking the 11 surveyors were again tested for Covid-19 and those that were tested returned negative results. Of the remainder, two had tests but no results were forthcoming and two were unable to get tests due to a national shortage in early September. None of the surveyors have developed Covid 19 symptoms or had positive test results.
- 3.3.3 Guidance set out by Eurobats (April 2020) on handling of bats during the pandemic was also followed. This resulted in handling of bats being undertaken using nitrile gloves and face masks with regular sanitising of hands and undergloves. Holding bags were only used once for an individual bat any given night and washed at temperatures above 60°C before being used again. Survey equipment and PPE was disinfected after each bat was processed.
- 3.3.4 The guidance set out by Eurobats and Defra also takes a precautionary approach in relation to handling bats and the decision was made not to trap bats from the tree roosts. Trapping from tree roosts would entail direct and closer contact with roost sites and potentially more bats than necessary to fulfil the objectives of the study and the survey licence.

Trapping and Radio-tracking

- 3.3.5 During the radio-tracking session, the UK experienced a turbulent spell of weather with a strong jet stream bringing deep areas of low pressure. This resulted in storms Ellen (19th to 21st) and Francis (25th) which brought periods of heavy rain and gusts of 40 to 50Kt (Met Office 2020) across the region. As a result, two evenings of trapping was cancelled due to rain on 19th August and 21st August and one evening tracking session had to be cancelled. For health and safety concerns, searches for tree roosts during the day on the 21st August were also abandoned and curtailed on 25th and 28th August due to winds, rain and lightning.
- 3.3.6 Access was limited to certain areas around Wimpole and the woodlands of Hayley Wood and Waresley Wood. Only limited access was permitted for the night time tracking which was largely restricted to safe stopping places adjacent to public roads. As a result, it was not possible to access large swathes of land at night which resulted in some bats not being tracked as widely as others. This also meant that in some areas surveyors were often too far apart to stay in radio contact making joint bearings more difficult. Only safe stopping locations, away from houses were used. Consideration had to be given to not disturbing local residents late at night when radio-tracking. This caused difficulties obtaining joint bearings as the radio tag reception would often be lost and on occasion the bat being tracked could not be picked up for some time.

4.0 RESULTS

4.1 Trapping Results

- 4.1.1 Full details of all bats caught are provided in **Appendix 4**. None of the bats caught had previously been ringed. A summary of the species and the breeding status of caught bats are provided in **Table A1** with trapping location in **Table A2**. Twenty barbastelles were caught and ringed with 12 fitted with radio tags. A summary of bats caught is shown in **Table A3**. Vantage points for taking bearings are shown in **Figure A1**. The trapping and roost locations are shown in **Figure A2**.

Table A1 - Summary of species and breeding status of bats caught during trapping August 2020

Species	Female			Male		Unknown	Grand Total
	Adult breeding	Adult non-breeding	Juvenile	Adult	Juvenile		
Barbastelle	6	4	1	5	4	0	20
Brown long-eared	6	3	0	3	0	0	12
Daubenton's	0	1	0	0	0	0	1
Natterer's	4	2	0	8	0	0	14
Common pipistrelle	0	0	6	2	6	0	14
Soprano pipistrelle	2	1	1	7	4	1 (escaped)	16
Grand Total	18	11	8	25	14	1	77

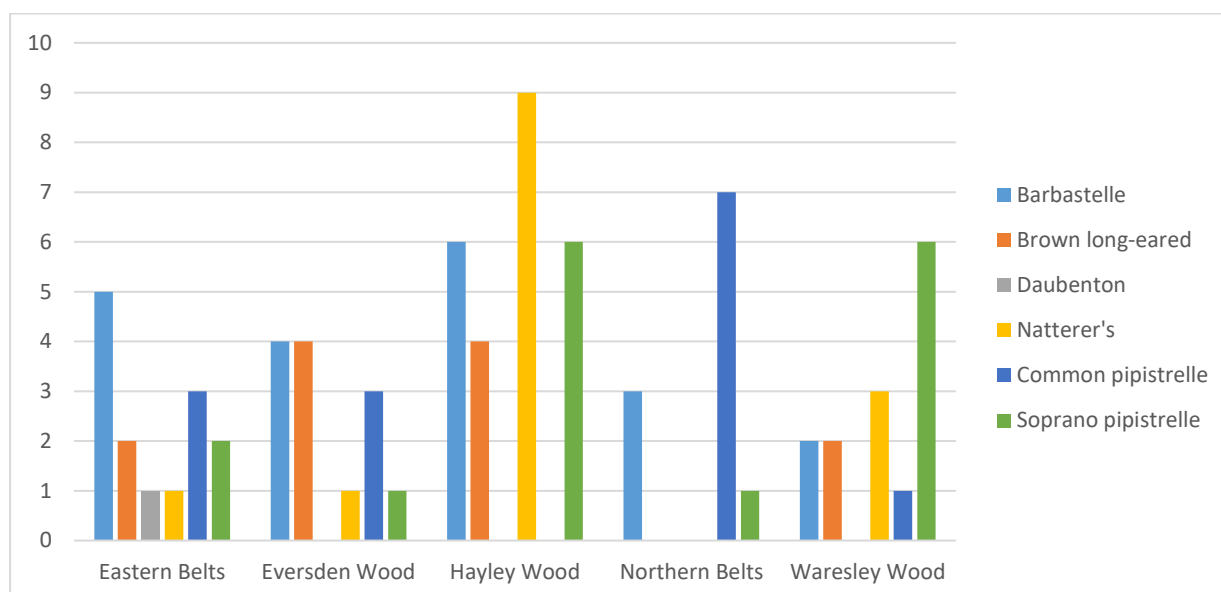
4.2 Trapping Overview

- 4.2.1 In total, 77 bats were caught during the trapping exercise and this included 20 barbastelles. This includes a single soprano pipistrelle that escaped the nets before it could be processed. Six species were caught across the five trapping areas. Barbastelle were caught at each trapping location with six breeding females caught at the five trapping locations; Eversden Wood, North Belts, Waresley Wood and Hayley Wood. Half of these breeding females were caught in Eversden Wood.

Table A2 - Summary of species of bats caught at each trapping location

Trapping Location	Barbastelle	Brown long-eared	Daubenton	Natterer's	C. pip	S. pip	Grand Total
Eastern Belts	5	2	1	1	3	2	14
Eversden Wood	4	4		1	3	1	13
Hayley Wood	6	4		9		6	25
Northern Belts	3				7	1	11
Waresley Wood	2	2		3	1	6	14
Grand Total	20	12	1	14	14	16	77

- 4.2.2 In addition to breeding barbastelle, post lactating (bred this season) brown long-eared, Natterer's and soprano pipistrelle bats were also caught. Male brown long-eared and soprano pipistrelle bats were found in breeding condition in Eversden Wood, the Eastern Belts and Waresley Wood.

Chart A1 – Numbers of bats caught per species at each trapping location

4.2.3 Twelve of the 20 barbastelle bats were tagged with radio transmitters. These comprised ten female (six post lactating) and two male bats. A summary of barbastelle trapping and tagging are given in **Table A3**.

4.3 Movement of Tagged Barbastelles (see Figures B1-B12)

Wimpole Bats

4.3.1 A total of seven barbastelles were caught and tagged in the woods around the Wimpole Estate: The Belts, The Gloucesters and Eversden Wood. These were bats 5, 6, 7, 8, 10, 11 and 12, and the majority of these bats were subsequently recorded roosting in trees within the Belts with the exception of bat 10 which was not recorded again after the evening it was tagged and bat 11 which roosted south in the Wimpole Estate on the days it was found. A total of 179 joint bearings were taken on this group of bats and 309 single bearings.

4.3.2 With the exception of bat 10 and 11, the remaining five bats followed a similar pattern in their activity during the tracking period. All five bats roosted in The Belts and all used Eversden Wood initially after emergence and before returning to roost. However, their activity pattern took them north and north-eastwards with several joint bearings recorded over the fields, woodland fragments and networks of ditches and brooks between Eversden Wood and the villages of Great Eversden, Toft and Comberton. On occasion, bat 7 and 8 were recorded in fields to the north of Comberton with bat 7 also being recorded further to the east around the River Cam at Grantchester a distance of 10.2km from its tree roost.

Table A3 - Barbastelle Trapping and Tagging Summary

Date	Bat tag no	Trapping Location	Time Caught	Sex	Age	Breeding status	Forearm (mm)	Weight (grms)	Ring number
17.08.20	1	Hayley Wood	20:55	F	A		38.3	8.5	J3516
17.08.20	4	Hayley Wood	23:40	F	A		38.4	9	J3521
17.08.20	3	Hayley Wood	22:20	F	A	Post lactating	39.3	9	J3520
17.08.20	2	Hayley Wood	20:55	M	A		36.7	7.5	J3517
17.08.20		Hayley Wood	20:55	M	Juvenile		37.6	9	J3518
17.08.20		Hayley Wood	01:25	M	Juvenile		38.4	8.5	J3522
17.08.20	6	Northern Belts	01:13	F	A	Post lactating	40.1	10	A2240
17.08.20	5	Northern Belts	00:32	M	A		37.4	9	A2210
17.08.20		Northern Belts	02:16	M	Juvenile		37	9	A2249
18.08.20	7	Eversden Wood	21:05	F	A	Post lactating	39.9	10	A2248
18.08.20	8	Eversden Wood	21:10	F	A	Post lactating	39	8.1	A2247
18.08.20		Eversden Wood	21:10	M	A		38	8	A2246
18.08.20	9	Waresley Wood	20:49	F	A	Post lactating	39.3	9.5	J3523
18.08.20		Waresley Wood	22:00	M	A		37.9	8.5	J3524
20.08.20	10	Eastern Belts	21:00	F	A		37.9	8.0	A2245
20.08.20	11	Eastern Belts	22:05	F	A		39.0	8.0	A2243
20.08.20		Eastern Belts	00:11	F	Juvenile		38.0	7.5	A2241
20.08.20		Eastern Belts	21:00	M	A		38.4	7.5	A2242
20.08.20		Eastern Belts	21:00	M	Juvenile		37.5	8.0	A2244
22.08.20	12	Eversden Wood	01:25	F	A	Post lactating	39.2	10.7	A2219

4.3.3 A cluster of single and joint bearings for bat 7 shows the importance of distinctive habitat features such as Bourn Brook which flows through the centre of its home range from Toft to Grantchester. This is also noted with bats 6 and 8.

4.3.4 The maximum distances recorded by the other bats in this group were less than bat 7 ranging between 3.65km for bat 12 to 6.97km for bat 6 (refer to **Table A4**).

4.3.5 Bat 11 was the only bat in this group with a home range to the south of the Wimpole Estate with several joint bearings recorded in fields around Wimpole Avenue and the River Cam and in fields to the west of the A1198. It was also recorded in woodland to the south of its trapping location, in Nurseries Wood (also known as Cobbs Wood on Ordnance Survey) and Four Acre Wood (also known as Four Acre Covert) where it was recorded roosting, although no roost tree was confirmed due to initial access constraints and then adverse weather constraints.

Hayley Wood Bats

4.3.6 Four bats; 1, 2, 3 and 4 were caught and tagged from Hayley Woods on the 17th August. Bat 2 was an adult male whilst bat 3 was a post-lactating female. Bats 1 and 4 were both non-breeding adult female bats. No

record was made of bat 4 after the night when it was trapped. The tag was working on its release but was it was not picked up again during either the day time roost tracking or the night time activity tracking. Bat 3 was only heard occasionally during the day time tracking with an approximate roosting location found to the south-east of Hayley Wood. No records were taken of this bat during the night tracking, access in the area to the south of Hayley Wood was very limited and there is a large area of open countryside between the road to the north of Hayley Wood and the nearest roads to the south, east and west. It is considered likely that this bat remained in this area during the night time. There were also fairly large areas to the north where there were large areas of countryside with limited locations for access.

- 4.3.7 A total of 26 joint bearings for bat 1 and 37 for bat 2 were made. Bats 1 and 2 both emerged from roosts in Hayley Wood and after foraging in the wood after emergence would leave the wood and head north. The bats were tracked as best as possible in this area but often only single bearings could be taken of these bats. It is thought they used the ditch and stream network around the Gransden Lodge Airfield (home to the Cambridge Gliding Centre).
- 4.3.8 Obtaining joint bearings of bats 1 and 2 was made more difficult due to road network in that part of the survey area as well as the local topography. Therefore, the assessment had to focus more on single bearings which were 79 for bat 1 and 110 for bat 2. However, the tracking has shown that both bats roosted in Hayley Wood only and both spent their time during the project predominately to the north of Hayley Wood. No single or joint bearings were recorded to the south of the wood. Bats 1 and 2 were often recorded roosting together and favoured tree roost R7 in the south-west section of the woodland.
- 4.3.9 Bat 1 was tracked to the south-west of the village of Cambourne with a good number of joint bearings around Caxton. Bat 1 was recorded as far north as Pastures Farm 7.53km north from its roost tree (R7) on that day and as far west as Little Gransden on the same night.
- 4.3.10 Bat 2 spent more time further to the west with several joint bearings to the south-west of the village of Eltisley. Joint bearings were recorded in Eltisley Wood, Turtlow Plantation and South Lodge Plantations to the south and west of Eltisley with the most northern triangulation recorded on the 25th August 7.12km from its roost tree (R7) on that day. A cluster of single bearings on 20th August suggest it may use Gransden Brook south of Great Gransden and Little Gransden.

Waresley Wood Bats

- 4.3.11 Bat 9, a post lactating female, was the only bat caught and tagged at Waresley Wood although a second barbastelle (a male was caught) but it was decided not to track it because the focus of the survey was to find breeding roosts and foraging areas used by female bats. The female that was tagged was caught on the 18th August and was recorded foraging within Waresley Wood on the 19th and 20th August. On 21st

August it was recorded more extensively to the north-east of Waresley Wood. It was recorded roosting in Waresley Wood only where it used six tree roosts. Bat 9 stayed very much in the same location on consecutive nights. It was difficult to get many joint bearings on this bat as it foraged along Gransden Brook to the south of Great Gransden and Little Gransden where there are few safe stopping locations or places away from dwellings for the surveyors to be able to get bearings. The majority of the activity has been recorded by single bearings from Great Gransden Mill. It was noted that when it became more blustery the bat appeared to move towards the lane at Great Gransden Mill and would fly up and down the ley side of the hedgerow. It was also recorded to the south on the road towards Hayley Wood west of Gransden Lodge foraging along the road and in the shelter between two tall parallel hedgerows.

- 4.3.12 Due to the difficulties tracking this bat only five joint bearings and 41 single bearings were taken. This data showed that the fields and ditch network immediately to the south and east of Little Gransden were important. Particularly Gransden Brook. The home range of this bat was fairly small and it is considered that this maybe fairly accurate although not many bearings were recorded as it was not recorded in other areas such as in foraging grounds of bats 1 and 2.

Table A4 - Distance travelled from roost

Bat No	Date	Distance in km	Roost	Joint Bearing number
Breeding Females				
Bat 3	N/A	N/A	N/A	N/A
Bat 6	27/08/2020	4.43	R12	6.26
Bat 7	24/08/2020	10.2	R12	7.20
Bat 8	26/08/2020	5.22	Unknown but likely R12	8.27
Bat 9	22/08/2020	2.34	R10	9.5
Bat 12	27/08/2020	3.65	R12	12.9
Mean distance		5.17		
Non-breeding female				
Bat 1	24/08/2020	7.53	R7	1.1
Bat 4	N/A	N/A	N/A	N/A
Bat 10	N/A	N/A	N/A	N/A
Bat 11	27/08/2020	4.76	R12	11.29
Mean distance		6.15		
Male				
Bat 2	25/08/2020	7.12	R7	2.29
Bat 5	24/08/2020	6.97	R12	5.25
Mean distance		7.05		

Distances travelled

- 4.3.13 The distances travelled from roosts are presented in **Table A4**. The distances measured are straight-line distances between the furthest recorded location and the roost used during the daytime beforehand. The maximum distance recorded from a roost in this study was by a breeding female (bat 7), travelling 10.2km,

nearly twice as far as the next longest distance by bat 8. The mean maximum distance for breeding females was 5.17km (excluding bats 3 and 4), slightly less to that of non-breeding females of 6.15km. The mean maximum distance for the male bats was 7.05km (range 6.79 to 7.12km).

4.4 Roost Information

- 4.4.1 The tracking survey confirmed a total of 21 tree roosts and a single barn. Roosts were found in the following locations:

The Belts – 12 tree roosts recorded supporting bats 5, 6, 7, 8 and 12;

Hayley Wood – three tree roosts recorded supporting bats 1 and 2;

Waresley Wood – six tree roosts supporting bat 9 only;

[REDACTED] (grounds of Wimpole House) – single roost used by bat 5 only.

- 4.4.2 In addition, several unconfirmed roosts were recorded. A roost supporting bat 3 was recorded in a tree belt to the south-east of Hayley Wood; the precise roost location could not be identified due to constraints with landowner consent. Roosts supporting bat 11 were identified in two woodlands in the Wimpole Estate area, Nurseries Wood and Four Acre Wood, for which access was later agreed but the roosts could not be precisely located; the locations of these two roosts are therefore listed as being approximate (denoted by AR). The roosts of bats 4 and 10 were not found during the radio-tracking study.
- 4.4.3 Of the 21 tree roosts that were confirmed in 2020, 13 were in ash trees, seven in oak and one in beech. Of these, nine were in trees with dense ivy cover, three were behind loose/lifted or flaking bark, and five were in large splits or cavities. A combined list of the tree roosts and their descriptions is provided in **Appendix 5**, whilst information regarding which tree roost was used per day by each bat is given in **Appendix 6 and 7**. Distances of each roost from the woodland edge are provided in **Table A5**.

The Belts

- 4.4.4 The Belts is a narrow band of planted deciduous woodland on the northern side of the main Wimpole Estate. The woodland is contiguous with The Gloucesters in the east and with woodland on the Wimpole Way to the west. It is understood the woodland was planted as part of the historic landscape design for the Wimpole Estate and as such the trees are mainly large mature specimens.
- 4.4.5 Twelve trees within The Belts were identified as roosts, comprising ash *Fraxinus excelsior* (10 trees) and oak *Quercus* sp. (2 trees). Five of the 12 tagged barbastelle roosted within this woodland with a peak of four bats (bats 6, 7, 8 and 12) roosting in the same roost (R12) on a single day. The roosts varied in their distance from the edge of the woodland with trees noted between 9m and 81m into the woodland; the mean distance of these trees from the edge of the woodland was 38m.

Hayley Wood

- 4.4.6 This is an area of ancient woodland and Site of Special Scientific Interest (SSSI) measuring approximately 46ha and located to the west of the Wimpole Estate. The woodland is classified as lowland mixed deciduous and is designated due being one of the largest oxlip *Primula elatior* woods in Britain. Structurally, the wood is coppice-with-standards of field maple *Acer campestre*, ash, hazel *Corylus avellana* and hawthorn *Crataegus monogyna* with a canopy of oak.
- 4.4.7 Three tree roosts were identified in the woodland and these were used by bats 1 and 2. The trees were ash and oak, located between 13m and 68m from the woodland edge; the mean distance of these trees from the woodland edge was 47m.

Waresley Wood

- 4.4.8 This wood is located 2.6km north-west of Hayley Wood and is an area of ancient woodland and SSSI that measures approximately 62ha. It is designated due to its ancient origin and the ash-maple community which has a national distribution restricted to lowland England. The tree species are similar to that of Hayley Wood but sections of the wood are now dominated by invasive species birch *Betula pendula*, aspen *Populus tremula* with regenerating English elm *Ulmus procera*.
- 4.4.9 Six tree roosts were found within Waresley Wood and all were used by bat 9 only. Tree roosts included oak (three trees), ash (two trees) and a single beech *Fagus sylvatica*. This wood had the most variation in the distance of the roosts from the woodland edge, ranging from R13 located at 0m, on the very edge of the woodland, to R18 located 192m into the wood; the mean distance from the edge was 78m, significantly higher than the other two woodlands.

- 4.4.10 Bat 5 was the only bat recorded roosting in a [REDACTED] [REDACTED] [REDACTED] the roosting location was under a lintel above the western double barn doors.

Use of Tree Roosts and Movement Between Roosts

- 4.4.11 Barbastelles are known to move roost regularly, and one key aim of this study was to establish if there was interaction between bats in the west of the study area, around Hayley Wood and Waresley Wood, and bats from the Wimpole Estate in the east. Of the 21 confirmed tree roosts, 12 were located in The Belts, six in Waresley Wood and three in Hayley Wood. The only non-tree roost recorded during the survey was the [REDACTED] [REDACTED]. A summary of bats recorded in each tree per day is shown in **Appendix 7**.

Table A5 - Distance from the nearest woodland edge of known roost trees used in 2020

The Belts		Hayley Wood		Waresley Wood	
Tree roost no.	Distance from nearest edge (m)	Tree roost no.	Distance from nearest edge (m)	Tree roost no.	Distance from nearest edge (m)
R1	36	R7	13	R9	53
R2	9	R8	68	R10	75
R3	30	R19	60	R11	33
R4	53			R13	0
R6	57			R15	113
R12	41			R18	192
R16	51				
R17	55				
R20	81				
R21	22				
R23	12				
R24	11				
Mean	38	Mean	47	Mean	78

- 4.4.12 Roost R12 in The Belts was used by the highest number of tagged bats, with four post lactating females (bats 6, 7, 8 and 12) recorded on 27th August. This is a large oak located 41m from the woodland edge and covered in dense ivy but with signs of die-back from the crown; the precise roosting feature could not be confirmed as there are multiple roosting features. The next highest number of tagged bats were recorded in R12 again (bats 6, 7 and 8) on 23rd August and R17 (bats 6, 7 and 12) on 28th August. Several other trees were used on the same occasion by two bats.
- 4.4.13 The straight line distances between roost switches between consecutive days was measured. For example, Bat 1, a non-breeding female, roosted in R7 on 19th August but on 20th August it had moved to R19. The straight line distance between these two trees is 72m. The distances between each tree roost switch recorded are given in **Table A6**. There are significant numbers of trees and clusters of trees with potential for supporting barbastelles in these woodland blocks, particularly within The Belts which has a very even age structure due to the history of this woodland which was planted as part of the designed landscape for the Wimpole Estate.
- 4.4.14 Bats 5, 6, 10 and 11 were caught in The Belts and bats 7, 8 and 12 were caught in Eversden Wood. The roosts of bats 10 and 11 were not confirmed during the survey, but the remaining bats were all recorded using tree roosts within The Belts. No roosts were recorded in Eversden Wood. On numerous occasions the tagged bats from these two woodlands were recorded roosting together in various combinations in different trees: bats 6, 7, 8 and 12 in R12 (27th August); bats 6, 7 and 8 in R12 (23rd August); bats 6, 7 and 12 in R17 (28th August); bats 6 and 7 in R2 (19th August) and in R21 (20th August); bats 6 and 12 in R6 (24th August); bats 7 and 8 in R12 (24th August); and bats 5 and 8 in R3 (19th August). The distance between the roosts in

which bats were recorded on successive nights within The Belts is: 15m (R2 to R21), 187m (R4 to R20), 105m (R23 to R12), 102m (R24 to R12), 156m (R12 to R6), 92m (R12 to R17) and 113m (R1 to R3). Two bats were recorded moving roost during the day: bats 5 and 8 were recorded together in R3 in the afternoon and subsequently moved, bat 5 to R5 and bat 8 to R4 prior to a planned emergence survey of R3.

Table A6 – Distances between barbastelle roost switches between consecutive days in 2020

Roosts	Distance (m)	Location of trees	Status and number of bats
R2 - R21	15	The Belts	Breeding females x2
R4 - R20	187	The Belts	Breeding female
R23 - R12	105	The Belts	Breeding female
R24 - R12	102	The Belts	Breeding female
R12 - R6	156	The Belts	Breeding female
R12 - R17	92	The Belts	Breeding females x2
R1 - R3	113	The Belts	Male
R3 - R5	979	The Belts [REDACTED]	Male
R5 - R16	1,069	The Belts [REDACTED]	Male
R8 - R7	322	Hayley Wood	Non-breeding female & male
R7 - R19	72	Hayley Wood	Non-breeding female
R10 - R11	133	Waresley Wood	Breeding female
R11 - R13	318	Waresley Wood	Breeding female
R13 - R18	383	Waresley Wood	Breeding female
R18 - R15	301	Waresley Wood	Breeding female
R15 - R13	471	Waresley Wood	Breeding female

- 4.4.15 Although the roosts of bat 11 could not be confirmed, joint bearings identified approximate roost locations as being within Nurseries Wood (AR25) and Four Acre Wood (AR22) in the Wimpole Estate. Movement between these locations was not recorded on successive evenings so it cannot be confirmed whether the distance between the approximate roosts (1,614m) was travelled on any particular evening.
- 4.4.16 Bat 5 was the only bat during the survey period to roost in both trees and a structure, being recorded in trees in The Belts (R1, R3 and R16) and in the [REDACTED] (R5). This bat was recorded in each of the tree roosts only once and in the barn on nine occasions, seven of which were consecutive from 19th to 25th August inclusive, followed by a further two consecutive evenings on 27th and 28th August. The distance between the roosts in The Belts and the barn in which bat 5 was recorded on successive nights is: 979m (R3 to R5) and 1,069m (R5 to R16); this is the furthest any bat was recorded travelling to a roost. Bat 5 shared a roost on only one occasion, roost R3 which it shared with bat 8 on 19th August, however both bats moved away from this roost during the day before the evening emergence.
- 4.4.17 Bats 1 and 2 were caught in Hayley Wood and were consistently recorded roosting in the same area; these bats did not venture to any other wood to roost. Bat 1 was recorded roosting in three different trees, whilst bat 2 was found in two. On the majority of evenings bats 1 and 2 were recorded together in R7 and on a

single occasion (18th August) these two bats were recorded together in R8. Roost R19 was only used on one occasion (20th August) and only by bat 2. An emergence survey of R7 was undertaken and a total of five barbastelle emerged including bats 1 and 2. Bat 1 was not found on 20th August, it was not in the same roost as bat 2. The signal within Hayley Wood was often dampened by the dense understorey in the woodland. The distance between the roosts in which these bats were recorded on successive nights is 322m (R8 to R7) for both bats and 72m (R7 to R19) for bat 2 only. Bats 3 and 4 were also caught in Hayley Wood but were not recorded roosting within this woodland: bat 3 was consistently recorded roosting in a tree belt to the south-east of Hayley Wood and the roost of bat 4 was not found during the survey period.

- 4.4.18 Bat 9 was trapped in Waresley Wood and, as with bats 1 and 2, was only recorded roosting in the same wood. This bat was recorded in six different trees, five of which it was only recorded in on a single occasion. During the period between 19th to 28th August, bat 9 shifted roost on a daily basis with the exception of 27th and 28th August when it remained in roost R13; this was the only roost bat 9 was recorded in more than once. The distance between the roosts in which bat 9 was recorded on successive nights is: 133m (R10 to R11), 318m (R11 to R13), 383m (R13 to R18), 301m (R18 to R15) and 471m (R15 to R13).
- 4.4.19 Bat 6 from The Belts and bat 9 from Waresley Wood were recorded using the greatest number of roosts of all the tagged bats, each moving between six different roosts within their respective woodlands. Bat 8, caught in Eversden Wood, used the next highest number of roosts and moved between five different roosts in The Belts. The three bats recorded using the greatest number of roosts were all breeding females. In contrast the two male bats and one of the non-breeding females were more faithful to their roosts: bat 5, caught in The Belts, was recorded in R5 on nine out of the 11 evenings it was recorded; and bats 1 and 2, both caught in Hayley Wood, were recorded together in R7 on eight occasions. Regarding confirmed roosts, each of the other bats was recorded using an individual roost on no more than four occasions through the survey period.
- 4.4.20 The greatest distances between roosts of any bats were by bat 5, one of the two tagged males, which travelled 1,069m and 979m between tree roosts in The Belts and [REDACTED] on consecutive nights. The greatest distance between two confirmed roosts used by breeding female bats within the study area was 471m (bat 9). The smallest distance between roost switches of breeding females in 2020 was 15m between R2 and R21 in The Belts. The mean distance between roost switches of breeding females was 176m, although there was a significant difference between the mean distances travelled by breeding females between roosts within The Belts (95m) and Waresley Wood (321m).

4.5 Foraging Areas and Home Ranges of Barbastelle Bats

- 4.5.1 Bats were recorded over a range of areas during the radio-tracking surveys. The areas used are summarised in **Figures B1 to B12** which illustrate triangulation points, extent of ranges and the MCP, neighbourhood

linkage (clusters) and kernels for each bat radio-tracked. The total number of bearings achieved (including night and day roosts used) have also been shown. These data are set out in **Table A7**.

- 4.5.2 Whilst the radio-tracking undertaken followed the bats for only a relatively short period of time, the data collected shows some patterns to barbastelle behaviour. The bats roosting in Eversden and Wimpole Woods SAC demonstrated a similar use of the landscape as shown by the Cambridgeshire Bat Group tracking studies between 2000 and 2002. However, there appears to have been no overlap in bats moving between the Wimpole colony to the east and the Hayley/Waresley Wood area.

Table A7 - 95% Home Range Analysis (areas in ha)

Breeding females					
Bat number	No. bearings achieved	MCP Ha	Cluster		Kernel
			Ha	No of nuclei	
6	117	1439.1	1293.1	2	1720.1
7	70	3474.9	284.7	5	4120.4
8	115	1964.7	1239.6	2	1830.5
9	45	306.2	122.9	3	289.6
12	65	632.3	328.3	2	620.6
Mean	-	1563.44	653.72	2.8	1716.24
Non-breeding females					
Bat number	No. bearings achieved	MCP Ha	Cluster		Kernel Ha
			Ha	No of nuclei	
1	104	1682	490.7	9	1429.1
11	53	347.3	48.9	5	289.2
Mean	-	1014.65	269.8	7	859.15
Males					
Bat number	No. bearings achieved	MCP	Cluster		Kernel
2	67	2400.8	687.99	4	2335.5
5	62	1528.2	331.3	4	1747.8
Mean	-	1964.5	509.645	4	2041.65

- 4.5.3 Of the Hayley Wood/Waresley Wood bats, no records were made of the bats from these respective woodlands visiting the other woodland, however, there is some overlap in foraging areas/home ranges between these bats. Obviously only a single breeding female bat was tracked from Waresley Wood and one non-breeding female from Hayley Wood. One of the tagged breeding female bats (bat 3) from Hayley Wood was not recorded during night time tracking and no access was possible to the area where an approximate

roost was found. The non-breeding bat 4 was not recorded again once it was released from being tagged.. When looking for the bats, regular checks were made of the woodlands in case any of the bats had returned during the night. Bat 9 was regularly recorded along the Gransden Brook.

- 4.5.4 Millsaugh and Marzluff (ed 2001) suggests that more than 100 fixes are required to obtain reliable estimates of home range size using minimum convex polygon (MCP) analysis, while the kernel analysis is useful when a smaller sample size is obtained and, along with cluster analysis, are useful at identifying multiple centres of activity, particularly in heterogeneous environments. A 95% MCP analysis was carried out instead of a 100% MCP as this eliminates outliers. **Figure C1** shows the MCPs for adult breeding female barbastelles. The sample size was good for two of the six tagged breeding female bats, 6 and 8 with 117 and 115 bearings achieved respectively: this includes single as well as joint bearings, roosts and night roosts. Of the other three, where the sample size was smaller, bat 9 appeared to have a smaller home range with a restricted area for foraging. Regular checks of the area where it had been found around Gransden were made and whilst it did not appear to move into any of the areas which may be affected by the proposals it was considered that sufficient effort had been made to determine the foraging areas for this bat. A total of 46 bearings was achieved.
- 4.5.5 Bat 3, the sixth breeding female tagged, which was trapped in Hayley Wood, appeared to remain to the south or south-east of Hayley Wood with only occasional records being made during the day or early in the evening towards an area of woodland to the south-east of Hayley Wood. No joint bearings were possible and therefore no home range analysis could be undertaken. The remaining bats all had over 60 locations, with Bat 7 recording 70 points and 12 recording 65 points.
- 4.5.6 The MCP areas for bat 12 (breeding female) measured 632.3ha but this does not represent the full home range of this bat. This is because on occasions it was not recorded in the Eversden Woods/Belts area nor in the area of the Bourn Brook south of Toft and it could not be recorded elsewhere.
- 4.5.7 The average MCP area for all the breeding females was 1,563.44ha. The greatest MCP area was generated by Bat 7 with a home range of 3,474.9ha. Bat 7 was recorded foraging to the south-west of Cambridge around Grantchester some 10.2km from the Belts where it was recorded roosting. It also appeared to show some fidelity to the Bourn Brook. Bats 6 and 8 also roosting in the Belts had home ranges smaller than bat 7 with 1,439.1ha and 1,239.6ha respectively were also found to use the Bourn Brook particularly between Comberton, Great Eversden and Kingston.
- 4.5.8 Two non-breeding female adult bats were tracked; Bats 1 and 11, a further two non-breeding females (bats 4 and 10) were not recorded after being released and it is thought that their tags failed. However, as bat 4 was not caught until 23:40hrs it is possible that it roosted further away to the south where access was limited.

The average MCP area recorded for the two non-breeding female bats was 1,014.65ha ranging from 347.3ha (bat 11) to 1,682ha (bat 1). Bat 1 was caught shortly after sunset in Hayley Wood and roosted within the wood, it was not found on several nights after it left Hayley Wood despite surveyors searching widely. It was then recorded west of Cambourne on three consecutive nights foraging widely around The Moats and Pastures Farm up as far north as the A428 and east of the A1198 over an area which is a mix of farmland and a construction site. On one of the windier nights it was found around the fishing lakes to the south-west of Cambourne just north of Bourn Road. It also spent some time foraging around Bourn airfield. It is thought that it may have been in Longstowe Park but the stopping points along the Old North Road were constrained by overhead powerlines producing electrical interference.

- 4.5.9 Bat 11 was caught in The Belts but its actual roosting tree was not located. Access into the wider Wimpole Estate had to be arranged and due to weather constraints the surveyors did not enter woodlands to search for tree roosts. The bat was recorded possibly roosting in Cobb's Wood and then down in Four Acre Covert. The 95% MCP of Bat 11 was 347.3ha and was recorded mainly south of The Belts with one particular period of sustained activity in the southern part of Wimpole around the River Cam.
- 4.5.10 For the male bats (2 and 5), the mean 95% MCP recorded was 1,964.5ha with bat 2 recording 2,400.8ha and bat 5, 1,528.2ha. It is thought that the full extent of the home range of bat 2 was not found as it was not recorded on a number of nights after leaving Hayley Wood. It left the roost woodland heading north and spent some time around Gransden Lodge airfield but could then not be found on several nights despite searches in all directions. It was then found foraging extensively around Eltisley and the southern site of Croxton Park. Given the access restrictions and the large area between the roads around Eltisley and Caxton, it is possible that the bat was in this area but the signal was not strong enough to carry to the surveyors.
- 4.5.11 Bat 5 was recorded regularly in the woodlands of The Belts and Eversden Wood and regularly along the Bourn Brook to the south-east of Toft. It is likely that the full range of this bat was not fully recorded, it was recorded further north to the east of Comberton and hadn't been recorded in the Bourn Brook area prior to that so is thought to have ranged further north.
- 4.5.12 The 95% kernel analysis (see **Figure C3**) recorded home range sizes of the breeding female bats of between 4,120.4ha and 122.8ha with a mean of 1,716.22ha. The non-breeding female bats resulted in kernel home range sizes from 289.2ha to 1,429.1ha with a mean of 859.15ha.
- 4.5.13 The 95% kernel analysis of the adult male barbastelle bats recorded home ranges between 1,747.8ha and 1,747.8ha and a mean of 2,041.65ha.

- 4.5.14 The core area size (based on a 95% cluster analysis) of the breeding female barbastelles ranged from 122.8ha to 1,293.1ha, with the number of core areas per bat ranging from 2 to 5 **Figure C2**.

Habitat Use

- 4.5.15 During the 2020 study, barbastelles have been recorded using a variety of habitats for foraging and commuting. The core foraging zones tend to consist of woodland blocks close to or within their roosting areas, but also open fields of mainly arable land which is the main habitat type to the north and north-east of Eversden Woods. These fields do, on occasion, have broad hedgerows with pockets of fragmented woodland. The fields are crossed by a network of ditches and the streams, such as Bourn Brook, seem to be an important feature in the landscape for this maternity colony. The golf course at Toft provides barbastelle with a fairly sheltered foraging environment with lines of mature vegetation but also ponds.
- 4.5.16 Habitats to the east within the home range of bats 1, 2 and 9 are also similar with open fields of arable with small fragments of woodland. Here too, streams in the local landscape are a key feature as are the ditch networks.

4.6 Interchange Between Eversden and Wimpole SAC and Eastern Woods

- 4.6.1 During the 2020 surveys, there were no bats that roosted outside of the area where they were caught. Certain bats such as bats 7, 8 and 11 that were trapped in Eversden Wood, roosted fairly close by in The Belts and Nurseries Wood respectively. No bats from the SAC roosted in Hayley or Waresely or other woods to the east and likewise neither did bats from these woodlands roost in Wimpole.
- 4.6.2 In addition, there was no overlap of activity with bats from Everley/Waresley Wood with bats from The Belts or Eversden Wood. The furthest west a bat from the Wimpole area was recorded was around Kingston Wood located to the east of the A1198 and likewise bats from the east ventured northwards rather than toward the Wimpole colony. A similar distribution of bats was recorded by the Cambridgeshire Bat Group 2004/5, although one bat was recorded west of the A1198 within 1 km of Hayley Wood.

4.7 Emergence Surveys of Barbastelle Roost Trees

- 4.7.1 Three emergence surveys were undertaken of two trees in The Belts, R4 and R17, and one tree in Hayley Wood, R7, on 19th and 26th August. No simultaneous combined emergence survey of all trees was undertaken as the emphasis was on the radio-tracking to ascertain habitat use. The emergence surveys assisted with determining where bats were roosting for trapping purposes and provided information on whether tagged bats were roosting with untagged barbastelles or other bat species. The results of the three emergence surveys were:

Tree R4 – three barbastelle emerged including bat 8;

Tree R7 – five barbastelle emerged including bats 1 and 2;

Tree R17 – bat 7 emerged and it could not be confirmed if any other barbastelle emerged.

- 4.7.2 No other bat species were recorded roosting in the same trees with the barbastelles during the emergence surveys.

4.8 Breeding Status

- 4.8.1 The bats during the 2020 survey were tracked in the post-lactation period. Of the 10 adult female barbastelle caught and tagged, six (60%) had bred in 2020; however, the sample size was too small to be other than indicative. Juvenile barbastelle bats that were caught but not tagged appeared to be well-developed.

- 4.8.2 Three of the post lactating female bats were caught from trapping locations in Eversden Wood, with one caught in each of the three other trapping woods (The Belts, Hayley Wood and Waresley Wood). The single juvenile female and two of the non-breeding females were caught in The Belts, and the remaining two non-breeding females in Hayley Wood. Of the five adult males, two were caught in The Belts and one from each of the other trapping woods (Eversden Wood, Hayley Wood and Waresley Wood). The four juvenile males were caught in The Belts and Hayley Wood, with two bats caught in each.

4.9 Other Species Trapping Information

- 4.9.1 In addition to the 20 barbastelles caught, 14 common pipistrelles, 16 soprano pipistrelles, 14 Natterer's bats, 12 brown long-eared bats and a single Daubenton's bat were trapped. Common pipistrelle and Daubenton's were the only species that no breeding females were caught although 11 of the 14 common pipistrelle were juvenile. Of all species, roughly equal numbers of male and females were caught (37 female and 39 male) with a single soprano pipistrelle escaping from the net before sexing.

- 4.9.2 In total 17 post lactating females were caught; six brown long-eared, four Natterer's, two soprano pipistrelle and the six barbastelle. Juvenile bats were recorded for all species with the exception of brown long-eared and Natterer's.

- 4.9.3 The largest number of bats was trapped in Hayley Wood with 25 and then fairly equal numbers ranging between 11 at the Northern Belts, 13 at Eversden Wood and 14 at the Eastern Belts and Waresley Wood.

5.0 EVALUATION

5.1 Barbastelle Tracking

- 5.1.1 The trapping and tagging project has shown that the woods at the Eversden and Wimpole Woods SAC and the SSSIs of Hayley Wood and Waresley Wood support breeding colonies of barbastelle bats. The radiotracking has shown that there was no interchange in roosting between bats from the Wimpole Area and the woods (Hayley and Waresley wood) to the west.
- 5.1.2 The tracking has shown that the bats caught in the east of the study area, in the Eversden and Wimpole SAC, and the west of the study area, in Hayley or Waresley woods, do not have home ranges that overlap. All bats tagged cover ground rapidly and continuously within foraging areas. The bats that were being tracked were rarely recorded as static, bat 1 was recorded possibly static on two nights for a short period of time. As the bats were not all recorded continuously it cannot be certain whether they used night roosts but only limited amount of night roosting appeared to have been recorded for those bats that were tracked at any given time.

Habitat Use

- 5.1.3 The main foraging areas for bats from the Wimpole Estate was primarily the areas to the north and east, with the exception of bat 11, which foraged over the Wimpole parkland and habitats to the south to the River Cam. The woodland areas within the SAC are obviously extremely important to the colony and are generally the only substantial broadleaved woodland habitat within their home range. The study has shown that the females use the woodlands in the early evening and prior to returning to roost but also in periods of inclement weather. This correlates to studies undertaken by Zeale *et al* (2012) where their study of barbastelles in Devon and Mottisfont SAC in Hampshire found that all their study bats foraged within woodland roost sites before commuting to core foraging areas. Both studies show the importance of managing woodland roost sites carefully by maintaining the canopy layer to provide cover from predatory birds and allowing bats to emerge and feed earlier (Jones and Rydell 1994; Russo et al. 2007). Similarly, the use of tree lines, such as The Belts, by bats when close to roost sites highlights the importance of preserving canopy connectivity beyond the borders of woodlands (Hillen et al. 2010).
- 5.1.4 The landscape to the north and north-east of the SAC is far more open than some of the other SAC's designated for barbastelle within the UK: Ebernoe Common SAC and the Exmoor and Quantock Oakwoods SAC which have breeding colonies in large woodland sites surrounded by a network of extensive woodland and other suitable habitat which are widely considered as optimal barbastelle habitat. The habitats surrounding Wimpole and Hayley/Waresley Woods are more agricultural and interspersed with hedgerows of varying degree of structure and small pockets of isolated woodland. Zeale *et al* (2012) found that arable habitats were least selected by their study bats due to the low prey populations over arable fields resulting from pesticide use. However, this 2020 study has shown the reliance on those arable habitats to the north

of the SAC by the colony. Within these areas is a network of hedgerows but also ditches and watercourse which have been confirmed as being used for foraging and also as a commuting link through the landscape.

- 5.1.5 Bat 11 was the only bat from the Wimpole Estate to forage to the south of its roosting area. It also roosted in different woodlands to the main colony. However, the foraging habitats were not too dissimilar with areas of open arable dominating the landscape. Tracking confirmed the importance of the River Cam/Rhee as a foraging area and commuting route.
- 5.1.6 A similar pattern emerged from bats from Hayley Wood and Waresley Wood showing the importance of woodland roost sites. The habitats in the home ranges of these bats are similar to the Wimpole colony of arable fields, hedgerows, ditches and watercourses.

Roost Selection

- 5.1.7 The 2020 study recorded 22 confirmed roosts, of which all but one (R5) were trees, and these were predominantly ash and oak with a single beech. Tree R19 could not be confirmed as the tag signal suggested either an oak or ash that were very close to each other. Some features confirmed as roosting sites included raised bark and large splits which is similar to that found in other radio-tracking research of this species in Italy (Russo *et al.* 2004), Germany (Kerth & Melber, 2009) and England (Billington, 2002; Greenaway 2008; Greenaway & Hill, 2004) where barbastelle nursery roosts tended to be within splits in trees or under loose bark. Russo *et al* 2004 found 20 out of 27 tree roosts of breeding female bats were under raised bark.
- 5.1.8 Other research has found that breeding roosts are found in quiet locations well away from the woodland edges and surrounded by dense cover (Russo *et al* 2004; Greenaway 2008) but this was not necessarily the case in this radio-tracking survey. In 2020, seven of the 21 confirmed tree roosts were found within 30m of a woodland edge: with 14 recorded beyond this. Roost R12 was found to support the largest number of bats and this was located 41m from the edge of The Belts. It was also noticed that there are a number of well used footpaths through The Belts which is a fairly narrow block of woodland. None of the trees were immediately adjacent to any of the footpaths but several were in view of the footpaths. The roost R3 was one of the closer roosts to a footpath and it was from this roost that bats 5 and 8 moved between after being found during the day and before the emergence survey that night.

Movements Between Roosts

- 5.1.9 Barbastelle are known to move roosts regularly even during the period when their young cannot fly (Russo *et al.*, 2004). The mean distance moved between trees by female bats in central Italy ranged between 31m and 626m, with distances contracting during the main lactating period (Russo *et al.*, 2004). This suggests that female barbastelles, in order to continue to move roosts regularly, need a large number of suitable roost trees relatively close to each other during the whole breeding season, but particularly during the main

lactating period. Russo *et al.* also found that barbastelle roosts were most frequently found within unmanaged woodland where the dead trees occurred most frequently, in comparison with managed woodland and pasture woodland, and where clusters of larger trees occurred. Greenaway and Hill (2004) found that the roosts tended to be located within a distinct area which they refer to as a “loyalty area”. Loyalty areas will gradually change over time as woodlands develop, and Greenaway and Hill (2004) suggest that management plans for nursery roosting sites should include areas of five to ten times the area that bats are presently using.

- 5.1.10 The distances between roost-switches (movements between roosts located in the two woodlands in which roosts of breeding females were recorded) in 2020 are summarised in **Table A8**.
- 5.1.11 Russo *et al.* (2004) found during the late lactation/post lactation phase that the range for distances between roost switches was between 0 (sic) and 352m with a mean of 89m. During this 2020 study 12 of the 14 combinations of roost switches fell within the distance range found by Russo *et al.* (2004) during the late lactation/post lactation phase; the remaining two roost switches, both from Waresley Wood, were greater. The mean distance of switches within The Belts was very similar to that found by Russo *et al.* (2005), whilst the mean distance moved between roosts within Waresley Wood was higher; however, it should be noted that the results from Waresley Wood relate only to one bat. Overall, tracked barbastelles at this site switched roosts on a regular basis, as found in other studies, but over larger distances than reported in some. However, a study in Germany found that female barbastelles could cover much larger distances (up to 9.0km between consecutive day roost locations: Kerth & Melber, 2009), and it seems likely that there is a great deal of variation between colonies, probably reflecting the relative availability of roost sites. The breeding females moved roosts the most. The males travelled furthest on average between roosts but were much more faithful to their roosts.

Table A8 – Summary of distances between roost-switches by breeding females in 2020

	Minimum (m)	Maximum (m)	Mean (m)	Number of switches	Number of bats	Mean switches per bat
Overall	15	471	176	14	5	2.8
The Belts	15	187	95	9	4	2.25
Waresley Wood	133	471	321	5	1	5

- 5.1.12 The difference between the mean distances moved by breeding females in The Belts and Waresley Wood could be for a number of reasons which have not yet been determined. The shape and size of Waresley Wood is very different to that of the Belts. Both are well used woods by walkers but due to the shape of the two woods the effect of disturbance by walkers is likely to be greater in The Belts than at Waresley. However,

at this stage an assessment of number of trees within the two woodlands has not been made and the distances moved within the two woodlands may be related to the distribution of trees within the woodland.

- 5.1.13 There was no overlap in bats roosting together from the different trapping locations. The study shows that the colony located in the Eversden and Wimpole SAC are separate to those colonies found in woodlands to the west. In addition, home ranges of bats in the eastern colony do not overlap with those of bats in the western colonies and there is a clear distinction in areas of the main foraging and commuting habitats. There was some overlap in home ranges between the Hayley Wood and Waresley Wood colonies but that is not considered significant due to the close proximity of those woodlands.

Colony Structure and Size

- 5.1.14 Barbastelle maternity colony sizes are difficult to estimate (as discussed in Greenaway, 2008), largely due to the numerous roost changes. Although simultaneous emergence surveys of all known tree roosts were not undertaken in 2020, as data on bat activity took priority, the results of the emergence surveys carried out recorded the tagged bats roosting with other barbastelles in both woodlands. A peak of five barbastelles were recorded emerging from tree R7 in Hayley Wood on 19th August, including bats 1 (a non-breeding female) and 2 (a male). However, on the days during which more than half of the tagged bats were tracked to a day roost in 2020 at least four, and up to seven, different day roosts were being used on any one day. All of these counts are therefore likely to have represented only a proportion of the population in the wider area.
- 5.1.15 Russo *et al.* (2004) found the number of bats in a maternity colony over seven different counts throughout July and August was 16.7 bats $\pm$ 4.2 (range 12-23 bats). Billington (pers. comm.) counted 26 bats within a single tree roost in Somerset. Greenaway (2008) studied two maternity colonies in Sussex, and estimated counts of at least 64 breeding females in one maternity colony and at least 80 breeding females in the other. Counts of a single tree near Norwich in August 2009 (BSG 2010) recorded between 55 and 59 bats from a single tree (these would be a mixture of female and juvenile bats). These colonies were further divided into sub-groups of 16-25 breeding females (Greenaway, 2008, Greenaway & Hill, 2004). Bats have been recorded changing sub-groups between different years, but never changing nursery colonies (Greenaway, 2004; Greenaway, 2008; Greenaway & Hill, 2004). It is not known whether the colonies in this study support the sub-group theory; those papers discussing sub-groups generally are of high-quality habitats covering larger areas such as the Ahringsbachtal Special Area of Conservation (SAC) in Germany and the Mens and Ebernoe Common SACs in England.
- 5.1.16 During the 2020 radio-tracking surveys, one non-breeding female bat (bat 1) was recorded within the same roost trees as one of the two male bats (bat 2) and appeared to move with this bat into different tree roosts. These two bats were recorded emerging from one of their roost trees with three other barbastelles, however,

the breeding status of the additional bats could not be confirmed and it is not possible to know the movements of the untagged bats. Three other non-breeding female barbastelles were tagged, one of which (bat 11) was recorded roosting within two woodlands to the south of the wood in which it was caught but it was not possible to ascertain the precise roost trees or whether this bat was roosting with other barbastelles. This bat did not appear to move with any of the other tagged bats that were roosting in this area. The roost locations of the final two non-breeding female bats were not recorded during the study period. Non-breeding females have been recorded roosting within maternity colonies (Greenaway, 2008), but have also been recorded roosting with small groups of males (Parsons *et al.*, 2003).

5.2 Foraging Areas and Home Ranges

Foraging Areas

- 5.2.1 As described above, the main foraging areas for the breeding females appear to extend out from the woodland areas of Wimpole and Hayley/Waresley Wood and extend over the habitats particularly to the north which is criss-crossed with streams and ditches. The landscape is dominated by arable farmland, which grassland restricted to small fields associated with the edge of the settlements and along watercourses or in larger blocks in golf courses, Gransden Lodge airfield, parkland (old and new) or institutional grounds. Fragments of ancient woodlands are present as are more recent blocks of plantation woodland. The field boundaries support a wide variety of hedgerow habitat or linear woodland/scrub often associated with watercourses.
- 5.2.2 Radio-tracking has been carried out at Wimpole in the past with an initial survey between 2000 and 2002 (Cambridgeshire Bat Group). This previous study recorded bats foraging to 6.5km from Wimpole with one bat foraging 11km to the west of Cambridge. This bat was found south of High Cross on one night, which is approximately 3km north of the Grantchester area where bat 7 was recorded in 2020. Some information provided by Cambridgeshire Bat Group of radio tracking studies in 2000, 2002, 2004 and 2005 showed home ranges of bats from the Wimpole Estate which largely covers the same areas as found during this 2020 survey including a bat foraging in the Grantchester area. The sex or breeding status of these bats is not known.

Home Ranges: Breeding Females MCP and Kernel Analyses

- 5.2.3 Home Range Analysis was undertaken for all bats where sufficient bearings were collected. These can be compared with data from other radio-tracking studies. The other studies typically used 100% MCPs, rather than (as here) 95% MCPs to eliminate outliers. The data for this tracking survey are similar to the ranges recorded for adult female barbastelles in the Mens (range 260-2,928ha; mean: 1,236ha); and are greater than the mean recorded in Germany (222ha; Kerth & Melber, 2009) and at Ebernöe Common (range: 45 - 2,521ha; mean: 779.5ha; ⁴Greenaway, 2008). Previous radio-tracking studies by Corylus Ecology have

⁴ Note the MCP% analysis is not given in Greenaway 2008 but given as 100% MCP in Kerth and Melber 2009)

recorded a lower mean home range area for other sites in East Anglia although with similar range for the 95% MCP and kernels recorded from radio-tracking at this same time of year (mid-August).

- 5.2.4 The home range kernel analysis results are greater than the home ranges recorded for 12 female barbastelle bats at the site in Germany, although a wider range of values were recorded (kernel 95%: range: 125-2551ha; median: 403ha; Hillen *et al.*, 2009). Another site in Germany recorded a smaller mean home range (90% kernel mean: 108.6ha) (Kerth & Melber, 2009)

Table A9 – Mean Home Ranges for breeding females (all areas in ha)

Status	Year	2020
Breeding females	95% MCP Mean (range)	1563.44 (306.2-3474.9)
	95% Kernel Mean (range)	1716.22 (289.5 – 4120.4)
	95% Cluster mean (range)	653.7 (122.8 – 1293.1)
	No. of nuclei/cluster	1 - 4

Home Ranges recorded in other studies							
Status	Analysis Type	Mens	Ebernoe	Hillen <i>et al.</i>	Kerth <i>et al.</i>	Norwich NDR	Suffolk
Breeding females	100% MCP Mean (range)	1,236 (260 – 2928)	779.5 (45 – 2521)	-	222		
	95% MCP Mean (range)					904 (393 – 1637)	714 (329-2020)
	95% Kernel Mean (range)			403 (125 – 2551)	108.6 (90% Kernel)	884 (460 – 2119)	582 (309 - 1275)

Core Areas Defined Through Kernel Analyses

- 5.2.5 Core areas are those where an animal spends the majority of its time. Hillen's radio-tracking study of barbastelle (Hillen *et al.*, 2009) looked at core areas used within each bat's home range. In that study, the core area was defined as 50% and home range was defined as 95% of the kernel density estimate. On that basis, the median number of core areas per bat was two with a range of one to five core areas per bat tracked per year. The core area size ranged from 5ha to 285ha. They found that all the home ranges of radio-tracked females (breeding and non-breeding) overlapped with at least one other home range but that only 41% of the core areas overlapped with another female's core area, suggesting a degree of partitioning.

Although the sample size for the study was small (19 data sets from 12 female bats), Hillen *et al.* 2009 determined that female barbastelles partition foraging areas and keep individual hunting areas constant over time.

- 5.2.6 The same analysis was undertaken of the 2020 Wimpole data (the Waresley Wood bat has been excluded), using the 50% kernel area of five breeding female barbastelle bats. This resulted in 66% of core areas having no overlap and therefore 34% being overlapped by at least one other core area, a very similar result to the Hillen study. **Figure C7** shows the 50% kernel areas of the breeding female barbastelle bats.
- 5.2.7 It should be noted that for both studies it is not known how many untagged bats were foraging in these core areas. Therefore it is possible that there is a greater degree of overlap in individual foraging areas than is otherwise indicated by the data presented here. The Hillen and East West Rail studies differ because at EWR the bats were radio-tracked over the same time period with multiple surveyors allowing the bats to be tracked simultaneously, whilst the Hillen study tracked either single bats or pairs of bats at any one time. The Hillen study did, however, track the same bat over different years with one bat tracked in each of the four years of the study, one during three of the four years and three during two of the four years. The researchers concluded that fidelity between years appeared to be more important in determining home range than intraspecific competition. None of the bats at EWR have been knowingly caught and tracked over different years as ringing has not previously taken place.

Cluster Analyses: Breeding Females

- 5.2.8 Cluster analysis creates a number of nuclei or clusters for each bat. The cluster area size defined by a 95% cluster analysis of breeding female barbastelle ranged from 122.8 to 1293.1ha with the number of nuclei ranging from 2 to 5 (as shown on **Figure C2**). Whilst a number of these cluster core areas overlap, there may be some partitioning of foraging habitat. It should be noted that only a subset of the population of barbastelle bats is tracked at any given time and it is not known how many other non-tagged bats may have been foraging in these areas. The main clusters for bats 6 and 8 largely overlap, both covering a wide area from Kingston to Toft and Comberton. Two smaller clusters to the east are close to each other either side of Wimpole Road south of Barton. Two of the five clusters of bats 7 overlap with the clusters recorded for bat 12. Three of bat 7's clusters overlap with the large areas of bats 6 and 8 whilst the fifth cluster towards Grantchester does not overlap with any of the others.

Non-breeding Female Barbastelles (MCP, Kernel and Cluster Analysis)

- 5.2.9 Two non-breeding female bats were successfully radio-tracked in 2020: Bat 1 from Hayley Wood and Bat 11 from Wimpole. Given the small sample size (two bats) comparisons on the average sizes of home ranges cannot be made. The 95% MCP home ranges for the non-breeding females ranged from 347.3 to 1,682ha (bat 1), the range of bat 1 being within the range of those recorded by the breeding female bats. The home

range of bat 1 is considered to potentially be an underestimate as it could not be found on several nights during the tracking, similarly bat 11 was not tracked as extensively as it tended to fly south and away from any potential areas of impact with the proposals. The 95% cluster analysis for bat 1 as 490.7ha compared to the mean size for breeding females of 653.7ha although the number of nuclei recorded was highest for this bat (9) compared to all other bats tracked. Bat 11 had five nuclei whilst all bar one of the breeding females had either two or three nuclei. One possible theory for this is the non-breeding female bats use a greater number of foraging areas than the breeding female bats. Bat 7 a breeding female had 5 nuclei with a small cluster size of 284.7ha which suggests this specific breeding bat used a greater number of nuclei.

- 5.2.10 The kernel analysis recorded a smaller overall kernel size for the non-breeding females compared to the breeding females. Bat 1 for example with an MCP of 1,682ha has a kernel of 1,429.1ha compared to bats 6 and 8 which had kernels of 1,720.1 and 1,830.5ha respectively despite the MCP being smaller than that of bat 1.
- 5.2.11 Greenaway (2008) found that there was greater variability in MCP size for non-breeding barbastelles (both male and female). The lower metabolic demands of non-breeding bats mean that they do not require such large foraging areas; conversely a tendency to 'wander' in the late summer to find mating opportunities means they can also have quite large ranges as defined by MCP. For example, it was determined that non-lactating female noctules used more marginal and less preferred habitats significantly more than lactating bats (Mackie & Racey, 2007), although there was little difference in timing of foraging activity or distances travelled.

Male Barbastelles (MCP)

- 5.2.12 Two male barbastelle bats were tracked in 2020, one from Hayley Woods and one from the Wimpole Estate. As with the non-breeding females the sample size is too small to assess differences based on average home ranges. The two bats had 95% MCPs ranging between 1528.2ha and 2400.8ha. These are the second and fifth largest out of the nine bats tracked with usable data. The breeding female bats recorded the largest and third largest MCPs. Male bats tend to range over much greater distance and tend not to be associated with the core breeding habitat monopolised by the females. Greenaway (2004) proposed that the foraging areas used by the male may more frequently be in sub-optimal habitats when compared to those used by the females; however, in this instance, there appears to be a greater degree of overlap for the male bats at this site than occurs in the Sussex sites. During the 2020 surveys, five adult male barbastelles were caught, compared to 10 adult female bats and in both instances the male bats were recorded roosting in the woodland where the breeding female bats were roosting. The male barbastelles were recorded flying in the areas of habitat used by the female tracked bats: male bat 2, for example, roosted in Hayley Wood often with bat 1 (a non-breeding female) and was recorded regularly in around the Great Gransden Mill area. Male bat 5 was caught in Wimpole and was regularly recorded foraging in Eversden Wood and over the Bourn

Brook. Its usual roost was the [REDACTED] but it was recorded roosting with bat 12 (a breeding female) on one occasion and in tree roosts in The Belts on two other occasions.

Distances Travelled

- 5.2.13 Barbastelle bats radio-tracked from The Mens Woodland SAC ranged widely (range: 2.64-11.98km; mean: 7.1km), as did those from Ebernoe Common SAC (range: 1.17-10.46; mean: 5.1) (Greenaway, 2008). The average flight distances for pregnant or lactating females at the same locations were 7.67km and 5.09km respectively (Greenaway, 2008). From Paston Barn near Cromer (Norfolk), female barbastelles flew a maximum of 2.75km to their foraging site, while males were tracked 4.75km (Parsons *et al.*, undated). At two sites in southern England, the home ranges varied considerably with bats travelling between 1 and 20km to reach foraging areas with the average range span being 6.8km (Zeale *et al.*, 2012). In Norfolk, the maximum distance travelled by a breeding female bat was 9.4km (average 5.84km), whilst for a male it was 13km (BSG 2010). During this survey, the maximum distance recorded from a roost was 10.2km for bat 7 (a breeding female) whilst the mean maximum distance from a roost for breeding females was 5.17km. The mean maximum distance for the non-breeding female bats in 2020 was 6.15km whilst the mean maximum distance for the male bats was 7.05km
- 5.2.14 The 2020 distances recorded are consistent with the results of previous studies (Greenaway, 2004; 2008 and Zeale *et al.*, 2012) despite the differences in the extent of woodland habitat found at the subject site compared to the habitat availability at the other study sites.
- 5.2.15 Research in Sussex suggested that breeding females dispersed from the roost area along established flight lines to foraging areas often several kilometres away; the female repeatedly using the same flight line, and juveniles following the mothers out along the flight lines to become familiarised with the routes and foraging zones (Greenaway 2004). Whilst the flight lines may be shared, they were generally found to end in a section used by a single bat to access the most distant foraging area (Greenaway 2004). The radio-tracking surveys to date have not found this, with bats flying widely within the landscape: that is, the tracked barbastelle did not tend to follow singular linear features rather they used the ditch, stream and hedgerow features within the landscape extensively. They appeared to be less reliant on linear features to commute to foraging areas than has been suggested for other studies. As stated above, the habitats at Ebernoe and the Mens are more extensive than at Wimpole or Hayley Wood/Waresley Wood. In Suffolk (Arcadis 2020) and in Norfolk (BSG, 2010), foraging over less high-quality foraging habitat has been recorded, with foraging over arable land being recorded in both instances. The prevalence of arable habitat surrounding the roost woodlands does not restrict the movement of the bats, and they do not appear to use singular linear corridors to move between the areas of higher quality habitat. However, certain water courses appear to be of significant importance, specifically the Bourn Brook which was used extensively for foraging and commuting, the Gransden Brook and associated water courses and ditches around the Gransdens and the water courses and ditches around the Cambridge Gliding Club and north around Caxton and Cambourne.

- 5.2.16 During the summer season, Greenaway (2004) records that male barbastelle tend to be active for fairly short periods of the night, and appeared to forage entirely in woodlands within 1km of their roost site. In the present study, although the male bats were not continuously followed, they were regularly recorded throughout the night, and were clearly foraging further from their roost than the Greenaway study. Bat 5, which roosted in The Belts/tithe barn, was recorded at least 6.97km from its roost whilst bat 2 was recorded 7.12km from its roost areas, and in all cases appeared to be spending considerable periods of time foraging. It is likely that there are a number of factors affecting the distances the male bats move including breeding. The trapping and tracking was undertaken in the latter part of August when mating may be starting. However, neither of the male bats were noted as being in breeding condition (with enlarged testes), although both were recorded roosting with female bats.
- 5.2.17 There could be some seasonal variations to habitat use for foraging due to temperature/food availability. Seasonal diet changes in barbastelle have been researched and it has been found that they selectively predate larger moth species even during periods when smaller moth species are more abundant (Andreas *et al.*, 2012). It was found that, whilst there were generally no abrupt seasonal changes in their diet within season, the exception is in autumn, when the larger moths are replaced by smaller moths. It is considered that this is due to prey availability as most moth species cease to fly and only the smaller species are still flying during this time. Larger moths are still present but display limited flying activities. This autumn period is reported as being into November in the study area within the Czech Republic. The radio-tracking of barbastelles particularly at Hayley Wood/Waresley Wood has only been undertaken in summer, and it is likely that there will be seasonal and weather-related changes to key foraging areas throughout the year.

6.0 CONCLUSION

Barbastelle Bats

- 6.1 The radio-tracking undertaken in 2020 largely achieved the four objectives set out in para 1.2, for barbastelle bats. No serotine bats were caught and therefore no information relating to their foraging areas or commuting routes has been gathered.
- 6.2 Bats were caught post maternity with roosts and roost areas for barbastelle bats recorded in Wimpole, at Hayley Woods and Waresley Wood. A total of 12 barbastelle bats were tagged, two of the tagged bats were not recorded after the evening they were caught. One of these (bat 4) from Hayley Wood was caught late at night and it is possible that this bat did not roost within Hayley Wood but used habitat to the south over which there was little access. Bat 3 was also caught in Hayley Wood was rarely recorded and usually only during the daytime in the direction of a small section of woodland to the south-east of Hayley Wood. It could not be recorded during the night time flying period and it is thought it remained within this area between Hayley Wood, Hatley St George and Croydon. Foraging areas and home ranges were tracked for the remaining nine bats.
- 6.3 No cross-over between bats from Wimpole and bats from the western woodlands of Hayley Wood and Waresley Wood was recorded. No interchange of roosts between Hayley Wood and Waresley Wood was recorded although there was some overlap in home ranges and foraging areas between bats from these two woodlands.
- 6.4 The main foraging areas for the breeding females appear to extend out from the woodland areas of Wimpole and Hayley/Waresley Wood and extend over the habitats particularly to the north which is criss-crossed with brook's streams and ditches. The habitats are a mixture of arable, golf courses, and an air field. Of most significance for foraging was the Bourn Brook through to Grantchester east of Cambridge and the various ditch and water courses around Gransden (Gransden Brook and Mandeian Brook) and water courses in the north around Caxton and Cambourne including Eastern Brook, Haydean and Gascote Dean. If the proposed railway passes through these areas there is an increased risk of loss of a proportion of foraging habitat, severance of flight lines and interaction between bats and trains than areas away from the Bourn Brook corridor and the water courses and mixed landscapes around Great and Little Gransden.

Other Bat Species Caught

- 6.5 Over four nights of trapping, 77 bats of six species were caught. Barbastelle was the most frequently caught species with 20 with soprano pipistrelle being the second most numerous species caught (16). Fourteen common pipistrelle and Natterer's bats were caught and 12 brown long-eared bats. A single adult non-breeding female Daubenton's bats was caught in the eastern belts.

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Appendix 1 – COVID-19 Survey Protocols

The Covid-19 pandemic resulted in a number of precautions the following guidance set out by Defra dated 28th May 2020 which includes the following:

- 1) For each trapping location three surveyors will work together, there will be one experienced tagger capable of tagging and ringing the target bats, a second licenced bat handler capable of removing bats from harp traps and mist nets, the third will be the recorder. This will prevent the potential cross-contamination of several handlers/surveyors using equipment whilst also ensuring the safety of bats caught in the traps and being tagged. It will also limit the number of people coming into close proximity/handling bats.
- 2) The following PPE and precautions will be used:
 - a. Face masks – these will be worn at all times when handling bats and for any occasions where a 2m social distance between surveyors cannot be maintained;
 - b. Gloves will be used as matter of course for handling bats and prior to handling any bats the gloves will be sanitised using hand sanitiser and then dried. They will be washed between trapping nights.
 - c. Animals will be kept separate from other individuals as much as reasonably possible with adequate trapping bags taken to site to ensure 1 bat per bag and if at all possible re-use of bags kept to a minimum.
- 3) All equipment will be cleaned and disinfected before and after use.
- 4) Water and soap will be carried in all cars to allow proper handwashing as well as using hand sanitiser between washes.

Appendix 2 –Detailed Radio Tracking Methodology

If a bat was recorded, then attempts were made to take synchronised, also referred to as 'joint', bearings, with another surveyor. This meant that surveyors frequently had to change locations in order to get joint bearings. It is recognised that gathering regular, accurate and triangulated fixes for foraging bats is difficult. This is because bats forage in flight and at speed, continually twisting and turning, causing fluctuations in transmitter pulse amplitude which can impede interpretation of distance and direction (Mackie & Racey, 2007). In addition, the barbastelle is a wide-ranging, fast-flying species which switches roosts frequently. Care also had to be taken to ensure that the surveyors were positioned away from overhead cables and electric fences to avoid disturbance to the compasses and radio-signals.

All surveyors were mobile, with each surveyor able to drive to new locations and were in contact with each other with long-range radios. Due to access arrangements with private landowners, not all areas of the landscape could be fully surveyed. Surveyors were allowed access to land [REDACTED]. However, access for vantage points (VPs) in order to take bearings were restricted to public highways and footpaths. As a result, varying numbers of triangulation points were taken for each bat, and not all bats were followed as closely as others. However, omni-directional aerials on cars allowed the presence of bats in certain areas to be determined even if there were no public road laybys to allow a bearing to be taken.

Collecting tracking data on female bats was prioritised over data collection from male bats when male bats were not present within the areas where most bats were being recorded. The receivers used allowed easy scrolling between the frequencies of the different tags/bats and the surveyors were constantly checking for the presence of all bats including the male tagged bats. As well as recording bats that were within range, surveyors also noted which bats were not recorded.

Appendix 3 – Data Analysis Methodology

The aim was to obtain a fix for at least every ten-minute interval. However, in real terms, this has not been possible for every radio-tracked bat. This is because barbastelles have a tendency to move through the landscape quickly, resulting in the transmitter not being detected by the receiver. In addition, survey constraints outlined in paragraph 3.3 meant that it was often difficult to get joint bearings

Therefore, once a radio-tagged barbastelle had been re-located it was imperative to obtain as much data as possible to establish a pattern of range use. If during the night time active tracking a number of similar fixes were achieved within a short period time, i.e. 10 minutes, then multiple fixes were discarded to correct for autocorrelation. Millspaugh and Marzluff (2001) conclude that for home range analysis adequate sampling of animal locations throughout the duration of the study is more important than determining a time interval between sampling that is statistically independent.

It is important therefore that the study incorporates biological traits of the animal into the sampling schedule: for example, studying nocturnal animals in both day and night locations to prevent bias towards a particular behaviour or activity. The data was checked to make sure there were no duplicates/clumping of fixes at the roosts during the night-time tracking to eliminate overestimate of habitat use around roosts due to swarming. Selection of a sampling interval less than that required for “time to independence” (TTI – the time at which autocorrelation is non-existent in successive observations) will not invalidate kernel or minimum convex polygons¹ (MCP) analysis, provided that the time frame of the study is adequate (Swihart and Slade 1997; Millspaugh and Marzluff, 2001).

Bat fixes were transferred to digital geo-referenced maps using AutoCAD and coordinates for triangulation points were determined; the extent of bat activity for each bat was plotted independently and the data were carefully scrutinised and any obviously false bearings were discarded. The coordinates of the plotted triangulation points were then transferred into Ranges 7 software (Anatrack) and analysed to produce MCPs, neighbour linkage² (or clusters) and kernel contours³. These are all methods of showing home ranges. Where roosts were found, the roost sites were included within the home ranges. The analysis was carried out using 95% of the locations closest to the home range centre (for polygons produced by MCP analysis) or the 95% nearest to each other for the contour analysis (the cluster and kernel contours).

¹ The MCP enables the creation of a boundary around all fixes using the smallest possible convex polygon. This is commonly used but may overestimate the size of home ranges.

² A type of multivariate analysis that uses records or measurements of a number of characteristics or features to group individuals into clusters or classes, so that individuals within each cluster/class are as alike each other as possible and as unlike individuals in other clusters/classes as possible.

³ Kernel methods quantitatively determine areas which are intensively used by animals by converting position coordinates into lines or areas with varying probabilities of use and present these graphically.

Within each data set, the trapping locations were specified as the focal sites and all coordinates from the night-time tracking and roost locations were inputted as location qualifying variables (LQVs) within Ranges (LQV's are time, activity, habitat, values associated with the x,y coordinates). The activities of the bats were assigned a numerical value for their activity, either roosting, flying or night-roosting for analysis within Ranges. Typically a focal site might consist of a static, repeatedly-used location such as a den or nest, but in the case of bats where roosts change regularly, the trapping location is the most appropriate focal point to use.

Appendix 4 – Full Trapping Results

Date	Trapping Location	Number	Time Caught	Species	Sex	Age	Breeding status	Forearm (mm)	Weight (grms)	Bat tag no	Ring number	Comments
17.08.20		1	20:55	Barbastelle	M	Juvenile		37.6	9		J3518	
17.08.20		2	20:55	Barbastelle	F	A		38.3	8.5	1	J3516	
17.08.20		3	20:55	Soprano pipistrelle	M	Juvenile		29.2	4			
17.08.20		4	20:55	Barbastelle	M	A		36.7	7.5	2	J3517	
17.08.20		5	21:06	Brown long-eared	F	A		39.1	9			
17.08.20		6	21:13	Soprano pipistrelle	M	A		30.9	4.5			
17.08.20		7	22:00	Natterer's	M	A		38.2	7			
17.08.20		8	22:00	Natterer's	M	A		38.6	7.5			
17.08.20		9	22:20	Barbastelle	F	A	Post lactating	39.3	9	3	J3520	
17.08.20		10	22:30	Brown long-eared	F	A		40	10.9			
17.08.20		11	23:40	Barbastelle	F	A		38.4	9	4	J3521	
18.08.20		12	01:10	Natterer's	F	A		40.8	7.5			
18.08.20		13	01:25	Barbastelle	M	Juvenile		38.4	8.5		J3522	
17.08.20		14	21:18	Common pipistrelle	M	Juvenile		32.8	4.76			
17.08.20		15	22:00	Common pipistrelle	F	Juvenile		31.2	4.7			
17.08.20		16	22:20	Common pipistrelle	F	Juvenile		32.1	4.9			
17.08.20		17	22:41	Common pipistrelle	F	Juvenile		32.8	5			
17.08.20		18	22:55	Common pipistrelle	M	Juvenile		30.9	4.7			
17.08.20		19	23:35	Common pipistrelle	F	Juvenile		32	4			
17.08.20		20	23:38	Soprano pipistrelle	M	Juvenile		31.1	4.7			
18.08.20		21	00:30	Common pipistrelle	M	Juvenile		32.4	4.9			
18.08.20		22	00:32	Barbastelle	M	A		37.4	9	5	A2210	eartag on each side
18.08.20		23	01:13	Barbastelle	F	A	Post lactating	40.1	10	6	A2240	eartag on each side
18.08.20		24	02:16	Barbastelle	M	Juvenile		37	9		A2249	
18.08.20		25	21:05	Barbastelle	F	A	Post lactating	39.9	10	7	A2248	eartag on each side
18.08.20		26	21:10	Barbastelle	M	A		38	8		A2246	eartag on each side
18.08.20		27	21:10	Barbastelle	F	A	Post lactating	39	8.1	8	A2247	
18.08.20		28	21:34	Common pipistrelle	F	Juvenile		30.5	4.8			
18.08.20		29	22:05	Common pipistrelle	M	Juvenile		30.5	4.3			

19.08.20		30	00:25	Soprano pipistrelle	M	A		31.2	4.7			
18.08.20		31	20:35	Brown long-eared	F	A	Post lactating	38.4	7.5			
18.08.20		32	20:49	Barbastelle	F	A	Post lactating	39.3	9.5	9	J3523	
18.08.20		33	21:35	Natterer's	M	A		40.0				
18.08.20		34	22:00	Brown long-eared	F	A		38.8	7.5			
18.08.20		35	22:00	Soprano pipistrelle	M	A	large testes	30.3	5.0			
18.08.20		36	22:00	Barbastelle	M	A		37.9	8.5		J3524	
18.08.20		37	22:30	Soprano pipistrelle	M	A		30.7	4.5			
18.08.20		38	22:30	Natterer's	M	A		39.7	8.0			
18.08.20		39	23:05	Common pipistrelle	F	Juvenile		32.5	5.5			
18.08.20		40	23:05	Soprano pipistrelle	N/A			N/A				Escaped
18.08.20		41	23:40	Soprano pipistrelle	M	Juvenile		30.3	4.5			
19.08.20		42	00:15	Soprano pipistrelle	F	Juvenile		31.2	4.5			
19.08.20		43	01:00	Natterer's	F	A	Post lactating	38.2	7.5			
19.08.20		44	01:35	Soprano pipistrelle	M	A	large testes, black epids	30.8	5.5			
20.08.20		45	21:00	Barbastelle	M	Juvenile		37.5	8.0		A2244	
20.08.20		46	21:00	Daubenton	F	A		37.8	6.8			
20.08.20		47	21:00	Barbastelle	F	A		37.9	8.0	10	A2245	eartag on each side
20.08.20		48	21:00	Barbastelle	M	A		38.4	7.5		A2242	eartag on each side
20.08.20		49	21:05	Common pipistrelle	M	Juvenile		30.5	4.3			
20.08.20		50	21:35	Common pipistrelle	M	A		32.3	5.0			
20.08.20		51	22:05	Soprano pipistrelle	F	A	Post lactating	32.7	5.5			
20.08.20		52	22:05	Barbastelle	F	A		39.0	8.0	11	A2243	eartag on each side
20.08.20		53	22:08	Common pipistrelle	M	Juvenile		29.1	4.0			
20.08.20		54	23:25	Brown long-eared	M	A	large testes	37.3	5.0			
20.08.20		55	23:35	Soprano pipistrelle	M	A	large testes	32.4	5.1			
20.08.20		56	23:56	Brown long-eared	F	A	Post lactating	40.8	8.4			
21.08.20		57	00:11	Barbastelle	F	Juvenile		38.0	7.5		A2241	
21.08.20		58	01:26	Natterer's	M	A		40.1	8.2			
20.08.20		59	20:30	Soprano pipistrelle	M	A		30.8	4.0			
20.08.20		60	21:15	Natterer's	M	A		37.2	7.5			
20.08.20		61	21:40	Brown long-eared	F	A	Post lactating	39.3	-			
20.08.20		62	21:40	Natterer's	M	A		39.8	7.0			
20.08.20		63	22:00	Natterer's	F	A	Post lactating	38.1	8.0			

20.08.20		64	22:00	Natterer's	F	NB		39.5	8.0			
20.08.20		65	23:10	Natterer's	F	A	Post lactating	39.3	8.0			
20.08.20		66	23:10	Soprano pipistrelle	M	Juvenile		30.0	4.5			
20.08.20		67	23:40	Natterer's	F	A	Post lactating	4.2	8.5			
21.08.20		68	00:05	Soprano pipistrelle	F	NB		31.1	5.0			
21.08.20		69	00:15	Soprano pipistrelle	F	A	Post lactating	31.1	5.0			
21.08.20		70	00:55	Brown long-eared	F	A	Post lactating	39.1	8.5			
22.08.20		71	21:05	Common pipistrelle	M	A	large testes	29.0	4.7			
22.08.20		72	21:35	Brown long-eared	M	A	early breeding condition	36.8	7.0			
22.08.20		73	21:35	Brown long-eared	M	A	large testes, black epids	37.1	8.0			
22.08.20		74	22:36	Brown long-eared	F	A	Post lactating	40.1	8.5			Mole on nipple
22.08.20		75	23:29	Brown long-eared	F	A	Post lactating					Recapture - recognised by mole on nipple
22.08.20		76	23:58	Natterer's	M	A		39.3	6.5			
23.08.20		77	01:25	Barbastelle	F	A	Post lactating	39.2	10.7	12	A2219	

Appendix 5 - Description of Roosts

Roost Number	Bat Number	Area	Tree/Building	Species of Tree	dbh (cm)	Description of Roost Feature	Distance from Woodland Edge (m)	Count Information	Grid Reference
1	5		Tree	Ash	50-100	Ash tree or possibly in sycamore leaning into the ash tree - trees covered in ivy.	36	-	
2	6, 7		Tree	Ash	80-100	Difficult to see due to canopy but on E side there is a fungus and splits and cavities. On S side larger cavity just below fork in tree high up.	9	-	
3	5, 8		Tree	Oak	1m+	Large split low down to 3m. Several dead branches higher up and dense ivy	30	-	
4	8		Tree	Ash	40	Dense ivy cover and splits	53	1 bat including emerged	
5	5		Barn	-	-	Above lintel of door	-	-	
6	6, 12		Tree	Ash	100	Ivy covered tree with snags at the top but no specific feature visible	57	-	
7	1, 2		Tree	Ash	50	Trunk cavity, large WP hole and split down stem	13	1 bat incl. bat and emerged	
8	1,2		Tree	Oak	50	Dying, stag headed tree with raised bark and a large section is missing revealing heartwood beneath	68	-	
9	9		Tree	Ash	200+	Twin stemmed ash, loose bark	53	-	
10	9		Tree	Beech	100	No obvious features visible however is a mature tree of substantial size and suitable to support a bat roost higher up	75	-	
11	9		Tree	Oak	50-100	1m vertical split in main limb and rotten branch	33	-	
12	6, 7, 8		Tree	Oak	100	Dense ivy cover but stag headed tree with likely numerous features	41	-	
13	9		Tree	Oak	50	Numerous features - tree covered with lifted, cracked and raised bark	0	-	

Roost Number	Bat Number	Area	Tree/Building	Species of Tree	dbh (cm)	Description of Roost Feature	Distance From Woodland Edge (m)	Count Information	Grid Reference
AR14	3		Unknown		Unknown	Unknown	Unknown	-	
15	9		Tree	Oak	50 - 99	Trunk cavity, twin stemmed tree and trunk interview to create cavity	113	-	
16	5		Tree	Ash	50 - 99	Group of ivy covered trees - actual tree could not be determined	51		
17	7		Tree	Ash	50 - 99	Dense ivy cover with WP hole and broken limb on northern elevation	55	Bat emerged	
18	9		Tree	Ash	30	Can't confirm - survey aborted due to high winds	192		
19	2		Tree	Oak (or ash adjacent)	80	Not sure which feature. If oak it has a lost top and has splits and snagged ends. Ash has wounds and holes. Probably in oak	60	-	
20	8		Tree	Ash	50 - 100	Dense ivy cover	81	-	
21	6, 7		Tree	Ash	50 - 100	Dense ivy cover	22	-	
AR22	11		Unknown	Unknown	Unknown	Unknown	Unknown	-	
23	6		Tree	Ash	-	-	12	-	
24	8		Tree	Ash	-	Large ivy stem on east side and ivy growth halfway up	11	-	
AR25	11		Unknown	Unknown	Unknown	Unknown	Unknown	-	

Appendix 6 - Roosts by Day

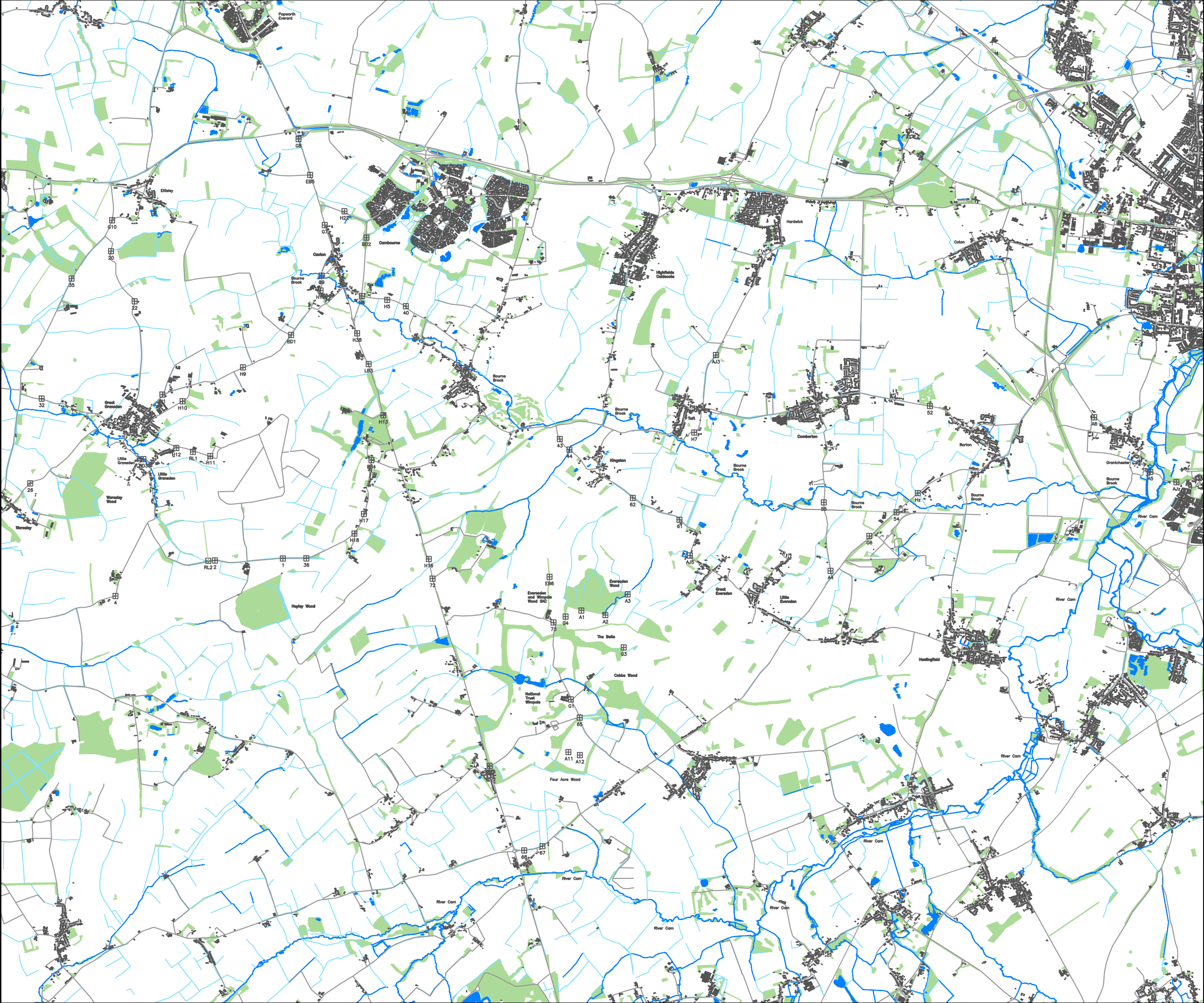
Bat no	Species	Sex	Breeding or Non-breeding	17/08/2020	18/08/2020	19/08/2020	20/08/2020	21/08/2020	22/08/2020	23/08/2020	24/08/2020	25/08/2020	26/08/2020	27/08/2020	28/08/2020
1	Barb	F	Non-breeding		8	7	-	high winds	7	7	7	7	7	7	7
2	Barb	M	-		8	7	19	high winds	7	7	7	7	7	7	7
3	Barb	F	Breeding		-	-	-	high winds	-						-
4	Barb	F	Non-breeding		-	-	-	high winds	-	-	-	-	-	-	
5	Barb	M	-		1	Roost R3 in day and roost R5 in evening	5	5	5	5	5	5	16	5	5
6	Barb	F	Breeding		-	2	21		23	12	6		-	12	17
7	Barb	F	Breeding			2	21		12	12	12		17	12	17
8	Barb	F	Breeding			Roost R3 in day and roost R4 in evening	20		24	12	12		-	12	-
9	Barb	F	Breeding			9	-	high winds	10	11	13		15	13	13
10	Barb	F	Non-breeding			-	-	high winds	-	-	-		-	-	-
11	Barb	F	Non-breeding			-	-	AR25		-	-		AR22	AR22	-
12	Barb	F	Breeding		-	-	-	-		-	6		12	12	17

Appendix 7 – Summary of Roost Occupancy by Day in August 2020

		Roost Number																							
Bat Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1							19,22-28	18																
	2							19,22-28	18											20					
	3														19,20,23-27										
	4	Roost not found																							
	5	18		19		19-25,27,28											26								
	6		19				24						23,27					28				20		22	
	7		19										22-24,27					26,28				20			
	8			19	19								23,24,27								20				22
	9									19	22	23		24,27,28			26			25					
	10	Roost not found																							
	11	Roost not found																							
	12						24						26,27					28							

The Belts

 Hayley Wood
 Waresely Wood
 Unamed wood



Key

32

Vantage Point
Location - Position 32

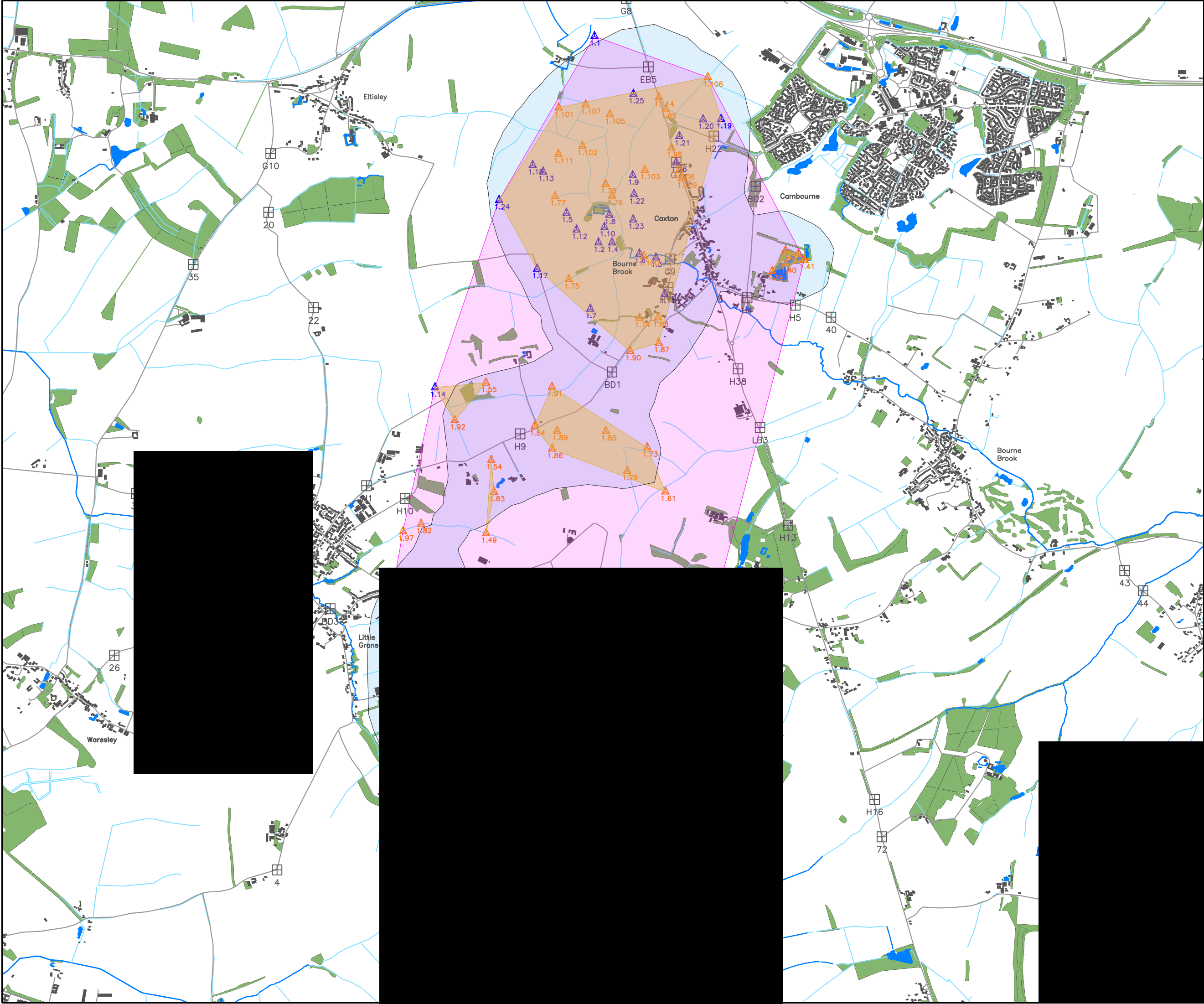
revision	description		date	checked by
<div>Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH</div>			<div>CORYLUS ECOLOGY</div>	
Project:				
20080 East West Rail Project				
Title:				
Vantage Point Location Plan				
status		drawing no.		
		Figure A1		
scale	size	date	drawn	checked
NTS	A3	05.03.2021	AW	HL
CAD filename				
Figure_1.dwg				



Key

-  Roost Location 1
-  Approximate Roost Location
-  Trapping Area
-  Eversden and Wimpole Woods SAC

revision	description			date	checked by
<p>Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR</p> <p>Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH</p>					
Project:					
20080 East West Rail Project					
Title:					
Trapping and Roost Location Plan					
status		drawing no.			
		Figure A2			
scale	size	date	drawn	checked	
NTS	A3	05.03.2021	AW	HL	
CAD filename					
Figure_1.dwg					



Key

R9

Roost 9

R9

Approximate Location of Roost 9

R1

Roost used by Bat

T1

Trapping Location - Bat caught here

1.21

Bat 1 joint bearing point 21

1.21

Bat 1 single bearing point 21

95% kernel analysis

95% cluster analysis

95% MCP analysis

revision	description	date	checked by
	Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH		
Project: 20080 East West Rail Project			
Title: Bat 1 NB Female Barbastelle - Triangulation Points			
STATUS		drawing no. Figure B1	
scale NTS	size A3	date 08.12.2020	drawn AW checked HL
CAD filename Figure_1.dwg			



Roost 9



Approximate
Location of Roost 9



Roost used by Bat



Trapping Location - Bat caught here

**Corylus Ecology Ltd, Unit A3, Speldhurst
Business Park, Went Farm, Langton
Road, Speldhurst, Kent TN3 0NR** Corylus
Ecology is the trading name of Corylus Ecology Ltd registered in
England, No 5005553, Registered Office: Herwood House,
Henwood, Ashford, Kent TN24 8DH



Project: 20080 East West Rail Project

Title:
Bat 3 breeding Female Barbastelle
- Triangulation Points

status		drawing no. Figure B3		
scale NTS	size A3	date 08.12.2020	drawn AW	checked HL

CAD filename	Figure_1.dwg
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Key

R9

Roost 9

R9

Approximate
Location of Roost 9

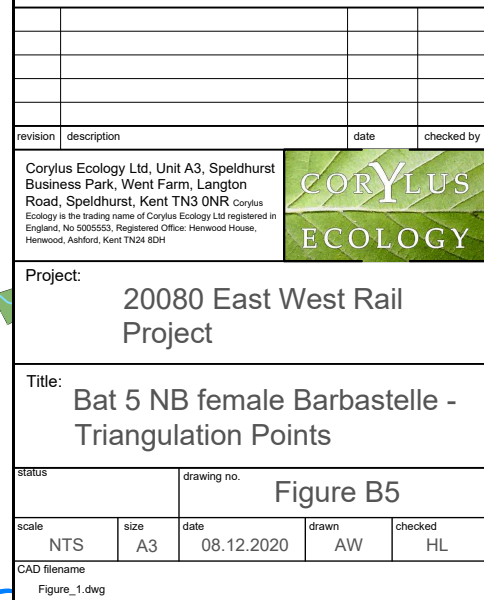
R1

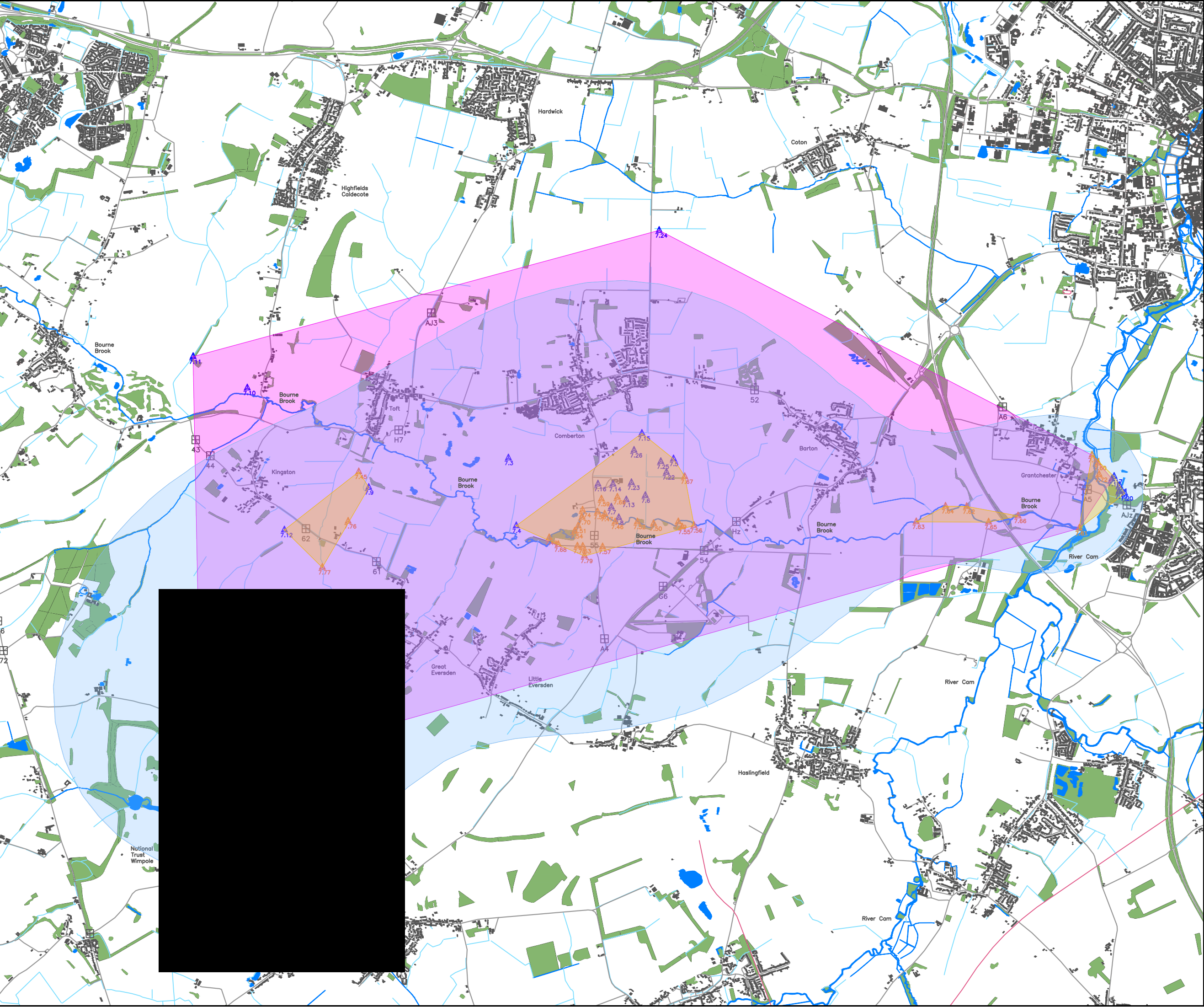
Roost used by Bat

T1

Trapping Location - Bat
caught here

revision	description		date	checked by
Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH				
Project: 20080 East West Rail Project				
Title: Bat 4 NB Female Barbastelle - Triangulation Points				
status		drawing no. Figure B4		
scale	size	date	drawn	checked
NTS	A3	08.12.2020	AW	HL
CAD filename Figure_1.dwg				





Key

Roost 9

Approximate Location of Roost 9

Roost used by Bat

Trapping Location - Bat caught here

Bat 7 joint bearing point 21

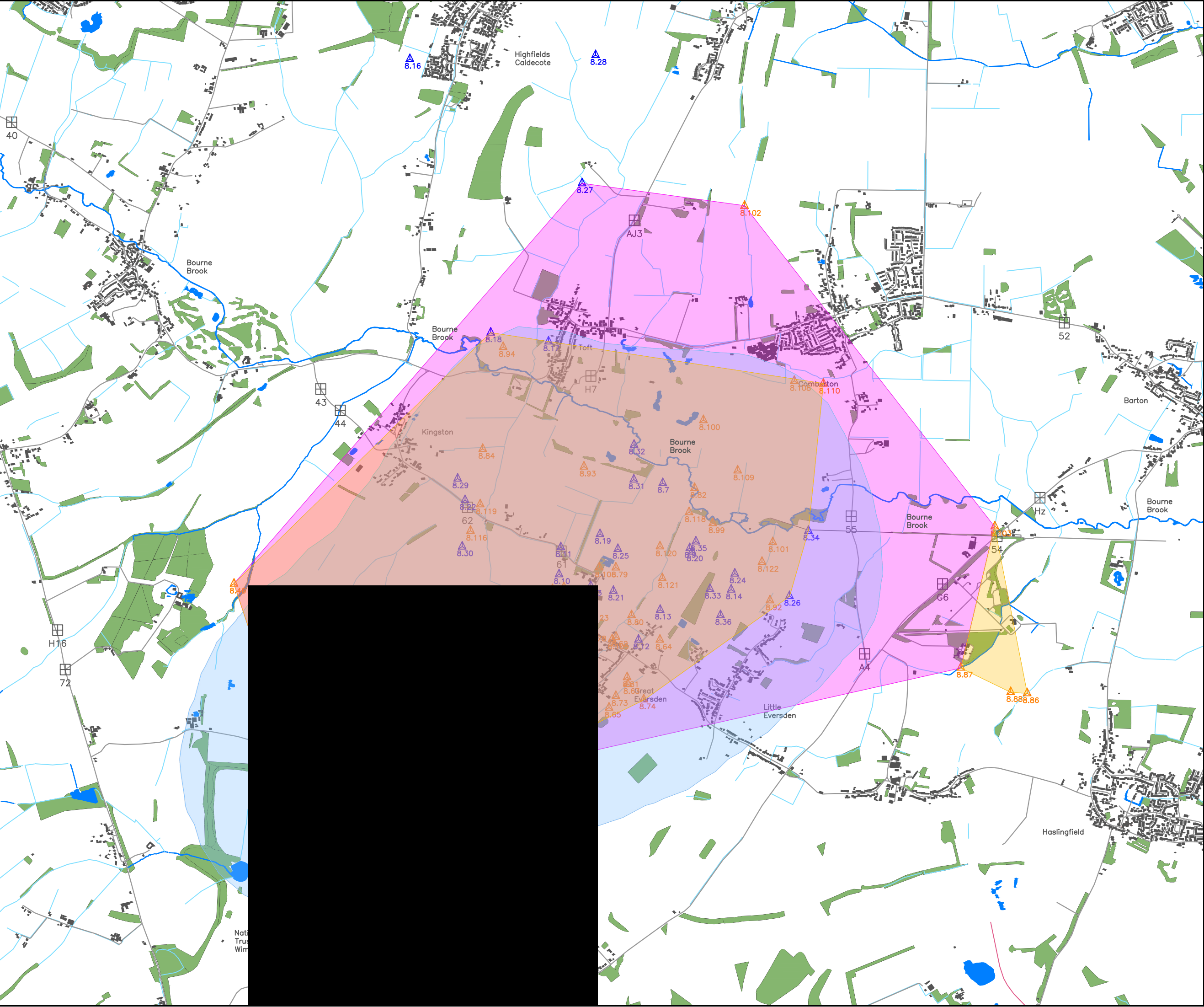
Bat 7 single bearing point 21

95% kernel analysis

95% cluster analysis

95% MCP analysis

revision	description		date	checked by				
Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR <small>Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH</small>								
Project: 20080 East West Rail Project								
Title: Bat 7 Breeding female Barbastelle - Triangulation Points								
status		drawing no. Figure B7						
scale	NTS	size	A3					
date	11.12.2020	drawn	AW	checked HL				
CAD filename Figure_1.dwg								



Key

R9

Roost 9

R9

Approximate Location of Roost 9

R1

Roost used by Bat

T1

Trapping Location - Bat caught here

8.21

Bat 8 joint bearing point 21

8.21

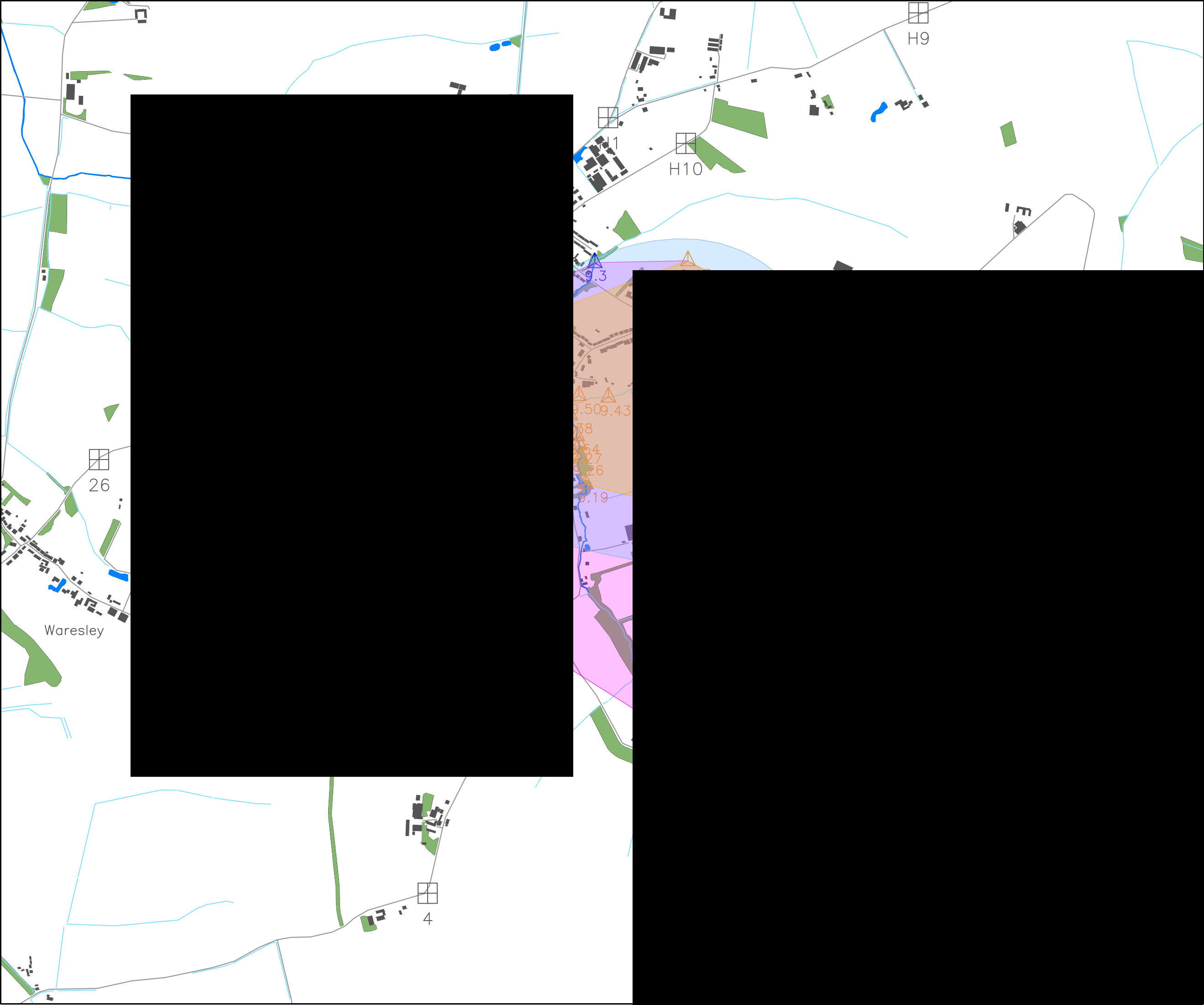
Bat 8 single bearing point 21

95% kernel analysis

95% cluster analysis

95% MCP analysis

revision	description			date	checked by			
Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR <small>Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH</small>					<div>CORYLUS ECOLOGY</div>			
Project: 20080 East West Rail Project								
Title: Bat 8 breeding female Barbastelle - Triangulation Points								
status		drawing no. Figure 1						
scale	NTS	size	A3	date	08.12.2020			
		drawn	AW	checked	HL			
CAD filename Figure_1.dwg								



Key

R9

Roost 9

R9

Approximate Location of Roost 9

R1

Roost used by Bat

T1

Trapping Location - Bat caught here

9.21

Bat 9 joint bearing point 21

9.21

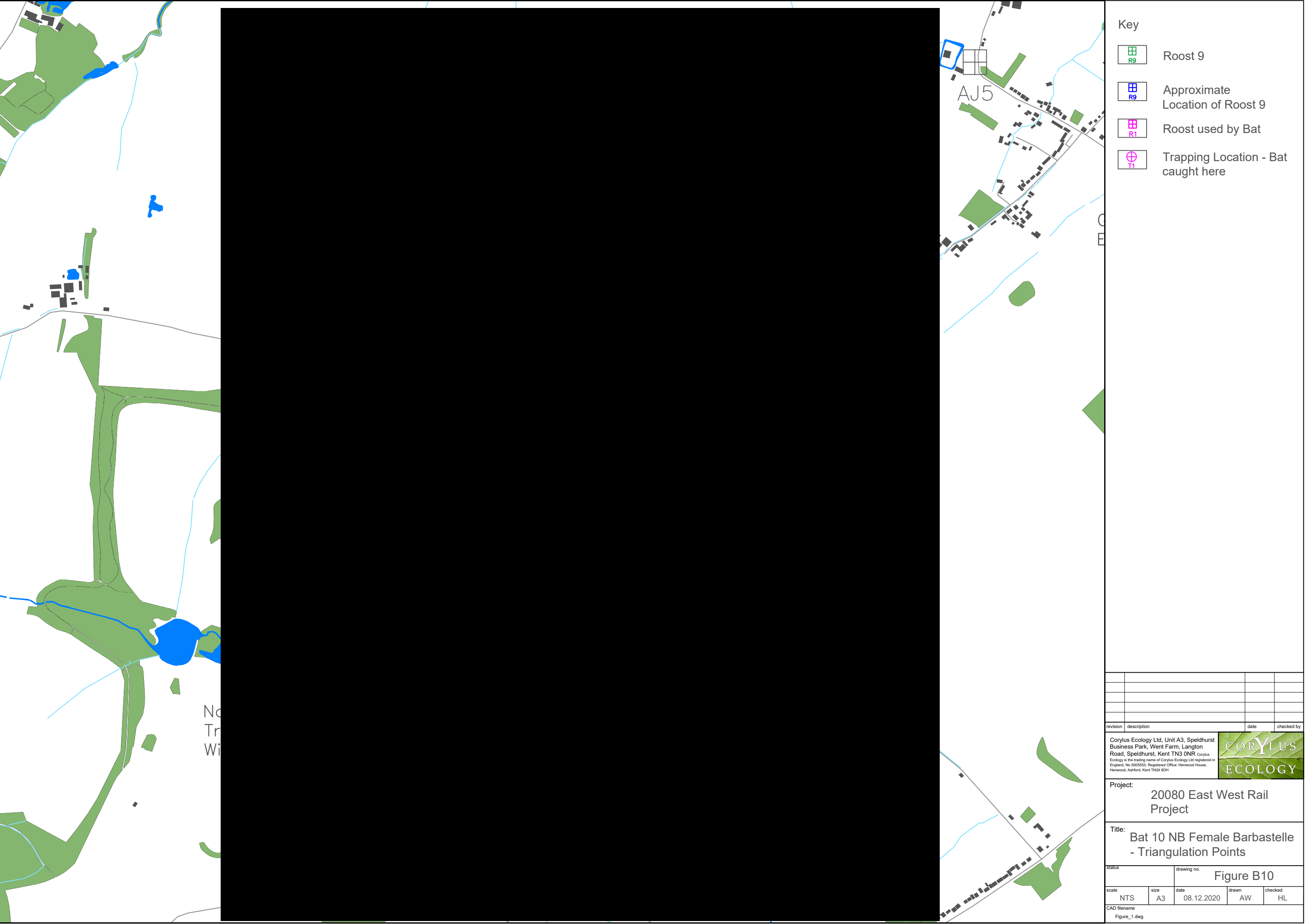
Bat 9 single bearing point 21

95% kernel analysis

95% cluster analysis

95% MCP analysis

revision	description	date	checked by	
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Project:		20080 East West Rail Project		
Title:		Bat 9 breeding female Barbastelle - Triangulation Points		
STATUS		drawing no. Figure B9		
scale	size	date	drawn	checked
NTS	A3	08.12.2020	AW	HL
CAD filename Figure_1.dwg				



- Key
-  Roost 9
 -  Approximate Location of Roost 9
 -  Roost used by Bat
 -  Trapping Location - Bat caught here

revision	description	date	checked by
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Project: 20080 East West Rail Project

Title: Bat 10 NB Female Barbastelle - Triangulation Points

status		drawing no. Figure B10		
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scale	size	date	drawn	checked
NTS	A3	08.12.2020	AW	HL

CAD filename
Figure_1.dwg



Key

R9

Roost 9

R9

Approximate Location of Roost 9

R1

Roost used by Bat

T1

Trapping Location - Bat caught here

11.21

Bat 11 joint bearing point 21

11.21

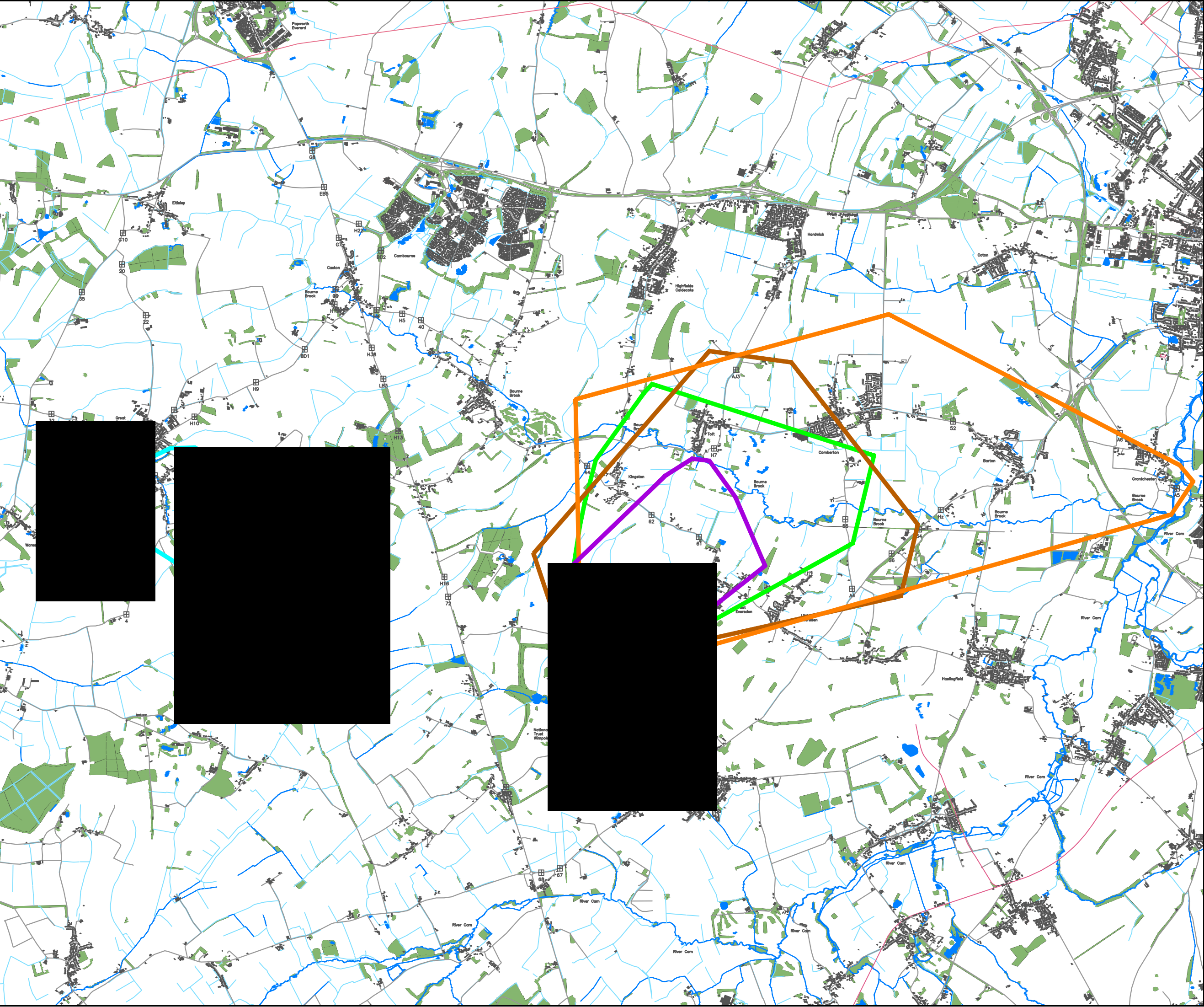
Bat 11 single bearing point 21

95% kernel analysis

95% cluster analysis

95% MCP analysis





- Key
- Bat 6 95% MCP analysis
 - Bat 7 95% MCP analysis
 - Bat 8 95% MCP analysis
 - Bat 9 95% MCP analysis
 - Bat 12 95% MCP analysis

revision	description	date	checked by
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Project: 20080 East West Rail Project

Title: Adult breeding female Barbastelle MCP 95% analysis

status		drawing no. Figure C1			
scale	NTS	size	A3	date	11.12.2020
		drawn	AW	checked	HL

CAD filename
Figure_1.dwg

- Key
- Bat 6 95% Cluster analysis
 - Bat 7 95% Cluster analysis
 - Bat 8 95% Cluster analysis
 - Bat 9 95% Cluster analysis
 - Bat 12 95% Cluster analysis

revision	description	date	checked by

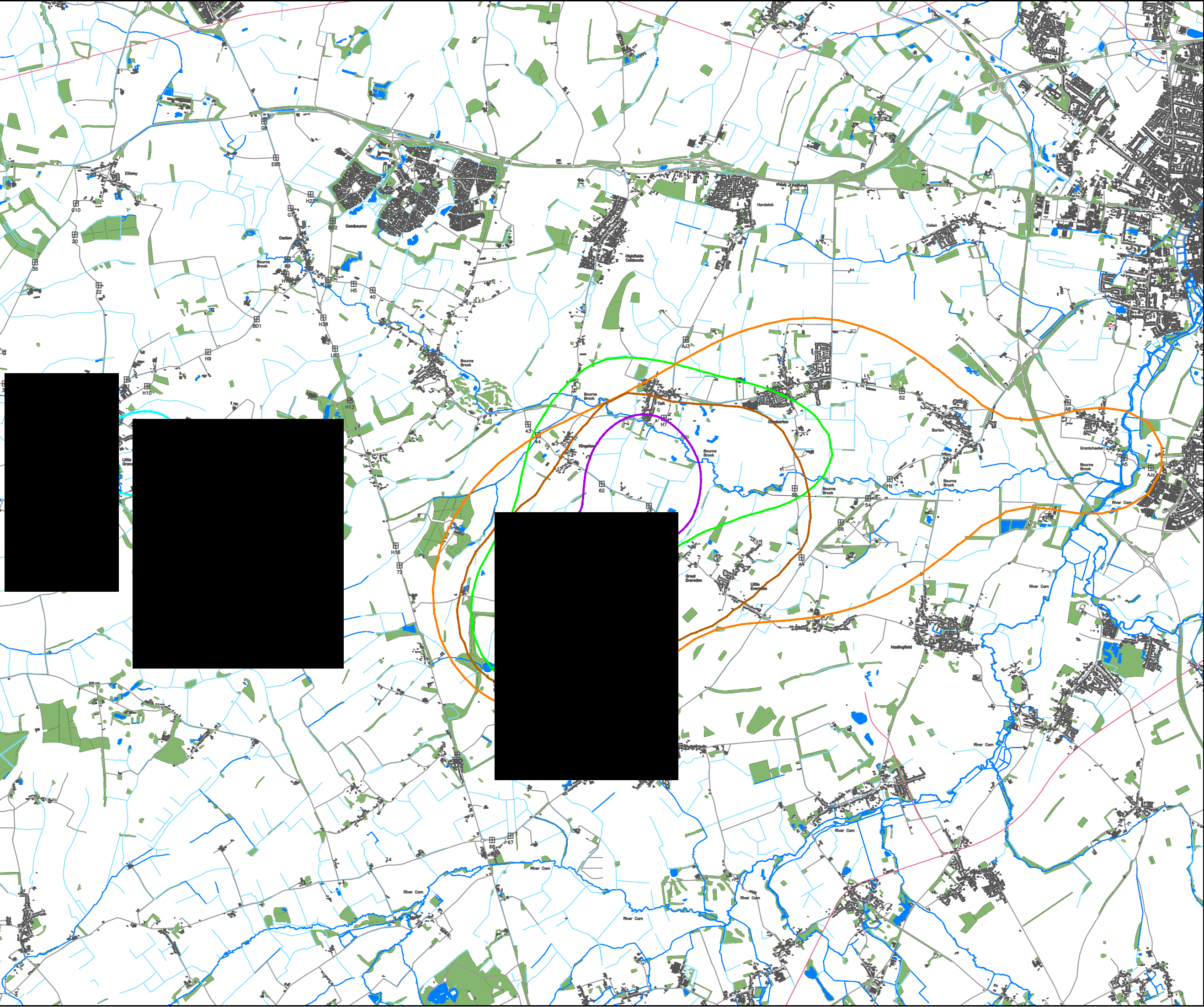
Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR
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Project: 20080 East West Rail Project

Title: Adult breeding female barbastelle Cluster 95% analysis

status		drawing no. Figure C2			
scale	NTS	size	A3	date	08.12.2020
		drawn	AW	checked	HL
CAD filename Figure_1.dwg					



Key

Bat 6 95% Kernel analysis

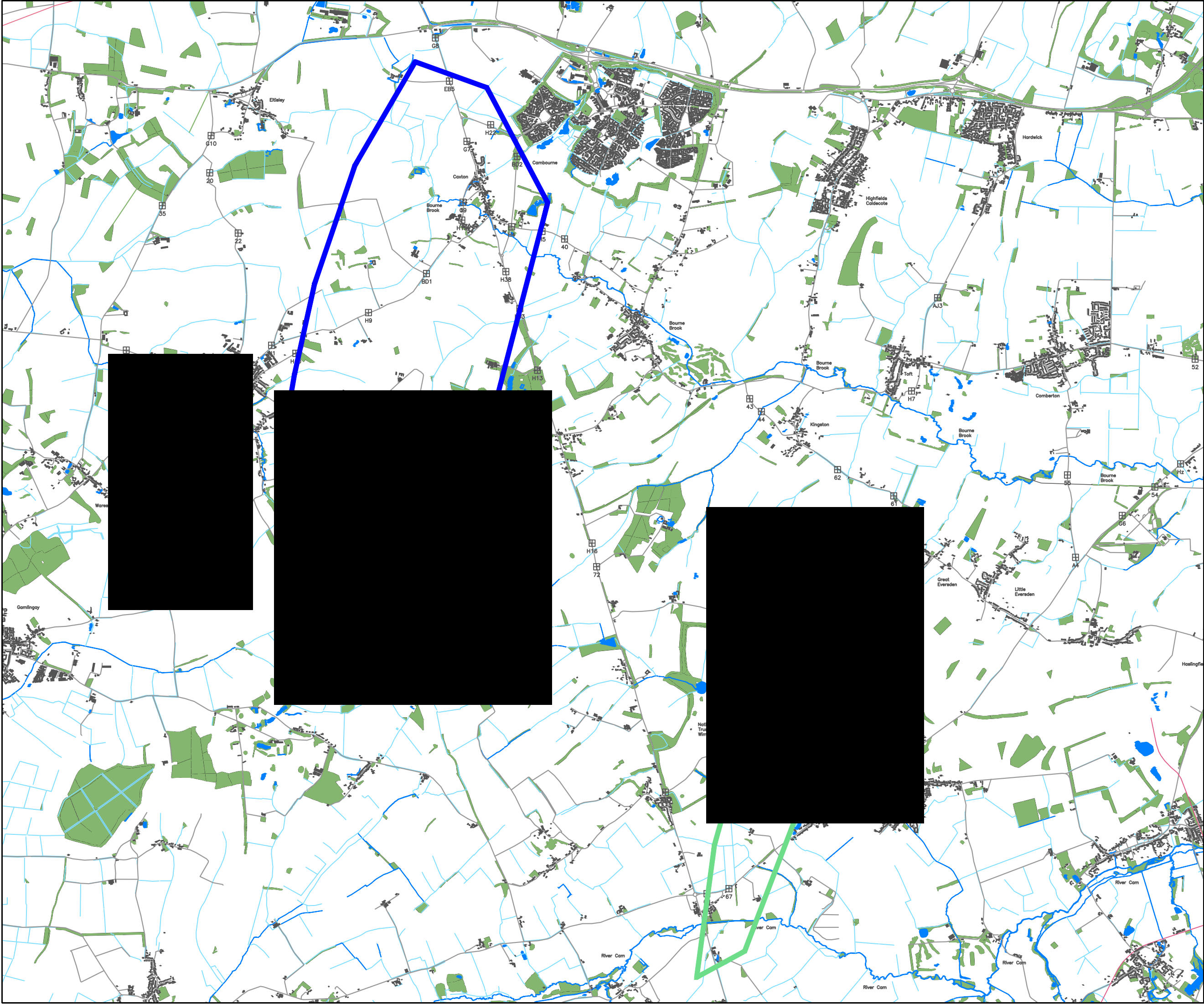
Bat 7 95% Kernel analysis

Bat 8 95% Kernel analysis

Bat 9 95% Kernel analysis

Bat 12 95% Kernal analysis

revision	description	date	checked by
<div><div>Corylus Ecology Ltd, Unit A3, Speldhurst Business Park, Went Farm, Langton Road, Speldhurst, Kent TN3 0NR <small>Corylus Ecology is the trading name of Corylus Ecology Ltd registered in England, No 5005553, Registered Office: Henwood House, Henwood, Ashford, Kent TN24 8DH</small></div><div><div>CORYLUS</div><div>ECOLOGY</div></div></div>			
Project: 20080 East West Rail Project			
Title: Adult breeding female barbastelle Kernel 95% analysis			
STATUS		drawing no. Figure C3	
scale NTS	size A3	date 08.12.2020	drawn AW checked HL
CAD filename Figure_1.dwg			

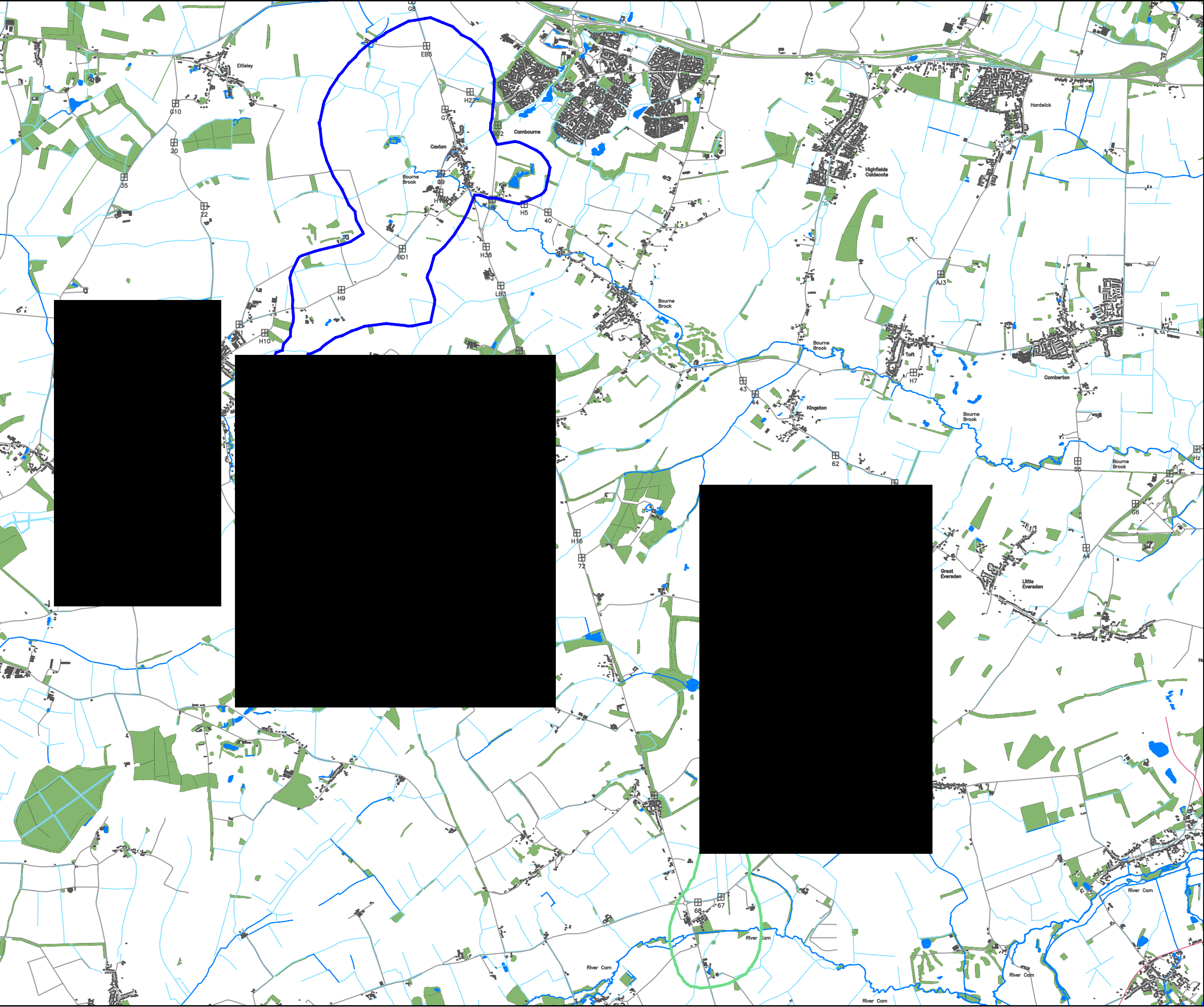


Key

Bat 1 95% MCP analysis

Bat 11 95% MCP analysis

revision	description		date	checked by
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Project: 20080 East West Rail Project				
Title: Non-breeding female barbastelle MCP 95% analysis				
status		drawing no. Figure C4		
scale	NTS	size	A3	date 08.12.2020
		drawn	AW	checked HL
CAD filename Figure_1.dwg				

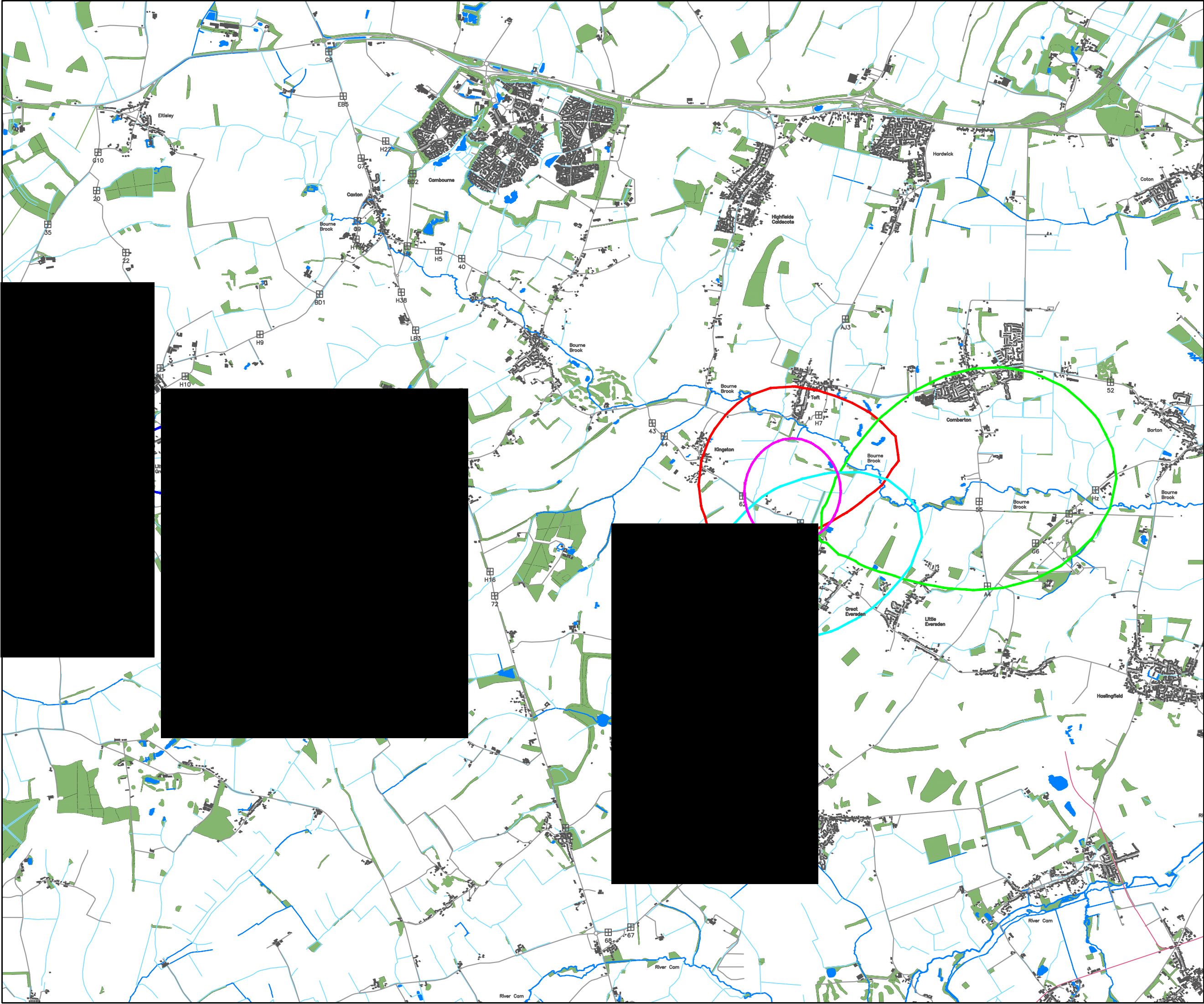


Key

Bat 1 95% Kernel analysis

Bat 11 95% Kernel analysis

revision	description		date	checked by		
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Project: 20080 East West Rail Project						
Title: Non-breeding female barbastelle Kernel 95% analysis						
STATUS		drawing no. Figure C6				
scale	NTS	size	A3	date		
				08.12.2020		
		drawn	AW	checked		
				HL		
CAD filename Figure_1.dwg						



Key

- Bat 6 50% Kernel analysis
- Bat 7 50% Kernel analysis
- Bat 8 50% Kernel analysis
- Bat 9 50% Kernel analysis
- Bat 12 50% Kernel analysis

revision	description		date	checked by
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Project:				
20080 East West Rail Project				
Title:				
Breeding Female Barbastelle 50% Kernel analysis				
status		drawing no.		
		Figure C7		
scale	size	date	drawn	checked
NTS	A3	08.12.2020	AW	HL
CAD filename				
Figure_1.dwg				