

A47 North Tuddenham to Easton Dualling

Scheme Number: TR010038

Volume 6

6.1 Environmental Statement **Chapter 8 – Biodiversity**

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The A47 North Tuddenham to Easton
Development Consent Order 202[x]

**ENVIRONMENTAL STATEMENT CHAPTER 8
BIODIVERSITY**

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8. Biodiversity

8.1. Introduction

- 8.1.1. Highways England (the Applicant) has submitted an application for an order to grant a development consent order (DCO) for the North Tuddenham to Easton Dualling Scheme (hereafter referred to as ‘the Proposed Scheme’). The Proposed Scheme comprises the dualling of a section of the A47 between North Tuddenham and Easton, including the creation of two grade separated junctions (Wood Lane junction and Norwich Road junction), associated side road alterations and walking, cycling and horse-riding connections. This section of A47 road is currently unable to cope with the high traffic volume and there are limited opportunities to overtake slower moving vehicles on the single carriageway. This section of the A47 also has a poor safety record. The Proposed Scheme aims to reduce congestion related delay, improve safety, improve journey time reliability and increase the overall capacity of the A47. Full details of the Proposed Scheme are provided in Environmental Statement Chapter 2 (The Proposed Scheme) (**TR010038/APP/6.1**).
- 8.1.2. Under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, the Proposed Scheme is an Environmental Impact Assessment (EIA) development and as such requires submission of an Environmental Statement (ES) presenting the likely significant environmental effects of the Proposed Scheme.
- 8.1.3. As part of the EIA process, this ES chapter reports the potential significant effects on biodiversity as a result of the Proposed Scheme. This assessment includes a review of the existing baseline conditions, consideration of the potential impacts and identification of proportionate mitigation and enhancement.
- 8.1.4. The approach to this assessment follows the methods set out in the EIA Scoping Report which was issued to the Planning Inspectorate in September 2019 (**TR010038/APP/6.5**) and subsequent Scoping Opinion received (November 2019) for the Proposed Scheme (**TR010038/APP/6.6**). The assessment has been undertaken in combination with the most up to date standard in the Design Manual for Roads and Bridges (DMRB), LA 108 Biodiversity and LD 118 Biodiversity design.
- 8.1.5. The main chapter text is supported by appendices 8.1 to 8.17 (**TR010038/APP/6.3**) and figures 8.1 to 8.4 (**TR010038/APP/6.2**):
- Appendix 8.1: Botanical Survey Report
 - Appendix 8.2: Fungi Survey Report

- Appendix 8.3: Terrestrial Invertebrate Survey Report
- Appendix 8.4: Aquatic Invertebrate Survey Report
- Appendix 8.5: White-clawed Crayfish Survey Report
- Appendix 8.6: Great Crested Newt Survey Report
- Appendix 8.7: Reptile Survey Report
- Appendix 8.8: Breeding Bird Survey Report
- Appendix 8.9: Barn Owl Survey Report
- Appendix 8.10: Wintering Bird Survey Report
- Appendix 8.11: Bat Hibernation Report
- Appendix 8.12: Bat Survey Report
- Appendix 8.13: Bat Crossing Point Report
- Appendix 8.14: Otter and Water Vole Survey Report
- Appendix 8.15: Confidential Badger Survey Report
- Appendix 8.16: DMRB biodiversity evaluation assessment methodology
- Appendix 8.17: Legislation and policy framework
- Figure 8.1: Designated sites and priority habitats
- Figure 8.2: Ecological Constraints
- Figure 8.3: Phase 1 Habitat Map
- Figure 8.4: Fungi Survey Map

8.2. Competent expert evidence

- 8.2.1. The ecological competent expert for this assessment has over 19 years' experience in UK ecological and environmental consultancy, as well as experience of planning and conducting ecological survey work overseas. They are an active member of the Chartered Institute of Ecology and Environmental Management (CIEEM) sits on their Professional Standards Committee as well as being a Chartered Environmentalist (CEnv) and a Chartered Biologist (CBiol).
- 8.2.2. They have conducted and produced a wide variety of ecological surveys and reports and they have designed, implemented and managed mitigation projects for bats, badgers, otters, reptiles and great crested newts (GCN).
- 8.2.3. They have used their EIA knowledge and professional judgement in identifying the likely significant impacts associated with the Proposed Scheme and providing technical guidance through the assessment.

8.3. Legislation and policy framework

8.3.1. In preparation of this chapter, the following key legislation and policy documentation has been used. For full details of the relevant legislative scope of each document, please see Appendices 8.1 to 8.17 (**TR010038/APP/6.3**).

- Key Legislation (National)
 - Conservation of Habitats and Species Regulations 2017 (as amended)
 - The Wildlife & Countryside Act (WCA) 1981 (as amended)
 - The Countryside and Rights of Way (CRoW) Act 2000
 - The Protection of Badgers Act 1992
 - Hedgerows Regulations 1997
 - The Natural Environment and Rural Communities Act (NERC) 2006
 - Highways England Biodiversity Action Plan (HEBAP) 2015
- National Policy Statement for National Networks (2014) (Section 5)
- National Planning Policy Framework (2019) (Section 15)
 - Statement 9 (PPS9): Biodiversity and Geological Conservation (2005) (withdrawn)
 - ODPM 06/2005: Biodiversity and Geological Conservation – Statutory Obligations and their impact within the Planning system.
- Planning Policy (Regional) - The East of England Plan (2008)
 - POLICY ENV1: Green Infrastructure
 - Policy ENV3: Biodiversity and Earth Heritage
- Breckland District Council Local Plan (2019-2036)
 - Policy ENV 02: Biodiversity protection and enhancement
 - Policy ENV 03: The Brecks Protected Habitats and Species
- Broadland District Council Local Plan (2014-2026)
 - Policy 18: The Broads
- Norfolk Biodiversity Action Plan (BAP)

8.4. Assessment methodology

8.4.1. The assessment of impacts on ecology and nature conservation follows the most recent Highways England standards, the DMRB:

- Ecological survey and design measures – DMRB, LA 118 Biodiversity Design
- Assessing and reporting the effects of highway projects on biodiversity – DMRB, LA 108 Biodiversity (Revision 1)
- Assessment and reporting of the implications on European sites – DMRB, LA 115 Habitats Regulations assessment) (Revision 1)

- 8.4.2. The assessment has also been undertaken in reference to the Chartered CIEEM's Ecological Impact Assessment (EclA) guidance (2018).
- 8.4.3. The following key stages are involved in the EIA:
- The zone of influence of the project and which important biodiversity resources could be significantly affected (Section 8.6)
 - Identification and description of the baseline ecological conditions at the site and likely ecological/biodiversity constraints (Section 8.7)
 - Valuation of each individual biodiversity resource in respect of geographical scale as described in Section 8.7 of this chapter
 - Identification and characterisation of development activities that may affect biodiversity resources (Section 8.8)
 - Identification of mitigation measures and enhancement opportunities to avoid or reduce the effects, as well as compensation measures where effects cannot be avoided (Section 8.9)
 - Identification of enhancement opportunities that will support environmental net gain (Section 8.9)
 - Evaluation of the significance of residual effects (nature and scale) (Section 8.10)
- 8.4.4. Biodiversity resources are valued based upon their importance at a geographical scale as detailed in Table 1-1 of Appendix 8.16 (taken from DMRB LA 108 Biodiversity). Resources valued at lower than local value were defined as having negligible value. Only biodiversity resources of value (local value or higher), or those which have legal constraints (for example, badger and Invasive Non-native Species (INNS)) were taken forward in the impact assessment process.
- 8.4.5. Impacts are defined as the changes resulting from an action, and effects are defined as the consequences of these impacts.
- 8.4.6. The level of impact upon biodiversity resources is assessed in reference to DMRB LA 108 Biodiversity, which is detailed in Table 1-2 in Appendix 8.16. Activities that are not considered to have any observable impacts (either positive or negative) upon some biodiversity resources were not taken forward in the impact assessment process. The predicted impacts for the Proposed Scheme are presented in Table 8-7 and 8-8 prior to the consideration of mitigation.
- 8.4.7. Professional judgement has been used to predict the level of the impact upon each biodiversity resource in accordance with DMRB standards set out in LA 108 Biodiversity.
- 8.4.8. Potential impacts on biodiversity resources are divided into two categories:

- Construction activity impacts: includes those impacts which arise as a result of construction activities which also includes the permanent effects (such as habitat loss).
- Operation impacts: includes those impacts which arise as a result of activities during use of the Proposed Scheme (such as bird mortality through traffic collisions).

8.4.9. Activities during construction and operation of the Proposed Scheme have the potential to result in impacts on biodiversity resources. The level of impact of these activities on the biodiversity resources that have been carried through to assessment are characterised taking account of the following parameters:

- Positive (beneficial) or negative (adverse): a positive impact is a change that improves the quality of the environment or impacts that may halt or slow an existing decline in quality of the environment from baseline or future baseline conditions. A negative impact is a change which reduces the quality of the environment from baseline or future baseline conditions.
- Duration: the duration of an impact (permanent or temporary) is determined in relation to the biodiversity resource's characteristics and lifecycle.
- Reversibility: an impact is considered to be irreversible (permanent) if it is *"one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it"*. An impact is considered reversible (temporary) where *"Spontaneous recovery is possible, or which may be counteracted by mitigation"* (CIEEM, 2018).
- Extent: this is defined as the geographical area over which the impact will occur. In relation to sites and habitats, the extent and magnitude will be the same.
- Magnitude: magnitude refers to the 'size' of the impact such as the total area of habitat (extent) or in terms of species, the number of individuals impacted. The description of an impact's magnitude is quantitative where possible.
- Timing and frequency: the number of times an activity occurs which will influence the resulting impacts and the timing of an impact upon the biodiversity resource's life-stages or seasonal behaviour.

8.4.10. Measures to avoid or reduce the impact on ecological resources have been considered throughout the development of the Proposed Scheme as part of an iterative process. Mitigation measures have been developed to reduce impacts during both the construction and operation phases as detailed within this chapter.

8.4.11. In accordance with CIEEM guidance, mitigation and design interventions for the Proposed Scheme have been detailed in Section 8.9.

8.4.12. Cumulative impacts of multiple threats or pressures can make habitats and species more sensitive to effects. The cumulative effects of the Proposed

Scheme have been considered in combination with all other developments within a potential Zone of Influence (ZOI) including developments currently in planning, consented, being built, completed or operational.

- 8.4.13. No in-combination effects have been anticipated with the other A47 corridor improvement schemes due to the distance involved between the Guyhirn junction (60km), Thickthorn Junction (16km) and Blofield to North Burlingham (32km) which are located to the west and east of the Proposed Scheme. These have been scoped out from further assessment.
- 8.4.14. The cumulative residual effects of ES chapters 5 to 14 have been considered on each biodiversity resource and reported in ES Chapter 15 (Cumulative Effects Assessment) (**TR010038/APP/6.1**).
- 8.4.15. Biodiversity gains and losses have been assessed by using the Defra metric 2.0, which has informed the proposed mitigation measures to minimise the effects of the Proposed Scheme.

Consultation

- 8.4.16. Consultation has been undertaken with the following consultees:
- Natural England
 - Environment Agency
 - Norfolk Wildlife Trust (NWT)
 - Norfolk Biodiversity Information Service (NBIS)
 - Norfolk County Council (NCC) and WSP ecologist
 - Norwich Western Link (NWL) Ecology Liaison Group – includes WSP (NWL ecological consultants); Norwich Bat Group; NCC; The Woodland Trust; Wensum Valley Bird Watching Society, Norfolk and Norwich Naturalist Society, Norfolk Badger Trust, Natural England, Environment Agency, Friends of Tud Valley, Costessey Conservation Volunteers, Norfolk Amphibian and Reptile Group, Norfolk River Trust, Buglife and Butterfly Conservation.
 - Anna Fullford (formerly Berthinussen) at Conservation First
- 8.4.17. Consultation was undertaken with Natural England and the Environment Agency to consider the ability to achieve biodiversity net gain. A discussion on how the fragmented landscape presents an opportunity for biodiversity net gain and to mitigate habitat severance took place.
- 8.4.18. As a result of this consultation, NWT were contacted regarding the information and species data for the Roadside Nature Reserves (RNR) road verge habitat. A response was received in the same month stating that records must be sought from NBIS. Data received showed no RNR within the site boundary.

- 8.4.19. A bat survey data exchange between the Proposed Scheme and the proposed Norwich Western Link Road (NWL) was recommended in the meeting with NCC and Natural England held in February 2020.
- 8.4.20. NCC and the WSP ecologist for the NWL have been consulted regularly on a monthly basis regarding barbastelle bats *Barbastella barbastellus* and the wider mitigation proposals for bats by the Proposed Scheme. In addition, bat mitigation implemented as part of the completed northern distributor road and the associated monitoring data was discussed. Data was exchanged on the locations of barbastelle bats, survey techniques and mitigation. Data was also exchanged for GCN, reptiles, birds, fungi and invertebrates. The meetings are ongoing.
- 8.4.21. Natural England were consulted regarding the methodology for the crossing point surveys and bat mitigation on the proposed bridge over the River Tud. The reply was *"We advise you use the data you have collected from the surveys as well as all available data from the area. Please use this data to inform and justify a recommended approach to mitigation which should be most appropriate based on the available evidence. We expect for you to be able to demonstrate why your proposed mitigation would be most effective at protecting the bats in accordance with the Habitat Regulation and the Wildlife and Countryside Act"*.
- 8.4.22. A meeting was attended with the NWL Ecology Liaison Group on 15 September 2020. Progress updates of the NWL and this Proposed Scheme were presented and discussions regarding the low GCN and common toad populations took place. It was suggested by Toadwatch that existing ponds should be restored rather than new ones created for toads. Norwich Bat Group recommended any bat boxes used should be Schwegler 1FF as barbastelle bats are known to use them. Biodiversity Net Gain assessment was discussed and attendees were assured that calculations will be undertaken.
- 8.4.23. NBIS were consulted for records of designated sites and protected and notable species in 2017 and for designated sites again in 2020.
- 8.4.24. Anna Fullford (formerly Berthinussen), the author of the bat crossing point guidance used for the Scheme, was consulted regarding changing the survey methodology for bat assemblages and from the results gained, what the trigger for mitigation was. She replied with no comment on the methodology and that the need for mitigation is site and species specific. She suggested that any site that requires further survey (and is consistently used by a number of bats) should at least be considered for mitigation.

8.4.25. NWT are a statutory consultee and provided comments on the Preliminary Environmental Information Report¹. They were additionally consulted regarding the ground investigation works on the edge of a proposed CWS and no reply was received. The works did not affect the CWS.

Assessment criteria

8.4.26. The relative biodiversity resource importance has been considered within the geographical framework set out in DMRB LA 108 , table 3.9 (see Table 1-1 of appendix 8.16):

- International or European
- National (UK)
- Regional (East of England)
- County (Broadland, South Norfolk & Breckland)
- Local (Scheme and vicinity).

8.4.27. Reference to DMRB LA 108 Biodiversity is used to determine the level of importance of a resource, and whether the resource is at a level of importance which should be carried through the assessment stage.

8.4.28. DMRB LA 108 Biodiversity states that the importance of designated sites depends on the geographical level to which they are protected. The importance of habitats depends on whether they are listed as priorities for conservation action (such as in the UKBAP or LBAP); their relative naturalness, rarity, size, level of connectedness with other habitats and whether they are threatened by the impacts from Proposed Scheme at a given geographic scale. Included are areas of habitat which meet the definition for designated habitats, but which are not themselves designated. See Appendix 8.16 (**TR010038/APP/6.3**) for full tables from LA 108 Biodiversity.

8.4.29. For species, the importance is determined according to their level of protection and also their relative rarity (for example inclusion in red data lists²), population size, how easily they spread/or disperse and whether they are threatened. Included are species at a critical stage of their life cycle and populations of species that form critical parts of the wider population. The category levels of importance are the same as for habitats.

8.4.30. Legally controlled species (that is, Invasive Non-native Species (INNS)) listed in Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) are

¹ https://highwaysengland.citizenspace.com/he/a47-north-tuddenham-to-easton-february/supporting_documents/A47%20North%20Tuddenham%20to%20Easton%20%20Preliminary%20Environmental%20Information%20Report%20PEIR.pdf

² Those listed within the IUCN Red Data List and Red Data Book of British Invertebrates (Bratton 1991)

considered important species because of the legal requirements to control or manage them.

- 8.4.31. Badgers are considered because of the legal requirements of The Protection of Badgers Act, 1992 (Appendix 8.17 for details of the Act).
- 8.4.32. The level of impact is considered in line with DMRB LA 108, which is described in detail in Table 1-2 of Appendix 8.16 (**TR010038/APP/6.3**). Professional judgement will be used to categorise the level of impact of each activity as being 'major', 'moderate', 'minor', 'negligible' or 'no change' and 'adverse' or 'beneficial'.
- 8.4.33. To summarise, activities during construction and operation of the Proposed Scheme have the potential to result in impacts on biodiversity resources. The level of impact of these activities on the biodiversity resources that have been carried through to assessment are characterised taking account of the following parameters:
- Positive (beneficial) or negative (adverse)
 - Duration: the duration of an impact (permanent or temporary)
 - Reversibility
 - Extent or magnitude
 - Timing and frequency
- 8.4.34. Magnitude of impact refers to size, amount, intensity and volume, as per the CIEEM guidance for EclA (2018).
- 8.4.35. The term 'level of impact' has been used in place of 'magnitude' for the purposes of this ES chapter, as stated in the DMRB LA 108 Biodiversity.
- 8.4.36. The importance of the biodiversity resource and the level of impact will be used to determine the significance of effects taking account of the matrix in Table 8-1, and professional judgement. Effects that are categorised as Moderate, Large or Very Large are considered significant.

Table 8-1 Significance of effects matrix

Biodiversity resource Importance	Level of Impact				
	No Change	Negligible	Minor	Moderate	Major
International/European	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
National (UK)	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large

Biodiversity resource Importance	Level of Impact				
	No Change	Negligible	Minor	Moderate	Major
Regional (East of England)	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
County (Broadland, South Norfolk & Breckland)	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
Local (Scheme & vicinity)	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

8.4.37. Mitigation was deemed as being required where one or both of two criteria were met:

- the biodiversity resource is offered legal protection and a mandatory obligation is imposed to provide measures to ensure that an offence would not be committed;
- where impacts have been identified in the assessment process. Mitigation is proposed (where practicable) at the relevant scale of significance, using the following hierarchy: Avoidance, Mitigation, Compensation, Enhancement.

8.4.38. Residual effects take into consideration committed mitigation and design interventions, and these are assessed and detailed in Table 8-11 and 8-12.

8.5. Assessment assumptions and limitations

8.5.1. Specific limitations relevant to each survey, such as access constraints, are detailed in the relevant ecology survey results contained within Appendices 8.1 to 8.15 (**TR010038/APP/6.3**). It is not considered that any of these survey specific constraints represent a significant limitation, barrier or data gap to the collation of a robust baseline.

8.5.2. It is also noted that the absence of protected species records from the desk study, as part of the EclA, and observations of the same during the surveys undertaken does not preclude their presence within the study area (or on-site). There is always the risk of protected species being overlooked either owing to the timing of the survey, the scarcity of the species on site and limitations to survey methodologies.

8.6. Study area

8.6.1. The site is located between North Tuddenham and Easton where there is currently a section of single carriageway. The area surrounding the Proposed Scheme is predominately arable land, hedgerows, with pockets of ancient woodland and remnant heath cut through by the River Tud. The broadly flat,

rural landscape is an ancient countryside with a long-settled agricultural character.

- 8.6.2. The distance over which the Proposed Scheme could affect protected species can vary, due to the variability between biodiversity resources. The ZOI includes the DCO boundary (Figure 8.1 Proposed Scheme (**TR010038/APP/6.2**)), and the appropriate species-specific areas used for ecological surveys. Table 8-2 below details the study areas for each considered biodiversity resource.

Table 8-2. Zone of influence for each biodiversity resource.

Biodiversity resource	Study Area (Zone of Influence from the Proposed Scheme)
International and nationally designated sites (including Special Areas of Conservation (SACs), possible SACs (pSAC), Special Protection Areas (SPAs), potential SPAs (pSPA), Wetlands of International Importance (Ramsar Sites), National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs))	2km from the DCO boundary unless connected via a green corridor or hydrologically
SACs designated for bats Desk study for bat records	30km from the DCO boundary 10km from the DCO boundary
Locally designated conservation sites (including Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs and CWSs) and RSPB reserves)	2km from the DCO boundary
Phase 1 habitat survey	All accessible land within the DCO boundary of the Proposed Scheme, plus a 100m buffer
Botanical Survey	All accessible land within the DCO boundary of the Proposed Scheme
Terrestrial Invertebrate	Targeted areas within the DCO boundary of the Proposed Scheme
Aquatic Invertebrate	Targeted areas within the DCO boundary of the Proposed Scheme and 50m buffer
White-clawed crayfish	Targeted survey along River Tud
Great crested newts (GCN) <i>Triturus cristatus</i>	All waterbodies within 500m of the DCO boundary of the Proposed Scheme
Reptile	All accessible land within the DCO boundary of the Proposed Scheme, plus a 50m buffer

Biodiversity resource	Study Area (Zone of Influence from the Proposed Scheme)
Breeding Bird	All DCO boundary land within the footprint of the Proposed Scheme, plus a 500m buffer
Barn owl <i>Tyto alba</i>	Targeted areas within the DCO boundary identified anecdotally during the breeding bird survey
Wintering Bird	All accessible land within the DCO boundary of the Proposed Scheme, plus a 500m buffer
Fungi	All accessible land within the DCO boundary of the Proposed Scheme, plus a 50m buffer
Bat roosts – (all species)	All accessible trees and buildings within 50m of the construction boundary
Bat activity – (all species)	Up to 1km from the DCO boundary
Otter	All accessible, suitable habitat within the DCO boundary of the Proposed Scheme, plus a 250m buffer
Water Vole	All accessible, suitable habitat within the DCO boundary of the Proposed Scheme, plus a 250m buffer
Badger	All accessible land within the DCO boundary of the Proposed Scheme, plus a 50m buffer
Invasive species	All accessible, suitable habitat within those areas surveyed above

8.7. Baseline conditions

- 8.7.1. The baseline condition of the biodiversity resources listed in Table 8-2 within the Proposed Scheme ZOI was determined using established standard methodologies as detailed in full within the appendices for each species.
- 8.7.2. A list of surveys undertaken to date, including the dates of survey and good practice guidelines employed, is provided in Table 8-3 below.

Table 8-3 Surveys undertaken

Survey	Dates undertaken	Guidance and methodologies
Phase 1 habitat survey and preliminary ecological appraisal (PEA)	May 2016. Habitat updates recorded during Phase 2 surveys in 2019	JNCC's Handbook for Phase 1 habitat survey - a technique for environmental audit (JNCC, 2010) CIEEM's Guidelines for Preliminary Ecological Appraisal (CIEEM, 2017)
Phase 2 Botanical surveys	May 2017 and August 2019	List of species using dominance DAFOR scale Aquatic National Vegetation Classification Terrestrial habitats assessed using National Vegetation Classification
Aquatic invertebrates and molluscs	June 2017 - October 2017 September 2019	Drake <i>et al.</i> , (2007)
White-clawed crayfish	August – September 2017, 2018 September 2019	Peay (2003)
Badgers	March – July 2016 April 2017 April - June 2019	Standard methodology [Harris <i>et al.</i> , (1989)] Search for all field signs within the study area. Field signs include setts and other excavations, latrines, prints and paths, hairs, feeding evidence etc.
Bat roost appraisals	January – March 2017 May – July 2017 May - September 2019	Collins, J. (ed.) (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd edition, Bat Conservation Trust. Emergence and re-Entry surveys for high roost potential took place three times, for moderate two times, and for low once, in the period described Crossing Point survey specific Berthinussen and Altringham (2015) and Elmeros <i>et al.</i> , 2016
Bat emergence and re-entry Surveys	May - September 2017 May - October 2019 June 2020	
Bat activity transect surveys	September - October 2016 April - September 2017 July - October 2020	
Bat activity crossing point surveys	June and July 2020	

Survey	Dates undertaken	Guidance and methodologies
Bat hibernation survey	February 2019 December 2019 – February 2020	
Birds - breeding	July 2017 April - June 2019	Bibby <i>et al.</i> , (2000). Gilbert <i>et al.</i> , (1998). Birds were recorded by walking, listening and scanning by eye and with binoculars Birds were considered to be breeding if singing, displaying, carrying nest material, nests or young found, repetitively alarmed adults, disturbance displaying, carrying food or in territorial dispute
Birds - wintering	March 2016, November 2016 January - March 2017 January, February, November and December 2019	Bibby <i>et al.</i> , (2000) Gilbert <i>et al.</i> , (1998) As above, Birds were recorded by walking, listening, and scanning by eye and with binoculars All birds were recorded, regardless of the activity/behaviour
Barn owl	June 2020	Shawyer (2012)
Birds - migratory	March 2017 September 2017 October 2019	Bibby <i>et al.</i> , (2000) Gilbert <i>et al.</i> , (1998) As above, Birds were recorded by walking, listening, and scanning by eye and with binoculars All birds were recorded, regardless of the activity/behaviour
Great crested newts (GCN)	Habitat Suitability Index (HSI) assessments in summer 2016. Environmental DNA surveys in 2016, 2017 Population survey 2017 Updated HSI assessments April 2019 and eDNA surveys updated in April & May 2019 Population survey March – Mid June 2019	Biggs <i>et al.</i> , (2014) English Nature (2001) Oldham <i>et al.</i> , (2000)
Reptiles	Reptile surveys commenced in May 2016, followed by September and October 2016	Gent and Gibson (2003) Froglife (1999) Advice Sheet 10

Survey	Dates undertaken	Guidance and methodologies
	May, July, August, September and October 2019	Use of refugia to attract reptiles on site, manual searches of suitable refugia present on site, checks for signs of reptile activity including sloughed skins, burrows, egg laying sites etc.; and sustained visual observation of banks and other suitable habitat within the site.
Water vole and otter	April 2017 October 2019 June 2020	Standard water vole survey methodologies of Strachan <i>et al.</i> , (2011) and Dean <i>et al.</i> , (2016), searching for field signs including latrine sites, feeding stations, lawns, prints and runways Standard otter survey methodology as identified in the Environment Agency's Fifth Otter Survey of England 2009-2010 (Environment Agency, 2010), and Monitoring the Otter Chanin, 2003) Surveys involved searching for spraints, footprints, feeding remains, slides and haul-outs, couches and holts
Fungi survey	September – October 2017 October 2020	Woodlands - The British Mycological Society Guidance (Illiffe, R. 2006). Vesterholt (1999) (in Wood and Dunkelman, 2017)
Terrestrial invertebrate survey	September 2017 July, August, September 2019	Drake <i>et al.</i> , (2007) By visual identification

Designated sites

- 8.7.3. A desk top baseline assessment using online resources (MAGIC) identified designated sites and pockets of ancient woodland (which are additionally County Wildlife Site (CWSs) or Site of Special Scientific Interest (SSSI)) within the ZOI. Some areas of land within the study area may be designated as CWSs in the future due to the diversity of plant species, including some regionally rare specimens. These areas are highlighted within the environmental constraints plan provided in Figure 8.2 (**TR010038/APP/6.2**).
- 8.7.4. The desk study identified three statutory designated sites within 2km and one statutory designated site notified for bats within 30km of the DCO boundary as detailed in Table 8.4 below.

Table 8-4 Designated Sites

Designated Site	Approximate distance from proposed construction boundary at closest point (m) and direction	Description and reason for designation
River Wensum Special Area of Conservation (SAC) / SSSI	1.6km north-east	<p>The SAC is designated for:</p> <ul style="list-style-type: none"> Annex I priority habitat: Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation Annex II primary species: White-clawed crayfish, <i>Austropotamobius pallipes</i> Annex II qualifying species: Desmoulin's Snail, <i>Vertigo moulinsiana</i>, Brook lamprey, <i>Lampetra planeri</i>, Bullhead, <i>Cottus gobio</i>. <p>The SSSI is designated as an example of enriched, calcareous lowland river. Supporting over 100 species of plants, a rich invertebrate fauna including white-clawed crayfish and a mixed fishery consisting of brown trout (<i>Salmo trutta fario</i>), chub (<i>Leuciscus cephalus</i>), pike (<i>Esox lucius</i>), eel (<i>Anguilla Anguilla</i>) and barbel (<i>Barbus barbus</i>). Kingfisher (<i>Alcedo atthis</i>) and little grebe (<i>Tachybaptus ruficollis</i>) breed along the River, whilst the adjacent wetlands have good populations of reed warblers (<i>Acrocephalus scirpaceus</i>), sedge warblers (<i>Acrocephalus schoenobaenus</i>) and barn owls (<i>Tyto alba</i>).</p>
Paston Great Barn SAC	29.3km north-east	<p>The SAC is designated for its barbastelle (<i>Barbastella barbastellus</i>) populations. Paston Great barn is the only known example of a maternity roost of barbastelle bats located within a building.</p>
Hockering Wood SSSI and Ancient Woodland	0.33km north	<p>Hockering Wood is one of the largest blocks of ancient, semi-natural woodland in Norfolk. The major stand-type is acid oak-lime wood which is rare in the county. Large areas of the ancient woodland have remained undisturbed and the site contains many rare and local species, particularly bryophytes but also higher plants, with a diverse ground flora. The woodland ponds which support a breeding population of the Great Crested Newt <i>Triturus cristatus</i>,</p>
Rosie Curston's Meadow SSSI	1.7km south-west	<p>A small unimproved calcareous clay pasture grazed by cattle with a herb rich sward composed of over 60 grassland species. The grassland is the meadow vetchling <i>Lathyrus pratensis</i> variant of the crested dog's-tail <i>Cynosurus cristatus</i> -- black knapweed <i>Centaurea nigra</i> community.</p> <p>The meadow supports five locally rare plants; green-winged orchid <i>Orchis morio</i>, present here as many thousands of flowering spikes in one of its largest populations in Norfolk. Adder's-tongue <i>Ophioglossum vulgatum</i>, Bee Orchid <i>Ophrys apifera</i>, twayblade</p>

Designated Site	Approximate distance from proposed construction boundary at closest point (m) and direction	Description and reason for designation
		<i>Listera ovata</i> and yellow rattle <i>Rhinanthus minor</i> . It also supports a large population of common spotted orchid <i>Dactylorhiza fuchsii</i> .

- 8.7.5. The River Wensum SAC and Paston Great Barn SAC have been assessed as biodiversity resources of international importance.
- 8.7.6. River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs and Hockering Wood Ancient Woodland have been assessed as biodiversity resources of national importance.
- 8.7.7. There are four unnamed parcels of ancient woodland within 2km of the Proposed Scheme which have been assessed as a biodiversity resource of national importance.
- 8.7.8. In addition to the statutory sites detailed above, the desk study also identified 21 non-statutory designated CWSs plus one proposed CWS which includes a further five ancient woodlands simultaneously designated, within 2km of the DCO boundary detailed in Table 8.5 below and Figure 8.1: Designated sites and priority habitats (**TR010038/APP/6.2**).

Table 8-5 Non- statutory designated sites

Designated Site	Approximate distance from proposed DCO boundary at closest point (m) and direction
Fen West of East Tuddenham CWS	0.2km south
Land adjoining River Tud CWS	0.16km north
Fen Plantation CWS	0.3km south
River Tud (west) CWS	0.4km east
Park Grove CWS and Ancient Woodland	0.5km north
Harman's Grove CWS and Ancient Woodland	0.4km north
Old Covert, Wood Lane CWS	adjacent to the northern boundary
Hall Hills/ Ringland Covert CWS	0.1km north
Clippings Green Farm CWS	0.8km south-west
Gravel pits, E Tuddenham CWS	0.6km south

Designated Site	Approximate distance from proposed DCO boundary at closest point (m) and direction
Mouse Wood CWS and Ancient Woodland	0.5km north
Holly Woods CWS and Ancient Woodland	0.9km east
Land adjoining Foxburrow Plantation CWS	0.5km north
Ringlands Hills CWS	1.3km north-east
Lord's Hill and Easton Reeds and Blackhill Wood CWS and Ancient Woodland	1.5km east
Old Hall Meadow CWS	1km south
Ringland Pits CWS	1.6km north-east
Yare Valley CWS	1.8km south-east
North Tuddenham Common CWS	1.7km west
Long Dale CWS	1.6km east
Pasture at Easton College CWS	1.9km south-east

8.7.9. Sixteen of the CWS have been assessed as biodiversity resources of county importance along with one proposed CWS, named Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation and the River Tud upstream of Church Farm which is adjacent to the DCO boundary.

8.7.10. Those which are also Ancient Woodland have been assessed as national importance.

8.7.11. There were no LWS or RSPB sites identified within 2km of the DCO boundary.

Priority Habitats

8.7.12. Within 2km of the DCO boundary, Habitats of Principal Importance under the NERC Act (2006) Section 41 include; arable field margins, good quality semi-improved grassland, lowland fen habitat, rivers, traditional orchard habitat, coastal floodplain grazing marsh habitat, pond habitats, good quality semi-improved neutral grassland habitat, lowland meadows habitat, hedgerows and lowland mixed deciduous woodland habitat.

8.7.13. Norfolk Biodiversity Action Plan priority habitats present within 2km of the DCO boundary; hedgerows and defunct hedgerows, arable field margins, lowland

mixed deciduous woodland, ponds, fens, wet woodlands, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture.

Extended phase 1 habitat survey (2016-2019)

8.7.14. An Extended Phase 1 Habitat survey was undertaken by suitably qualified ecologists in May 2016, in order to assess the ecological importance of the site and determine the requirement for Phase 2 Surveys (Figure 8.3) (TR010038/APP/6.2). Subsequent surveys were undertaken in 2017 and 2019 to provide updates to the existing information and additional surveys following the Scoping Opinion. Habitats identified during the Extended Phase 1 Habitat survey and subsequent updates were³:

- Woodland
 - Broadleaved semi-natural
 - Broadleaved plantation
 - Coniferous semi-natural
 - Coniferous plantation
 - Mixed semi natural
 - Mixed plantation
 - Recently felled broadleaved
- Scrub
 - Dense/continuous
 - Scattered
- Grassland
 - Neutral unimproved
 - Neutral semi-improved
 - Improved
 - Marsh/marshy
- Tall ruderal
- Standing water
- Running water
- Boundaries
 - Native species rich intact hedge
 - Species poor intact hedge
 - Native species rich defunct hedge

³ Listed as per headings and descriptions in the JNCC (2016), Handbook for Phase 1 habitat survey A technique for environmental audit.

- Species poor defunct hedge
 - Native species rich hedge with trees
 - Species poor hedge with trees
 - Dry ditch
 - Earth bank
 - Arable
 - Amenity grassland
 - Bare ground
 - Buildings
- 8.7.15. Semi-improved, amenity and improved grassland, tall ruderal, buildings, bare ground and dense and scattered scrub have been assessed as a biodiversity resource importance at a negligible level due to being in small patches and of poor species diversity.

Botanical surveys

- 8.7.16. The site was scoped for botanical interest with a walk over on 16 - 17 July 2019. Priority was given to areas which had previously been covered in 2017, but other areas were also surveyed where the habitat was considered to be of interest or value.
- 8.7.17. The survey covered 49 separate habitat units. Dominant plant species were noted, using the DAFOR scale (D = dominant, A= abundant, F= frequent, O= occasional and R= rare, with L=local often used as a prefix to moderate abundance categories). Photographs were taken of habitats and species. Where rare or scarce species of plant were encountered, the location of it was recorded and the species photographed.
- 8.7.18. Six units were identified as of county level importance and fourteen units are identified as local level importance. Two county level sites including one old area of woodland and an area of floodplain grassland adjacent to the River Tud on Easton Estates and two local level sites containing good grassland habitats are directly affected by the Proposed Scheme.
- 8.7.19. Scarce plant species include sharp-leaved fluellin *Kickxia elatine*. Species considered rare in the county include martagon lily *Lilium martagon* and bee orchid *Ophrys apifera*. Red Data Book species include common cudweed *Filago vulgaris*, wild basil *Clinopodium vulgare*, marjoram *Oreganum majorana* and pyramidal orchid *Anacamptis pyramidalis* were found within the Proposed Scheme.

8.7.20. The botanical assemblages on site have been assessed as a resource of county level biodiversity importance at six locations, with fourteen being of local biodiversity importance. Therefore, to ensure a conservative assessment, the higher value has been adopted.

Hedgerows

8.7.21. Twenty-six hedgerows were surveyed for species richness, gathering sufficient information to judge whether the hedgerow was likely to be an important hedgerow under the Hedgerow Regulations 1997 in July 2019.

8.7.22. Fourteen important hedgerows are within the Proposed Scheme. A further hedgerow may qualify on historic value. Ten of these hedgerows would be bisected by the Proposed Scheme. These hedgerows have been assessed as a nationally important biodiversity resource. The remaining defunct and species-poor hedgerows have been assessed as of county importance.

Fungi

8.7.23. The surveys in 2017 found that the site had a low value for fungi almost certainly due to extensive nitrogen deposition through diffuse sources such as fertiliser spray drift and poor air quality through emissions from long-term vehicle usage of the existing A47. Further surveys were conducted in October 2020 targeting sandy stiltball (*Battarraea phalloides*) and any other notable species. The results concluded that all fungi on site were common and widespread.

8.7.24. The fungi assemblages on site have been assessed as a resource of negligible level biodiversity importance.

Terrestrial and aquatic invertebrates

8.7.25. Ten sites including three stretches of the River Tud and seven standing waterbodies within the DCO boundary were surveyed for aquatic invertebrates in 2019. From these ten survey locations five did not contain water at the time of survey. In total 45 invertebrate species were recorded during the survey solely consisting of common or very common species therefore the conservation value is considered low. Mollusc habitat suitable for *Vertigo moulinsiana* was not found at any survey location.

8.7.26. A terrestrial invertebrate survey was undertaken in July, August and September 2019. In total 384 species were recorded with ten species being classed as nationally scarce. The four areas which were surveyed were all considered to be a local importance.

8.7.27. The terrestrial and aquatic invertebrate assembly has been assessed as a biodiversity resource of local level importance.

White-clawed crayfish

- 8.7.28. Ten sites within the DCO boundary were surveyed for White-clawed crayfish in 2019. Out of the ten survey locations, a tree lined section of the River Tud at TG 0672 was the only location where this species was recorded, a single specimen (**TR010038/APP/6.3**).
- 8.7.29. The white-clawed crayfish assemblage has been assessed as a biodiversity resource of national level of importance due to the citation within Schedule 5 of the Wildlife and Countryside Act (1981). Professional judgement has been taken in scoping the assemblage within the works boundary down to local importance. During the survey only a single individual was recorded amongst numerous invasive signal crayfish. This suggests that its continued long-term survival in the watercourse is unlikely as the latter species is both a vector for crayfish plague, to which the white-clawed is susceptible and successfully outcompetes the white-clawed in habitats where the signal crayfish enters. A large number (60+) of crayfish were translocated by Norfolk Rivers Trust and the Environment Agency from another area of the river in October 2018 to a confidential safe Ark Site and are no longer present.

Great crested newt

- 8.7.30. In 2016, out of 102 waterbodies that underwent a Habitat Suitability Assessment for great crested newt (GCN), 53 were identified as suitable and had environmental DNA (eDNA) surveys. The eDNA surveys undertaken during 2016 determined four waterbodies as positive for GCN, three were returned as indeterminate and nine which could not be assessed, with the remaining ponds showing negative results.
- 8.7.31. Further eDNA and population size class surveys were undertaken in 2017 on the 16 waterbodies which were previously subject to eDNA in 2016 and which could not be assessed or had positive or indeterminate results. The results of the combined phase two surveys in 2016 and 2017, identified five ponds with 'small' GCN populations and one pond with a 'medium' GCN population.
- 8.7.32. In 2019, once the preferred route option has been chosen and the DCO boundary reduced in size, a total of 89 waterbodies were subject to a Habitat Suitability Index (HSI) assessment of which 62 waterbodies were subject to Environmental DNA (eDNA) surveys. Of these 62 ponds, six had a positive result.
- 8.7.33. Population size-class assessment surveys were undertaken in 2019 on ten ponds including the ones with positive eDNA results from 2019 and 2016-2017 that were within 500m of the DCO boundary. The surveys confirmed small populations of GCN in three waterbodies with a max count of one in each pond.

8.7.34. The GCN assemblage has been assessed as biodiversity resource of county level of importance. The newt is locally common through south and mid Norfolk and Breckland but has suffered a major decline in the Broads and to the north east of the county. The small, dwindling population in the Proposed Scheme DCO boundary is considered to be in decline.

Reptiles

8.7.35. The desk study undertaken to inform the route options feasibility study identified records of common lizard *Zootoca vivipara*, slow worm *Anguis fragilis*, grass snake *Natrix helvetica* and adder *Vipera berus* within 2km of the outermost route options. Areas within the site with reptile potential were identified.

8.7.36. Reptile surveys undertaken in 2019 focussed on the preferred route option and identified good populations of grass snake and slow worm within Area B between Church Lane and the A47 (Appendix 8.7) (**TR010038/APP/6.3**). As juveniles of both species were recorded this area is considered a breeding ground for grass snake and slow worm. During ground investigation works, an ecologist found a common lizard in Area D adjacent to the River Tud, north of Honingham.

8.7.37. The population of reptiles has been assessed as a biodiversity resource of county importance although common lizard and grass snake are listed on the East of England Priority Species List, reptiles are locally common in the Broadland district where the reptiles were found.

Birds

Breeding birds

8.7.38. A breeding bird survey was initially undertaken in July 2017. In total 44 species were recorded including three species listed on the Birds Directive Annex 1, two on Wildlife & Countryside Act (1981) Schedule 1, four species on the red-listed species of conservation concern and four species on the amber list.

8.7.39. A follow up survey was undertaken on three occasions (April, May, June) in 2019. In total 79 species were recorded. Of these species recorded within the site:

- 41 species were confirmed as breeding. This was concluded through the identification of recently fledged young, adults visiting the nest and adults carrying food.
- 12 species were considered probable breeders on the site. This was concluded through pair observed in suitable breeding habitat, bird permanently on territories, agitated behaviour, nest building and performing courtship displays.

- 12 species were considered as possible breeding on site. This was concluded by birds either being observed in suitable breeding habitat or singing males present in suitable habitat.
- 14 species were considered as non-breeders. This includes all birds flying over the site and species which were presumed to still be on migration.

Table 8-6 Total species recorded which cited on European and UK legislation and of conservation concern

Designation	Number of species
Birds Directive	5
Wildlife and Countryside Act	3
NERC	13
BoCC Red List	12
BoCC Amber List	19
LBAP	5
IUCN	8
No Designation	14

8.7.40. As 79 species were recorded, the overall assemblage of bird species recorded on site was typical of the range of habitat which dominates the site including hedgerow, woodland, scrub habitat and agricultural habitat. This places the site within the range of regional importance.

8.7.41. The breeding bird assemblage has been assessed as a biodiversity resource of regional importance.

Wintering Birds

8.7.42. Previously, a wintering bird survey was undertaken between January and March 2017. In total 28 species were recorded including three species listed on the Wildlife & Countryside Act (1981) Schedule 1, ten species on the red-listed species of conservation concern and nine species on the amber list.

8.7.43. A follow up survey was undertaken on four occasions (January, February, November, December) in 2019. In total 69 species were recorded.

Table 8-7 Total species recorded which cited on European and UK legislation and of conservation concern

Designation	Number of Species
Wildlife and Countryside Act	6

Designation	Number of Species
Birds Directive	5
NERC	13
BoCC Red List	14
BoCC Amber List	14
LBAP	3
IUCN Red List	9
No Designation	4

8.7.44. The overall assemblage of bird species recorded on site was typical of the range of habitat present and the site falls within the range of species assemblages of county importance. However, professional judgement by a suitably qualified ornithologist has been used to upgrade the status of the species assemblage to one of regional importance, due to the number of species recorded (69 species) being the upper threshold and over 50% of the species which have been recorded are cited on European and UK legislation and included as species of conservation concern.

8.7.45. To ensure a conservative assessment, the higher value has been adopted.

Barn Owl Survey

8.7.46. Anecdotal records of three barn owl tree roosts were noted during the aerial bat tree roost assessment in 2017.

8.7.47. A barn owl survey was conducted in March 2020 to inspect potential nesting and roosting sights observed anecdotally during the breeding bird report. A follow up survey was done in June 2020 to confirm if breeding had occurred at any of the six sites which had been highlighted.

8.7.48. Of the six locations, two confirmed nest sites were identified, and roosting was confirmed in three of the sites.

8.7.49. The barn owl assemblage has been assessed as a biodiversity resource of county level importance due to its citation within the Norfolk Biodiversity Action Plans.

Bats

Summer bat roosts

- 8.7.50. A desk study undertaken during the route options appraisal identified 177 records of roosts of 10 species of bat, and activity records for the same 10 species, within 10km of the Scoping boundary.
- 8.7.51. Trees, buildings and structures within 50m of the boundary used for Scoping were assessed for bat roost potential (BRP) in January 2017 as part of the extended phase 1 habitat survey. Biodiversity resources identified include 241 trees/groups of trees, 33 areas of woodland (50.85ha) and nine buildings with confirmed bat roosts. In addition, four anecdotal bat roosts were identified. As of October 2017, ten buildings had confirmed bat roosts including brown long eared bat, Natterer's bat and pipistrelle *Pipistrellus spp.* roosts. Roosts had also been identified in five trees, with one containing a hibernaculum (winter hibernation roost). Of those ten buildings with confirmed bat roosts in 2017 only [REDACTED] remained within 50m of the DCO Boundary.
- 8.7.52. Aerial tree inspections undertaken in February and March 2017 identified five confirmed bat roosts, 43 trees with high BRP and 66 trees with moderate BRP.
- 8.7.53. The 2019 Scoping boundary and a 50m buffer were reassessed in 2019 and emergence surveys updated of trees and nine buildings [REDACTED] that would be impacted by the Proposed Scheme. Eleven previously un-surveyed trees were included along with thirty one previously surveyed trees. The results confirmed six buildings were in use by bats, which are:
- [REDACTED] (mixed species roost used by brown long-eared, soprano pipistrelle and unidentified bats for day roosting by single bats)
 - [REDACTED] (mixed species roost used by common and soprano pipistrelles for day roosting by max. 2-3 bats)
 - [REDACTED] (common pipistrelle day roost used by max. 5 bats)
 - [REDACTED] (common pipistrelle day roost used by max. 1 bat)
 - [REDACTED] (mixed species common and soprano pipistrelle day roost used by single bats)
 - [REDACTED] (brown long-eared bat potential maternity roost with a maximum of 25 individuals found during internal inspection surveys and 20 during emergence surveys).
- 8.7.54. In addition to those roosts identified within buildings, the 2019 bat roost surveys identified 20 roosts within trees.

8.7.55. In total, three species, common pipistrelle, soprano pipistrelle and brown long-eared plus a potential Myotis were recorded roosting within the study area, all of which are regularly present within Norfolk.

Bat hibernation

8.7.56. A confirmed tree hibernacula reported in 2017 was approximately 200m outside of this DCO boundary further south down Mattishall Lane and at the opposite side of the river. The main major works are approximately 350m away. Ground level BRP assessments were undertaken in 2017 which identified nine trees with hibernation potential. A combination of aerial inspections, automated detector monitoring and ground level assessments were used in February 2019 to reassess seven of the nine trees. Furthermore, an additional two trees were subject to aerial inspections. The results of the surveys concluded that six of the surveyed trees had no hibernation potential, one tree (T1) could not be assessed as there was no access and the surveys on two trees (T8 & T9) were considered inconclusive and required further survey.

8.7.57. Between December 2019 and February 2020 further automated detector hibernation surveys were undertaken on T1, T8 and T9. Results for all ten trees are that hibernacula are likely absent and five trees contained features that could be used as summer roosts and not for hibernation. The five trees were surveyed for summer roosts during 2019.

Bat activity

8.7.58. During the preliminary ecological appraisal undertaken in 2016 the site was assessed as having high potential for commuting and foraging bats. The landscape within the study area is well connected by treelines and hedgerows which may provide commuting corridors to larger areas of potential foraging habitat in woodlands.

8.7.59. Initial bat activity surveys (walked transects and automated surveys) undertaken in 2017 identified a minimum of nine species of bat within the study area; common and soprano pipistrelle, Nathusius's pipistrelle *Pipistrellus nathusii*, brown long-eared, Myotis sp., noctule *Nyctalus noctula*, serotine *Eptesicus serotinus*, Leisler's *Nyctalus leisleri* and barbastelle *Barbastella barbastellus*. Common pipistrelle and soprano pipistrelle were the first and second most commonly recorded species respectively. In late summer/early autumn barbastelle bats were recorded especially in the woodlands to the west of Taverham Road at a time which suggests a roost is located near this location.

8.7.60. Bat activity walked transect and automated surveys were undertaken twice a month on the same eight transects as in 2017 between June and October 2019 and in April 2020. The highest activity was recorded to the north of the existing

A47 from Wood Lane eastwards through Easton Estates. The transect in this area is considered very important particularly for barbastelle bats which are woodland specialists. Barbastelle activity was low in June and July and then peaked in the early part of August during the combined dusk and dawn surveys. The majority of passes were recorded along the part of the transect that passed alongside Church Plantation, there were also occasional passes by these bats elsewhere on the transect where it was heavily wooded. Other areas of high activity included small wooded areas, the River Tud and tree lines.

Crossing Point Survey

8.7.61. Bat activity crossing point surveys have been undertaken between June and September 2020 in order to understand how and where bats are crossing the existing and proposed roads. Based on the activity survey data obtained in 2018, 2019 and 2020, along with results of roost surveys and consultation advice with WSP, eleven potential crossing points were initially surveyed on two occasions.

- Crossing point 1: A point east of the Fox Lane junction and Poppy's Wood where the cycle path meets parallel to the A47 on the north and Oak Farm driveway meets the A47 on the south.
- Crossing point 2: A point west of Hockering where Low Road meets the A47 on the south and an unnamed lane meets the A47 on the north.
- Crossing point 3: A point south-west of Hockering where The Street meets the A47 on the north
- Crossing point 4: A point south-east of Hockering where an unnamed road meets the A47 on the south and The Street meets the A47 on the north
- Crossing point 5: The Church Lane/Sandy Lane/A47 junction
- Crossing point 6: The Berrys Lane/Wood Lane/A47 junction
- Crossing point 7: A point north-east of Honingham where the Easton Estates lane meets the A47 on the north and Hall Drive meets the A47 on the south.
- Crossing point 8: A point north-east of Honingham where the River Tud crosses the A47.
- Crossing point 9: A point east of St Andrew's Church and west of Taverham Road.
- Crossing point 10: The Taverham Road/Blind Lane/A47 junction.
- Crossing point 11: A point east of Taverham Road and west of Easton where a field entry meets the A47 on the north and a layby is on the south.

8.1.1 Based on the results of the initial two surveys, four of the eleven crossing points were found to have enough bats crossing the road on repeated visits to warrant further surveys according to the guidelines. These had a further six surveys totalling eight in all. The surveys found that:

- Crossing point 1: The highest number of bats confirmed crossing the road at crossing point 1 recorded in any one survey was eight bats. Overall, species recorded crossing at this point included common and soprano pipistrelle, and an unidentified bat species.
- Crossing point 7: The highest number of bats confirmed crossing the A47 at crossing point 7 recorded in any one survey was thirty two bats. Overall, seven species were recorded crossing at this point including common and soprano pipistrelle, noctule, brown long-eared bat, barbastelle, *Myotis* sp. and an unidentified bat species.
- Crossing point 8: The highest number of bats confirmed crossing the A47 at crossing point 8 recorded in any one survey was thirty two bats. Overall, six species were recorded crossing at this point including common and soprano pipistrelle, noctule, brown long-eared bat, barbastelle and an unidentified bat species.
- Crossing point 9: The highest number of bats confirmed crossing the A47 at crossing point 9 recorded in any one survey was twelve bats. Overall, seven species were recorded crossing at this point including common and soprano pipistrelle, noctule, Leisler's, serotine, brown long-eared bat and barbastelle.

8.7.62. The majority of bats crossed the road at safe heights where they would not collide with traffic, as the vegetation is currently mature and the bats fly high above it. A small number of pipistrelle bats flew lower as they were foraging along the tree lines and not just flying over.

8.7.63. The assemblage of bat species, which includes the presence of the rare bat barbastelle, has been assessed a biodiversity resource of national importance.

Otters

8.7.64. The desk study in 2017 identified records of otter along the A47 which are suspected to be records associated with road casualties. Surveys undertaken in 2017 identified one potential holt on the River Tud east of Taverham.

8.7.65. Surveys were undertaken in 2019 on sections of the River Tud and one drainage ditch and identified one potential otter holt on the River Tud to the south-east of Hockering. Surveys were undertaken in 2020 of the River Tud and ditches in Easton Estates. Field signs of otter were found along most of the River Tud. Otter presence is site-wide and it is likely that the River Tud is an important commuting and foraging corridor for this species.

8.7.66. Otters are a European Protected Species, fully protected by the Wildlife and Countryside Act (1981) and are listed on the NERC Act (2006) S41, Norfolk Local Biodiversity Action Plan and the East of England Priority Species List with populations increasing throughout Norfolk. The otter assemblage on site has been assessed as a biodiversity resource of county level importance.

Water vole

- 8.7.67. Targeted water vole surveys in 2017 identified burrows, latrines, feeding signs and pathways along the River Tud, but not in any ditches confirming water vole presence. Further surveys were undertaken in October 2019 and June 2020.
- 8.7.68. A low population of water vole was confirmed to be present in the river. No permanent direct habitat loss is predicted, but habitat will be temporarily disturbed during the installation of outfalls into the river and the construction of the bridge over the river.
- 8.7.69. Water Vole are fully protected by the Wildlife and Countryside Act (1981) and are listed on the NERC Act (2006) S41, Norfolk Local Biodiversity Action Plan and the East of England Priority Species List with Norfolk and East Anglia being a UK stronghold for this species. The water vole assemblage on site has been assessed as a biodiversity resource of county level importance.

Badgers

- 8.7.70. An initial baseline badger survey was undertaken in 2017. During this survey three active main setts, three subsidiary setts, three annexe setts and six outlier setts and thirteen disused setts were recorded.
- 8.7.71. Surveys during 2019 re-assessed all the previously located setts. The three main setts remain active, one of the three annexe setts is now disused, two of the three subsidiary setts remain active and four of six the outliers remain active. Four setts are within the DCO boundary and two further setts are within 30m of the DCO boundary.
- 8.7.72. The badger population on-site has been assessed as a biodiversity resource value at a local level.

Invasive non-native species

- 8.7.73. Ad hoc records of invasive species were received throughout 2019 during other Phase 2 surveys. Those species which have been identified on site and are cited on Schedule 9 of the Wildlife and Countryside Act (1981) are:
- Himalayan Balsam, *Impatiens glandulifera*
 - Signal Crayfish, *Pacifastacus leniusculus*
 - Rhododendron, *Rhododendron ponticum*
 - Cotoneaster, *Cotoneaster spp.*
 - Parrot's Feather, *Myriophyllum aquaticum*
 - Japanese Knotweed, *Fallopia japonica*
 - Chinese Water Deer, *Hydropotes inermis*

- Muntjac Deer, *Muntiacus reevesi*
- Ring-necked Parakeet, *Psittacula krameri*
- Canada Goose, *Branta canadensis*
- Egyptian Goose, *Alopochen aegyptiacus*
- Grey Squirrel, *Sciurus carolinensis*

8.7.74. Non-native species not cited within Schedule 9 which have been identified on site are:

- Red-necked terrapin, *Trachemys scripta elegans*
- New Zealand mud snail, *Potamopyrgus antipodarum*
- Freshwater shrimp, *Cragonyx pseudogracilis*
- Killer shrimp, *Dikerogammarus*
- Least duckweed, *Lemna minuta*
- Snowberry, *Symphoricarpos spp.*

Other notable species

8.7.75. During reptile surveys undertaken in 2019, observations of common toad were recorded at locations south-west of Hockering and north-east of Easton. Common toad is cited on Section 41 of the NERC Act 2006.

8.7.76. Brown Hare were recorded across the Proposed Scheme in all suitable habitat and are cited on Section 41 of the NERC Act 2006. Hedgehog are likely to be present in suitable habitat and are a NERC Act 2006 S41 species.

Valuation of biodiversity resources

8.7.77. The assessment criteria for the valuation of biodiversity resources are detailed in sections 8.4.

8.7.78. A summary of the valuation and level of threat from the scheme of biodiversity resources relevant to the Proposed Scheme is provided in Table 8-8.

Table 8-8 Summary of valuation of biodiversity resources

Biodiversity resources	Resource importance Valuation
River Wensum and Paston Great Barn SAC	International
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSI	National
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	National
County Wildlife Sites (Sixteen sites) and one proposed CWS	County

Biodiversity resources	Resource importance Valuation
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margins, lowland fens, traditional orchards, intact hedgerows, standing and running water, coastal and floodplain grazing marsh, good quality semi-improved grassland and lowland mixed deciduous woodland.	National
Norfolk priority habitats present within the 2km study area; hedgerows and defunct and species-poor hedgerows, arable field margins, lowland mixed deciduous woodland, ponds, fens, wet woodlands, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture.	County
Other habitats within the study area: Semi-improved, amenity and improved grassland, tall ruderal, buildings and hard standing, bare ground and dense and scattered scrub.	Negligible
Botanical	County
Fungi	Negligible
Terrestrial Invertebrates	Local
Aquatic Invertebrates	Local
White-clawed Crayfish	Local
Great-crested Newt	County
Reptiles	County
Breeding birds	Regional
Barn Owl	County
Wintering birds	Regional
Bats	National
Otters	County
Water vole	County
Badgers	Local (Legal constraints apply)
Invasive species	Negligible (Legal constraints apply)
Other notable species (brown hare, common toad, hedgehog)	Local

- 8.7.79. Biodiversity resources which have been assessed as having a resource importance value of local or above have been taken forward for further assessment. INNS have been taken forward, although negligible as legal constraints apply.
- 8.7.80. Further surveys for biodiversity resources that are to be licensed; bat roosts, badger, water vole and great crested newt; will be undertaken as stated in the respective licence method statements to update results. There is likely to be spreading of INNS that would reduce the existing biodiversity in the habitats where they are located. Future changes between the time of the surveys and the Proposed Scheme proceeding in February 2023 are not anticipated to be significant.

8.8. Potential impacts

Internationally designated sites

- 8.8.1. No works are to take place within the River Wensum nor Paston Great Barn SACs therefore, no direct impacts are anticipated. Any negative impacts to the SACs are likely to be through indirect pathways. A Habitats Regulations Screening Assessment (HRA) has been undertaken for the Proposed Scheme to assess the impacts on the River Wensum and Paston Great Barn SACs (**TR010038/APP/6.9**).
- 8.8.2. Paston Great Barn SAC is designated for its barbastelle populations. The HRA screening report determined that, without mitigation, there will be no Likely Significant Effects on the features of the SAC due to its distance the site is away from the works.
- 8.8.3. The River Wensum SAC primary qualifying habitat, Water courses of plain to montane levels with *Ranunculion fluitantis* and *Callitriche-Batrachion* vegetation, was assessed as being susceptible to reduction in water quality and increased sedimentation.
- 8.8.4. The key species within the River Wensum SAC, white-clawed crayfish, bullhead, brook lamprey and Desmoulin's whorl snail could all be impacted through displacement, a decrease in air quality, increased sedimentation, reduction in water quality and changes to the baseline flow.
- 8.8.5. The HRA screening report determined that, without mitigation, there will be no Likely Significant Effects on any of the qualifying features of the River Wensum SAC. This was primarily down to the distance the site is away from the works (1.6km overland, 7.3km downstream), whereby any pollution would be highly dissolved or dispersed before reaching the site the impacts would be negligible.

8.8.6. Therefore, designated sites have been scoped out of this assessment (for both construction and operation).

Construction

8.8.7. The potential impacts pathways which may arise during the construction stage include:

- Site clearance and the land take of habitats
- Creation of barriers along habitats decreasing site connectivity and increasing fragmentation
- Physical damage to on site vegetation from smothering via soil piles
- The damage to root systems
- Changes to soil chemistry
- Increase surface water run off changing hydrological quality through sedimentation
- Damage of watercourses and habitats through accidental spillages of pollutants (chemical)
- The change in natural on-site hydrological flow
- Loss of foraging habitats for breeding and wintering species due to fragmentation of the site and severance of linear biodiversity resources such as hedgerows.
- Increased atmospheric, noise and light pollution during construction
- Noise and visual disturbance resulting in the dissipation of sensitive biodiversity resources within and adjacent to the construction footprint
- Direct mortality of local fauna due to site plant collisions or earthworks
- Spreading of invasive species and disease through the movement of plant.

8.8.8. The predicted levels of impact (without mitigation) from construction for the Proposed Scheme are presented in Table 8-9.

Table 8-9 Predicted construction impacts on biodiversity resources prior to mitigation

Biodiversity resources	Resource importance	Description of impact	Level of impact
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs	National	Potential of indirect impacts through the pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages.	Moderate adverse
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	National	Indirect impacts during construction through increased air pollution.	Negligible adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
County Wildlife Sites (Sixteen sites) and one proposed CWS	County	Potential of indirect impacts upon all CWSs from pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages.	Moderate adverse
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margins, lowland fens, traditional orchards, intact hedgerows, standing and running water, coastal and floodplain grazing marsh, lowland mixed deciduous woodland, good quality semi-improved grassland.	National	<p>Permanent loss of hedgerows, deciduous woodland, good quality semi-improved grassland, ponds and coastal and floodplain grazing marsh (adjacent to Mattishall Lane and the River Tud).</p> <p>Indirect effects on lowland fens, arable field margins, traditional orchards, coastal and floodplain grazing marsh, ponds, rivers, deciduous woodland and hedgerows from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages.</p>	<p>Major adverse (hedgerows, deciduous woodland, good quality semi-improved grassland, ponds, coastal and floodplain grazing marsh)</p> <p>Moderate adverse (all other biodiversity resources)</p>
Norfolk priority habitats within the 2km study area; hedgerows and defunct hedgerows, arable field margins, ponds, lowland mixed deciduous woodland, wet woodlands, fens, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture	County	Permanent loss of hedgerows and defunct hedgerows, lowland meadow and pasture, coastal and floodplain grazing marsh, ponds, fens, wet woodland and lowland deciduous woodland.	Major adverse
		No direct impacts on churchyards and cemeteries and arable field margins. Indirect effects on all habitats from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages.	Moderate adverse
Botanical	County	<p>Permanent loss of habitat (old woodland, floodplain grassland and good quality grassland) resulting in loss of botanical composition.</p> <p>Damage to existing habitat from construction traffic driving over sensitive botanical areas.</p> <p>Indirect effects from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages.</p>	Major adverse
Terrestrial invertebrates	Local	<p>Removal of habitat (permanent).</p> <p>Risk of population decline through habitat fragmentation. Habitat degradation through pollution events from dust and accidental spills.</p> <p>Disturbance from light pollution.</p>	Minor adverse
Aquatic invertebrates	Local	<p>Removal of habitat (permanent).</p> <p>Risk of mortality of individuals through pollution from accidental spills, changes to water levels and habitat suitability for common aquatic invertebrates.</p>	Minor adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
		Disturbance from light pollution (temporary).	
White-clawed crayfish	Local	<p>Risk of mortality of individuals through pollution from dust, accidental spills, changes to water levels and habitat suitability for common aquatic invertebrates.</p> <p>Crayfish are not present in parts of river likely to be disturbed and the individual recorded is likely a remnant individual from the translocation of this species into an Ark Site. Natives have been out competed from the increased spread of invasive signal crayfish.</p> <p>Disturbance from light pollution (temporary).</p>	Minor adverse
Great-crested newt	County	<p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment.</p> <p>Loss of supporting and breeding habitat.</p>	Major adverse
Reptiles	County	<p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment. Loss of supporting and breeding habitat.</p>	Minor adverse
Breeding birds	Regional	<p>Direct mortality of individuals from site clearance of vegetation during breeding season, disturbance of nesting locations from water, noise and light pollution. Collisions with construction traffic.</p> <p>Loss, obstruction and disturbance of foraging and loafing habitat of breeding individuals from the fishing lake, streams and river, noise and light pollution leading to abandonment of area.</p>	Major adverse
Barn owl	County	<p>Direct mortality of individuals from site clearance of vegetation during breeding season, disturbance of nesting locations from noise and light pollution.</p> <p>Loss of foraging habitat and suitable roosting habitat.</p>	Major adverse
Wintering birds	Regional	<p>Direct mortality of individuals from site clearance of vegetation, disturbance of foraging and loafing locations from fishing lake, river and streams, noise and light pollution. Collisions with construction traffic.</p> <p>Loss, obstruction and disturbance of key foraging and loafing habitat such as cereal crop and wintering crops leading to abandonment of area.</p>	Major adverse
Bats	National	<p>Direct mortality through roost destruction during removal of 14 tree roosts (permanent). Disturbance of known bat roosts from noise, vibration and light (temporary).</p> <p>Permanent loss of foraging habitat, severance of commuting routes and foraging areas, resulting in avoidance and abandonment of habitats and roosts.</p>	Major adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
		<p>Culverting and bridging across watercourses causing disturbance.</p> <p>Indirect impacts from lighting, vibration and noise.</p>	
Otters	County	<p>Direct mortality or injury of individuals from construction traffic and being trapped in excavations.</p> <p>Pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes.</p> <p>Disturbance from noise and light pollution leading to abandonment of foraging areas and resting places (temporary).</p>	Major adverse
Water vole	County	<p>Direct mortality of individuals during vegetation clearance, ditch dredging and realignment, Installation of outfalls and construction of bridge and culverts, collisions from construction traffic, and loss of habitat.</p> <p>This population will incur a pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes. Disturbance from noise and light pollution (temporary).</p>	Major adverse
Badgers	Local (Legal constraints apply)	<p>Permanent loss of a sett and commuting and foraging habitat. Temporary exclusion from one sett and disturbance to another sett. Disturbance from noise and light levels. Potential of death or injury of individuals from falling in excavations.</p>	Major adverse
Invasive species	Negligible (Legal constraints apply)	<p>Introduction and spread of diseases during construction could result in death of plants and animals (examples: Ash dieback, ranavirus) (permanent). Introduction and assisted spread of invasive species during construction may result in squeezing out of native habitats and species. (temporary).</p>	Major adverse
Other notable species (brown hare, common toad, hedgehog)	Local	<p>Permanent loss of commuting routes and areas of shelter and foraging. Direct mortality of individuals from collisions with construction traffic, entrapment in excavations, disturbance from noise and light pollution of places of shelter leading to abandonment. Pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes.</p>	Minor adverse

Operational

8.8.9. The impacts associated to the operational stage of the proposed works include:

- Increased air quality and noise levels upon biodiversity resources due to increase in use of the road by vehicles
- Barrier effect of new road caused by increased width

- Disturbance of breeding species and their resting places due to light spill
- Mortality of local flora and fauna due to pollution events and spills
- Direct mortality of species due to road traffic collisions (RTC)
- Flood events or drying out of water and wetland habitats

8.8.10. The predicted levels of impact for the Proposed Scheme are presented in Table 8-10.

Table 8-10 Predicted operational impacts on biodiversity resources prior to mitigation

Biodiversity resources	Resource importance	Description of impact	Level of impact
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs	National	No direct impacts. Indirect impacts during operation from surface water run-off, sedimentation, water level changes and air quality.	Major adverse
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	National	No direct impacts. Indirect impacts during operation through increased air pollution.	Minor adverse
County Wildlife Sites (Sixteen sites) and one proposed CWS	County	Indirect impacts during operation from surface water run-off, sedimentation, water level changes, air pollution gradually degrading habitats.	Major adverse
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margin, good quality semi-improved grassland, lowland fens, traditional orchards, intact hedgerows, standing and running water, coastal and floodplain grazing marsh and lowland mixed deciduous woodland.	National	Indirect impacts from pollution of habitat from air quality, surface water runoff, water level changes, sedimentation and accidental spillages.	Major adverse
Norfolk priority habitats within the 2km study area; hedgerows and defunct hedgerows, arable field margins, ponds, lowland mixed deciduous woodland, wet woodlands, fens, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture	County	Indirect impacts through the pollution of habitats from air quality and surface water runoff, sedimentation, water level changes and air pollution gradually degrading habitats.	Major adverse
Botanical	County	Indirect impacts upon on botanical composition during operation from surface water run-off, sedimentation, water level changes, air pollution gradually degrading habitats.	Minor adverse
Terrestrial invertebrates	Local	Reduction in abundance due to the presence of a physical barrier which will reduce dispersal of species. Potential risk of mortality of individuals through pollution from air quality and surface water runoff, sedimentation,	Minor adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
		water level changes and habitat suitability for common aquatic invertebrates. Disturbance from light pollution (permanent).	
Aquatic invertebrates	Local	Potential risk of mortality of individuals from pollution from air quality and surface water runoff, sedimentation, water level changes and habitat suitability for common aquatic invertebrates. Disturbance from light pollution (permanent).	Minor adverse
White-clawed crayfish	Local	Reduction in abundance due to the decline in habitat quality through pollution events from surface water runoff, sedimentation, water level changes and changes in air quality. This species is highly susceptible to pollution.	Minor adverse
Great-crested newt	County	Pollution of breeding ponds from surface water run-off carrying contaminants and pollutants due to increased area of hard-standing. Loss of terrestrial and breeding habitat leading to reduction in abundance. Any newts remaining have less resource by which to increase the population. New road forming a barrier to newt dispersal. Changes to habitat suitability through pollution	Major adverse
Reptiles	County	Reduction in abundance due to the presence of a physical barrier which will reduce dispersal of species. Changes to habitat suitability for reptiles through air pollution and surface water run-off.	Minor adverse
Breeding birds	Regional	Direct mortality of individuals through traffic collisions due to wider junctions and road. Disturbance of nesting locations from noise and light pollution. Water pollution may also affect nesting and feeding for wildfowl species. Degradation of habitat and obstruction and disturbance of foraging and loafing on individuals from water and light pollution leading to abandonment of area.	Minor adverse
Barn owl	County	Disturbance of nesting locations from noise and light pollution. Mortality from	Major adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
		<p>the increased potential for collisions with traffic.</p> <p>Loss, obstruction and disturbance of foraging habitat of breeding individuals from noise and light pollution leading to abandonment of area.</p>	
Wintering birds	Regional	<p>Direct mortality of individuals through traffic collisions due to wider junctions and road.</p> <p>Disturbance of foraging and loafing locations from noise and light pollution.</p> <p>Degradation of habitat and the obstruction and disturbance of foraging and loafing areas from water and light pollution leading to abandonment of area.</p>	Minor adverse
Bats	National	<p>Direct mortality through traffic collisions due to wider road.</p> <p>Pollution of water courses could lead to reduction in prey availability.</p> <p>Disturbance for noise, vibration or light spill resulting in permanent avoidance and abandonment of foraging habitats, commuting routes and roosts.</p>	Major adverse
Otters	County	<p>Direct mortality of individuals through traffic collisions due to wider road.</p> <p>Potential risk of mortality of individuals from air pollution and surface water runoff, sedimentation, water level changes and decreased habitat suitability for otters.</p> <p>Disturbance from light pollution (permanent).</p>	Major adverse
Water voles	County	<p>Potential risk of mortality of individuals from air pollution, pollution through increase surface water runoff, sedimentation, water level changes and decreased habitat suitability for water voles.</p> <p>Avoidance and abandonment of burrows due to bridge over river causing shading. Reduced breeding habitat available will reduce population.</p> <p>Disturbance from light pollution (permanent).</p>	Major adverse
Badgers	Local (Legal constraints apply)	Direct mortality of individuals through traffic collisions due to wider junction and new roads.	Major adverse

Biodiversity resources	Resource importance	Description of impact	Level of impact
		Disturbance from noise and light levels.	
Invasive species	Negligible (Legal constraints apply)	No operational impacts anticipated.	No change
Other notable species (brown hare, common toad, hedgehog)	Local	Direct mortality of individuals through traffic collisions due to wider junctions and road. Risk of mortality of individuals from air pollution, surface water runoff, sedimentation, water level changes and reduction in habitat suitability. Disturbance from light pollution (permanent).	Minor adverse

8.9. Design, mitigation and enhancement features

- 8.9.1. This section presents an overview of mitigation measures proposed in response to the impacts identified. The purpose of these measures is to avoid or reduce the ecological effects associated with the construction and operation of the Proposed Scheme and maximise benefits. These measures take into account the latest standards, best practice, legislation and guidance documents including DMRB LA 108 Biodiversity, CIEEM, CIRIA and Natural England guidance.
- 8.9.2. Guidance on best practice in relation to pollution prevention and water management is set out in Construction Industry Research and Information Association (CIRIA) Guidelines ((Soubry (2001), Murnane *et al.* (2006), Charles and Edwards (2015)), and the Environment Agency’s approach to groundwater protection (Environment Agency, 2017) and groundwater protection guides (Environment Agency, 2017 a), as required under the Water Framework Directive.
- 8.9.3. The Proposed Scheme design has been developed to maximise opportunities for biodiversity. The mitigation design is presented in the Environmental Masterplan (**TR010038/APP/6.8**).
- 8.9.4. All mitigation will be detailed and implemented as part of the record of environmental actions and commitments (REAC) and in the Environmental Management Plan (EMP) (**TR010038/APP/7.4**). Newly created or enhanced habitats will be managed and monitored for five years after planting. Future management requirements will be set out in the EMP for handover following the five year monitoring period.

8.9.5. Mitigation measures employed to reduce the impact of the Proposed Scheme on biodiversity resources have been categorised using a hierarchical system as follows and are detailed in Table 8-11 and 8-12.

- avoidance and prevention: design and mitigation measures to prevent the effect (for example. alternative design options or avoidance of environmentally sensitive sites)
- reduction: where avoidance is not possible, then mitigation is used to lessen the magnitude or significance of effects
- remediation: where it is not possible to avoid or reduce a significant adverse effect, these are measures to offset the effect by compensation or enhancement.

Table 8-11 Ecological design and mitigation measures during construction

Biodiversity resource	Description of impact (Construction)	Mitigation
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs	Potential of indirect impacts through the pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages	Pollution during construction will be mitigated by using best practice methods for pollution prevention and water management.
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	Indirect impacts during construction through increase air pollution.	Impacts of flood risk will be managed by the implementation of a construction-phase drainage system. Drainage around the main compound will be collected in a ditch and directed to settlement ponds before discharge.
County Wildlife Sites (Sixteen sites) and one proposed CWS	Potential of indirect impacts upon all CWSs from pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages	The installation of outfalls into the River Tud will have in-river sediment controls to reduce sedimentation. Monitoring during construction will also be implemented and will be outlined within the temporary surface water drainage strategy within the EMP (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/7.4). Although it was concluded that there would be no significant effects from dust during construction, best practice mitigation measures will be included in the EMP (TR010038/APP/7.4) as part of the dust management plan which includes ongoing monitoring (Chapter 5: Air Quality) (TR010038/APP/6.1)
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margins, lowland fens, traditional orchards, intact hedgerows, standing and running water, coastal and floodplain grazing marsh, good quality semi-improved grassland and	Permanent loss of hedgerows, deciduous woodland, good quality semi-improved grassland, ponds, and coastal and floodplain grazing marsh (adjacent to Mattishall Lane and the River Tud). Indirect effects on lowland fens, traditional orchards, arable field margins, coastal and floodplain grazing marsh, ponds, rivers, deciduous woodland and hedgerows from pollution of habitat, air	Reduction of as much permanent habitat loss as possible has been embedded in the design. Any hedgerow deemed species rich or 'important' will be translocated and not lost. New species rich hedgerows with trees will be planted in addition to areas of deciduous woodland. Wetland areas containing some permanently wet ponds are to be created with riparian woodland

Biodiversity resource	Description of impact (Construction)	Mitigation
lowland mixed deciduous woodland.	quality, surface water runoff, water level changes, sedimentation and accidental spillages	<p>and riparian seeding. Ponds are to be recreated with species-rich flora.</p> <p>Species-rich grassland areas are to be created.</p> <p>All pollution events will be managed though best practice guidance and continually monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p>
<p>Norfolk priority habitats within the 2km study area; hedgerows and defunct hedgerows, arable field margins, ponds, lowland mixed deciduous woodland, wet woodlands, fens, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture</p>	<p>Permanent loss of hedgerows and defunct hedgerows, lowland meadow and pasture, ponds, coastal and floodplain grazing marsh, fens, wet woodland and lowland deciduous woodland.</p>	<p>Reduction of as much permanent habitat loss as possible has been embedded in the design.</p> <p>New species rich hedgerows with trees will be planted in addition to deciduous woodland.</p>
	<p>No direct impacts on arable field margins and churchyards and cemeteries. Indirect effects on all habitats from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages</p>	<p>All pollution events will be managed though best practice guidance and continually monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p>
Botanical	<p>Permanent loss of habitat (old woodland, floodplain grassland and good quality grassland) resulting in loss of botanical composition.</p> <p>Damage to existing habitat from construction traffic driving over sensitive botanical areas.</p> <p>Indirect effects from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages.</p>	<p>Reduction of as much permanent habitat loss as possible has been embedded in the design. Compensation from planting specified above.</p> <p>In addition, the reduction in use of nutrient rich topsoil across the site will enable a more diverse botanical population to colonise newly created bare ground.</p> <p>Where possible construction vehicles should be excluded from driving over species rich grassland. If this is not possible, heavy duty ground protection should be installed to protect the soil and turf.</p> <p>All pollution events will be managed though best practice guidance and continued monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p>
Terrestrial invertebrates	<p>Removal of habitat (permanent).</p> <p>Risk of population decline through habitat fragmentation. Habitat degradation through pollution events from dust and accidental spills.</p>	<p>Reduction of as much permanent habitat loss as possible has been embedded in the design. Compensatory planting in accordance with the measure mentioned on the individual habitats (biodiversity resource) sections in the table above.</p>
Aquatic invertebrates	<p>Disturbance from light pollution (Temporary).</p>	<p>All pollution events will be managed though best practice guidance and</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
White-clawed crayfish	<p>Risk of mortality of individuals through pollution from dust, accidental spills, changes to water levels and habitat suitability for common aquatic invertebrates.</p> <p>Crayfish are not present in parts of river likely to be disturbed and the individual recorded is likely a remnant individual from the translocation of this species into an Ark Site.</p> <p>Increased competition from the increased spread of invasive signal crayfish</p> <p>Disturbance from light pollution (temporary).</p>	<p>continually monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p> <p>Night lighting during construction will be directed away from sensitive biodiversity resources and should not affect these species.</p>
Great-crested newt	<p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment.</p> <p>Loss of supporting and breeding habitat.</p>	<p>Trapping and translocation of GCN into suitable receptor sites under licence from Natural England will be undertaken prior to construction.</p> <p>Enhancement of the site to encourage this species back into the area includes the creation of refuges, tree lines, hedgerows, copses, species-rich grassland and ponds with newly created wetland areas.</p> <p>These will be designed and reported in the REAC, and in the EMP (TR010038/APP/7.4).</p> <p>All excavations to be covered at night or a ramp left in so animals can climb out.</p> <p>All pollution events will be managed through best practice guidance and continually monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p>
Reptiles	<p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment. Loss of supporting and breeding habitat.</p>	<p>Suitable habitats will be searched by an Ecological Clerk of Works (ECoW) prior to vegetation clearance. If any are found, they will be moved to a safe suitable area.</p> <p>Tool-box talks will be given by the on-site ECoW to contractors</p> <p>Areas of temporary land clearance will be replanted with native trees and shrubs and species-rich grassland.</p> <p>All excavations to be covered at night or a ramp left in so animals can climb out.</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
Breeding birds	<p>Direct mortality of individuals from site clearance of vegetation during breeding season.</p> <p>Collisions with construction traffic.</p> <p>Disturbance of nesting locations from, noise and light pollution. Water pollution may also affect nesting and feeding for wildfowl species.</p> <p>Total loss of nesting habitats and foraging habitat across the scheme through vegetation clearance.</p> <p>Loss, degradation obstruction and disturbance of foraging and loafing habitat used by breeding birds from noise and light pollution leading to abandonment of area.</p>	<p>Reduction of as much permanent habitat loss as possible has been embedded in the design and where possible, habitat planting would be undertaken before the start of construction to minimise the intervening period between vegetation clearance and the establishment of the new habitat.</p> <p>Timing of vegetation clearance works is to take place outside of the bird nesting season. If it goes into nesting season, the areas to be cleared will be checked by an ECoW immediately prior to clearance. Any nests or young must be avoided until the birds have fledged. Additionally Compound 3 (south of Honingham roundabout) is situated 190m from a schedule 1 nest site, as work activities in this compound location is uncertain the ECoW must review works and nesting status to determine if additional mitigation measures are required to prevent disturbance.</p> <p>Areas of temporary land clearance will be remediated with hedgerows, native trees, shrubs, wetland areas, ponds and species-rich grassland. Bird boxes will be installed on remaining trees at a density of between 10 and 40 nest boxes should be installed per hectare.</p> <p>Disturbance from noise will be mitigated by temporary noise barriers, quieter plant, leaving a buffer zone around sensitive biodiversity resources and reducing time on noisy activities. Real-time noise monitoring shall be provided on sites where there as sensitive biodiversity resources. Vibration will be reduced with early warning, pre-condition surveys, short work durations, and vibration monitoring. (Chapter 11: Noise and vibration) (TR010038/APP/6.1).</p> <p>Night lighting during construction will be directed away from sensitive biodiversity resources and should not affect these species.</p> <p>All pollution events will be managed though best practice guidance and continued monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP.</p>
Barn owl	<p>Total loss of nest site located at TG 07873 12565 and total loss of foraging habitat at Hall Farm, TG 10853 12067</p>	<p>Creation of areas of rough grassland will be included as part of the landscape plans to mitigate the loss of suitable foraging habitat. This will be set back from the road verge and separated from</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
	<p>(Site 3 & 5, Appendix 8.9) (TR010038/APP/6.3).</p> <p>Direct mortality of individuals from site clearance of vegetation during breeding season, disturbance of nesting locations from noise and light pollution.</p> <p>Loss of foraging habitat and suitable roosting habitat.</p>	<p>the road by a shrub belt in order to prevent road casualties.</p> <p>Installation of eight barn owl boxes close to suitable rough grassland in the wider landscape will help in enhancing the wider area for the species and provide additional nesting capacity. This mitigation measure will require landowner agreement and will be greater than 1.5km from the road.</p> <p>Low-flight prevention screening, in the form of appropriate landscape planting, should be installed to help prevent barn owl road casualties. This would consist of high hedges or tree screens being planted on raised banks (bunds) at locations where barn owls regularly cross the road.</p> <p>All remaining nest sites within the DCO boundary will have a buffer zone to reduce disturbance from noise during construction. Night lighting during construction will be directed away from sensitive biodiversity resources and Type I foraging habitat.</p>
Wintering birds	<p>Direct mortality of individuals from site clearance of vegetation.</p> <p>Collisions with construction traffic.</p> <p>Disturbance of foraging and loafing locations from, noise and light pollution.</p> <p>Loss, obstruction and disturbance of key foraging and loafing habitat such as cereal crop and wintering crops leading to abandonment of area.</p>	<p>Disturbance from noise will be mitigated by temporary noise barriers, quieter plant, leaving a buffer zone around sensitive biodiversity resources and reducing time on noisy activities. Real-time noise monitoring shall be provided on sites where there are sensitive biodiversity resources. Vibration will be reduced with early warning, pre-condition surveys, short work durations, and vibration monitoring. (Chapter 11. Noise and vibration) (TR010038/APP/6.1).</p> <p>Night lighting during construction will be directed away from sensitive biodiversity resources and should not affect these species.</p> <p>All pollution events will be managed through best practice guidance and continued monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p>
Bats	<p>Direct mortality through roost destruction during removal of 14 tree roosts (permanent). Disturbance of known bat roosts from noise, vibration and light (temporary).</p> <p>Permanent loss of foraging habitat, severance of commuting routes and foraging areas, resulting in avoidance and abandonment of habitats and roosts.</p>	<p>Tree roost loss will be undertaken under licence from Natural England. Habitat creation in the form of artificial roosting habitat will be installed prior to the start of construction. The tree felling will be undertaken to avoid sensitive seasons for bats. It will be soft felled with supervision from a registered bat licence holder with Natural England and under licence.</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
	<p>Culverting and bridging across watercourses causing disturbance.</p> <p>Indirect impacts from lighting, vibration and noise</p>	<p>Works near trees and that may disturb roosting bats in buildings will be undertaken under supervision from a registered bat licence holder.</p> <p>This will also be reported in the REAC and the EMP (TR010038/APP/7.4). Disturbance of buildings from noise and vibration will be mitigated by noise barriers, quieter plant and reducing time on noisy activities. (Chapter 11 (TR010038/APP/6.1)).</p> <p>Habitat loss and severance from the larger footprint of the new road cannot be mitigated at the start of construction. It will be compensated for as each phase of the road is completed with increased and enhanced tree planting as a remediation measure. Compensatory planting is proposed along the verges of the Proposed Scheme to mitigate the loss of foraging habitats and to shield suitable habitat and roosts from disturbance. Copses of trees and woodland grassland mosaics are proposed along the scheme to act as 'stepping stones' between suitable roosting and foraging habitat. Hop-overs and targeted planting at underpasses and overpasses have been designed to encourage use by bats to maintain connectivity and raise flight height above the carriageway.</p> <p>The bridge over the River Tud is low (2.7m) headroom, so bats currently flying over the road will be encouraged to fly high above traffic by planting high trees and fencing along the bridge.</p>
Otter	<p>Direct mortality or injury of individuals from construction traffic and being trapped in excavations.</p> <p>Pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes.</p> <p>Disturbance from noise and light pollution leading to abandonment of foraging areas and resting places (temporary).</p>	<p>Construction areas to be fenced off and all excavations to be covered at night or a ramp left in so animals can climb out.</p> <p>Water and air pollution events will be managed through best practice guidance and continually monitored throughout construction as part of the water drainage strategy and dust management plan within the EMP (TR010038/APP/7.4).</p> <p>Disturbance from noise will be mitigated by temporary noise barriers, quieter plant, leaving a buffer zone around sensitive biodiversity resources and reducing time on noisy activities. Real-time noise monitoring shall be provided on sites where there are sensitive biodiversity resources (Chapter 11 - Noise and vibration) (TR010038/APP/6.1).</p>
Water vole	<p>Direct mortality of individuals during vegetation clearance, installation of outfalls and construction of bridge and culverts, ditch dredging and realignment and collisions from construction traffic, and loss of habitat.</p> <p>This population will incur a pollution risk of mortality of individuals from dust and accidental spills and changes to habitat</p>	<p>Night lighting during construction will be directed away from sensitive biodiversity</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
	<p>suitability from sedimentation and water level changes. Disturbance from noise and light pollution (temporary).</p>	<p>resources and should not affect these species.</p> <p>Works must be more than 5m from the top of the banks of the River Tud if no works directly in the river.</p> <p>A Natural England licence will be obtained prior to work taking place in the River Tud. Under this licence:</p> <p>Habitat will be enhanced and increased along the river bank prior to works taking place. Where water voles will be disturbed through the installation of outfalls, they will be displaced using habitat manipulation at a suitable time of year under supervision of a licensed ecologist.</p> <p>In the area where the Proposed Scheme will cross the river, the water voles will be trapped out and translocated by suitably qualified ecologists in springtime to a receptor area that has previously been enhanced with vegetation and allowed to mature so the site is suitable to receive the water voles. Mesh fencing will be erected in the area of the river where the water voles have been moved from during the duration of the works there. It will be removed as soon as works have finished in the area.</p>
<p>Badger</p>	<p>Permanent loss of a sett and commuting and foraging habitat. Temporary exclusion from one sett and disturbance to another sett. Disturbance from noise and light levels. Potential of death or injury of individuals from falling in excavations.</p>	<p>Two badger tunnels will be installed on the realigned minor road and beneath the new dual carriageway. The first tunnel crosses the new road [REDACTED]; and the second tunnel crosses the mainline [REDACTED]</p> <p>Badger specific fencing will be installed on both sides of the Scheme between Sandy Lane and Wood Lane junction</p> <p>Prior to construction an ECoW will conduct a full resurvey of the site to identify any changes in the conditions on site.</p> <p>Work will be done under a Natural England licence that will involve the permanent closure of one sett and the temporary closure of another sett.</p> <p>Signage and Heras fencing will be installed around the sett to be disturbed to provide a suitable buffer zone.</p> <p>An ECoW will conduct a toolbox talks for all site personnel (including sub-contractors) prior to commencement of</p>

Biodiversity resource	Description of impact (Construction)	Mitigation
		<p>works and supervise works within buffer zones.</p> <p>All excavations to be covered at night or a ramp left in so animals can climb out.</p> <p>Reduction of as much permanent habitat loss as possible has been embedded in the design.</p> <p>Disturbance from noise will be mitigated by temporary noise barriers, quieter plant, leaving a buffer zone around sensitive biodiversity resources and reducing time on noisy activities. Real-time noise monitoring shall be provided on sites where there as sensitive biodiversity resources (Chapter 11 - Noise and vibration) (TR010038/APP/6.1).</p> <p>Night lighting during construction will be directed away from sensitive biodiversity resources and should not affect this species.</p>
Invasive species	<p>Introduction and spread of diseases during construction could result in death of plants and animals (examples: Ash dieback, ranavirus) (permanent). Introduction and assisted spread of invasive species during construction may result in squeezing out of native habitats and species. (temporary)</p>	<p>The introduction of INNS during construction will be mitigated by implementation of an INNS Management Plan. This will contain knowledge of appropriate treatment methods to ensure that construction proceeds within the legal framework to ensure prevention of spread both within and beyond the DCO boundaries. The INNS plan will also cover animal biosecurity if necessary.</p> <p>These will be designed and reported in the REAC, and in the EMP (TR010038/APP/7.4).</p>
Other notable species (brown hare, common toad, hedgehog)	<p>Permanent loss of commuting routes and areas of shelter and foraging. Direct mortality of individuals from collisions with construction traffic, entrapment in excavations, disturbance from noise and light pollution of places of shelter leading to abandonment. Pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes.</p>	<p>Habitat will be created as described for other species above.</p> <p>Vegetation clearance will be undertaken under the supervision of an ECoW. Tool-box talks will be given by the ECoW and excavations will either be covered at night, or a ramp left in, so animals can climb out.</p> <p>Construction will take place mainly throughout the daytime, and night lighting will only take place in areas that have had vegetation cleared during the daytime. Night lighting during construction will not affect these species. The permanent noise barriers that form part of the embedded mitigation for operational noise shall be built as early as possible in the construction programme so that they can offer noise mitigation during the construction phase to reduce impacts.</p>

Table 8-12 Ecological design and mitigation measures during operation

Biodiversity resource	Description of impact (Operation)	Mitigation
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs	No direct impacts. Indirect impacts during operation from surface water run-off, sedimentation, water level changes and air quality.	Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase. (Chapter 13: Road Drainage and Water Environment). No significant effects from air quality have been assessed on this site (Chapter 5: Air quality).
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	No direct impacts. Indirect impacts during operation through increase air pollution.	No significant effects from air quality have been assessed on this site (Chapter 5: Air quality) (TR010038/APP/6.1).
County Wildlife Sites (Sixteen sites) and one proposed CWS	Indirect impacts during operation from surface water run-off, sedimentation, water level changes, air pollution gradually degrading habitats.	Of the 21 ecological sites modelled in the assessment, Intwood Carr (CWS) predicted annual mean NO _x concentrations greater than the annual mean NO _x objective of 30 µg/m ³ on the boundary of the CWS. Overall, no significant effects from air quality have been assessed on this site (Chapter 5: Air quality) (TR010038/APP/6.1). Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margins, good quality semi-improved grassland, lowland fens, traditional orchards, intact hedgerows, standing and running water, coastal and floodplain grazing marsh and lowland mixed deciduous woodland.	Indirect impacts from pollution of habitat from air quality, water level changes, surface water runoff, sedimentation and accidental spillages.	Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).
Norfolk priority habitats within the 2km study area; hedgerows and defunct hedgerows, arable field margins, ponds, lowland mixed deciduous woodland, wet woodlands, fens, coastal and floodplain grazing marsh, churchyards and cemeteries and lowland meadow and pasture	Indirect impacts through the pollution of habitats from air quality and surface water runoff, sedimentation, water level changes and air pollution gradually degrading habitats.	Drainage design has been undertaken whereby surface water run-off will be infiltrated to ground via infiltration basins or infiltration strips and soakaways. These will be subject to a sufficient level of pollution attenuation through the Sustainable Urban Drainage System measures designed. (Chapter 13 Road Drainage and Water Environment) (TR010038/APP/6.1).
Botanical	Indirect impacts upon on botanical composition during operation from surface water run-off, sedimentation, water	No significant increases in air pollution has been identified in operation. (Chapter 5 Air Quality) (TR010038/APP/6.1).

Biodiversity resource	Description of impact (Operation)	Mitigation
	level changes, air pollution gradually degrading habitats.	
Terrestrial invertebrates	<p>Reduction in abundance due to the presence of a physical barrier which will reduce dispersal of species.</p> <p>Potential risk of mortality of individuals through pollution from air quality and surface water runoff, sedimentation, water level changes and habitat suitability for common aquatic invertebrates. Disturbance from light pollution (permanent).</p>	<p>The existing A47 already acts as a barrier and the new road is not likely to further hinder dispersal of the populations of these species that are already present.</p> <p>No significant effects from air quality have been assessed on these resources (Chapter 5: Air quality) (TR010038/APP/6.1).</p> <p>Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase on any other sites. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).</p>
Aquatic invertebrates	<p>Potential risk of mortality of individuals from pollution from air quality and surface water runoff, sedimentation, water level changes and habitat suitability for common aquatic invertebrates.</p> <p>Disturbance from light pollution (permanent).</p>	<p>Lighting will be designed with backlight shields and LED bulbs, directional, and positioned sympathetically, to minimise light spill and disturbance for sensitive biodiversity resources including notable habitats.</p>
White-clawed crayfish	<p>Reduction in abundance due to the decline in habitat quality through pollution events from surface water run-off, sedimentation, water level changes and changes in air quality. This species is very susceptible to pollution.</p>	<p>Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase on any other sites. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).</p>
Great-crested newt	<p>Pollution of breeding ponds from surface water run-off carrying contaminants and pollutants due to increased area of hard-standing.</p> <p>Loss of terrestrial and breeding habitat leading to reduction in abundance. Any newts remaining have less resource by which to increase the population. New road forming a barrier to newt dispersal.</p> <p>Changes to habitat suitability through pollution</p>	<p>Culverts in the design are close to breeding ponds and will prevent the barrier effect.</p> <p>Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase on any other resources. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1)</p> <p>Enhancement of biodiversity in new habitats and refuges to compensate for loss of terrestrial habitat and breeding ponds.</p> <p>The management of created habitat will be detailed in the EMP (TR010038/APP/7.4).</p> <p>Population to be monitored during operation and if required, changes to the EMP can be made.</p>
Reptiles	<p>Reduction in abundance due to the presence of a physical</p>	<p>New underpasses in the design will provide safe access to the other side of the road.</p>

Biodiversity resource	Description of impact (Operation)	Mitigation
	<p>barrier which will reduce dispersal of species.</p> <p>Changes to habitat suitability for reptiles through air pollution and surface water run-off.</p>	<p>No significant increases in surface water run-off pollution have been identified in operation. Chapter 13 (Road Drainage and Water Environment) (TR010038/APP/6.1). No significant increases in air pollution Chapter 5 (Air Quality) (TR010038/APP/6.1).</p> <p>Enhancement of biodiversity in new habitats and refuges to compensate for loss of terrestrial habitat.</p> <p>The management of created habitat will be detailed in the EMP (TR010038/APP/7.4).</p>
Breeding birds	<p>Direct mortality of individuals through traffic collisions due to wider junction and road.</p> <p>Disturbance of nesting locations from noise and light pollution. Water pollution may also affect nesting and feeding for wildfowl species.</p> <p>Degradation of habitat and obstruction and disturbance of foraging and loafing on individuals from water and light pollution leading to abandonment of area.</p>	<p>To minimise risk of mortality to birds, new and continuous habitat in the form of hedgerows, woodland, wetland areas, scattered broadleaved trees to include individual 'parkland' trees and species-rich grassland will be provided on both sides of the road as a refuge. This planting will also aid the visual screening from the road.</p> <p>The management of created habitat will be detailed in the EMP (TR010038/APP/7.4).</p> <p>No significant increases in surface water run-off pollution have been identified in operation. Chapter 13 (Road Drainage and Water Environment) (TR010038/APP/6.1)</p> <p>The assessment concluded that significant adverse traffic noise effects from the operations phase are not predicted and therefore no additional mitigation is required (Chapter 11 Noise and Vibration) (TR010038/APP/6.1).</p> <p>Lighting will be designed with backlight shields and LED bulbs, directional, and positioned sympathetically, to minimise light spill and disturbance for sensitive resources including notable habitats.</p>
Barn owl	<p>Disturbance of nesting locations from noise and light pollution. Mortality from the increased potential for collisions with traffic.</p> <p>Loss, obstruction and disturbance of foraging habitat of breeding individuals from noise and light pollution leading to abandonment of area.</p>	<p>The bat mitigation of hop-overs and targeted planting at overpasses will additionally provide a safer road crossing option for birds and barn owls.</p> <p>No significant increases in surface water run-off pollution have been identified in operation. Chapter 13 (Road Drainage and Water Environment) (TR010038/APP/6.1).</p> <p>Barn owl boxes will be monitored during the operational phase and road kill surveys will be undertaken post construction to monitor the effectiveness of the mitigation. If mitigation proves ineffective further actions will be taken through the EMP (TR010038/APP/7.4).</p>

Biodiversity resource	Description of impact (Operation)	Mitigation
Wintering birds	<p>Direct mortality of individuals through traffic collisions due to wider junction and road.</p> <p>Disturbance of foraging and loafing locations from noise and light pollution.</p> <p>Degradation of habitat and the obstruction and disturbance of foraging and loafing areas from water and light pollution leading to abandonment of area.</p>	<p>To minimise risk of mortality to birds, new and continuous habitat in the form of woodlands, wetlands, hedgerows, scattered broadleaved trees to include individual 'parkland' trees and species-rich grassland will be provided on both sides of the road as a refuge. This planting will also aid the visual screening from the road.</p> <p>The management of created habitat will be detailed in the EMP (TR010038/APP/7.4).</p> <p>The assessment concluded that significant adverse traffic noise effects from the operations phase are not predicted and therefore no additional mitigation is required (Chapter 11 Noise and Vibration) (TR010038/APP/6.1).</p> <p>No significant increases in surface water run-off pollution have been identified in operation. Chapter 13 (Road Drainage and Water Environment).</p> <p>Lighting will be designed with backlight shields and LED bulbs, directional, and positioned sympathetically, to minimise light spill and disturbance for sensitive biodiversity resources including notable habitats.</p>
Bats	<p>Direct mortality through traffic collisions due to wider road.</p> <p>Pollution of water courses could lead to reduction in prey availability.</p> <p>Disturbance for noise, vibration or light spill resulting in permanent avoidance and abandonment of foraging habitats, commuting routes and roosts.</p>	<p>Bat roosts disturbed by construction and bat boxes erected will be monitored during operation. Crossing points and their mitigation in the construction phase to be monitored during operation and if required, mitigation will be altered. These changes will be outlined in the EMP (TR010038/APP/7.4).</p> <p>Lighting will be directional, and positioned sympathetically, to minimise light spill and disturbance for sensitive biodiversity resources including foraging bats.</p> <p>No significant increases in surface water run-off pollution have been identified in operation. Chapter 13 (Road Drainage and Water Environment) (TR010038/APP/6.1)</p> <p>A low noise road surface and four permanent noise barriers are included in the design.</p>
Otter	<p>Direct mortality of individuals through traffic collisions due to wider road.</p> <p>Potential risk of mortality of individuals from air pollution and surface water runoff, sedimentation, water level changes and decreased habitat suitability for otters.</p>	<p>Permanent fencing systems will be installed in key areas throughout the Proposed Scheme to mitigate for operational traffic mortality.</p> <p>Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase on any other sites. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).</p>

Biodiversity resource	Description of impact (Operation)	Mitigation
	Disturbance from light pollution (permanent).	<p>Lighting will be designed with backlight shields and LED bulbs to reduce light spill onto habitats which are used by otter and water vole.</p> <p>New bridges and culverts have an otter ledge designed. The bridge over the river additionally has at least a 5m bank for otter to walk upon that will prevent them crossing the road.</p>
Water vole	<p>Potential risk of mortality of individuals from air pollution, pollution through increase surface water runoff, sedimentation, water level changes and decreased habitat suitability for water voles.</p> <p>Avoidance and abandonment of burrows due to bridge over river causing shading. Reduced breeding habitat available will reduce population. Disturbance from light pollution (permanent).</p>	<p>Habitat enhancement and an increase in breeding area will be undertaken for this species through the licence and will be sufficiently mature before operational phase.</p> <p>Appropriate drainage system in place including vegetated attenuation ponds to treat run off. No significant adverse effects are predicted during the operational phase on any other sites. (Chapter 13: Road Drainage and Water Environment) (TR010038/APP/6.1).</p> <p>Lighting will be designed with backlight shields and LED bulbs to reduce light spill onto habitats which are used by water vole.</p>
Badger	<p>Direct mortality of individuals through traffic collisions due to wider junction and new roads.</p> <p>Disturbance from noise and light levels.</p>	<p>Permanent fencing systems will be installed at the location of the badger tunnels and 500m either side to mitigate for operational traffic mortality.</p> <p>Although woodland planting will take several years to reach the maturity of the existing woodland, there is suitable quantities of surrounding woodland to enable badgers to remain in the area whilst the newly planted woodland are establishing.</p> <p>The assessment concluded that significant adverse traffic noise effects from the operations phase are not predicted and therefore no additional mitigation is required (Chapter 11 Noise and Vibration) (TR010038/APP/6.1).</p> <p>Lighting will be designed with backlight shields and LED bulbs to reduce light spill onto sensitive habitats.</p>
Invasive species	No operational impacts anticipated	None
Other notable species (brown hare, common toad)	<p>Direct mortality of individuals through traffic collisions due to wider junction and road.</p> <p>Risk of mortality of individuals from air pollution, surface water runoff, sedimentation, water level changes and reduction in habitat suitability.</p>	<p>New and continuous habitat provided on both sides of the road as a refuge.</p> <p>New underpasses in the design will provide safe access to the other side of the road.</p> <p>It is not considered that the effects of mortality to notable species will be at a level that would</p>

Biodiversity resource	Description of impact (Operation)	Mitigation
	Disturbance from light pollution (permanent).	justify the installation of mammal underpasses. Lighting will be designed with backlight shields and LED bulbs, directional, and positioned sympathetically, to minimise light spill and disturbance for sensitive biodiversity resources including notable habitats.

8.9.6. The type and area of habitat affected during construction is calculated below:

- Broadleaved Semi-Natural Woodland 10.67ha
- Broadleaved plantation woodland 9.58ha
- Mixed Semi-natural woodland 0.24ha
- Mixed Plantation Woodland 1.2ha
- Neutral unimproved grassland 5.25ha
- Semi-improved grassland (neutral) 24.8ha
- Marshy grassland 1.38ha
- Arable 185.89ha
- Amenity grassland 0.67ha
- Intact Hedgerow (species poor) 0.041ha
- Scrub 4.04ha
- Bare ground 0.14ha

8.9.7. The types and areas of habitat creation and the increases or decreases in size of each habitat are provided in Table 8.13.

Table 8-13 Habitat types and areas to be remediated or enhanced

Habitat type	Habitat loss amount (ha)		Reinstatement or enhancement of habitat amount	Net gain or loss of habitat type
	Permanent Works	Temporary Works		
Broad-leaved semi-natural woodland	7.1	3.5	18ha	<i>Net gain of 7.4ha</i>
Broadleaved plantation woodland	6.0	1.9	0ha	<i>Net loss of 7.9ha</i>
Mixed Semi-natural woodland	0.01	0.2	0ha	<i>Net loss of 0.21ha</i>
Plantation mixed woodland	0.4	0.8	0ha	<i>Net loss of 1.2ha</i>

Habitat type	Habitat loss amount (ha)		Reinstatement or enhancement of habitat amount	Net gain or loss of habitat type
	Permanent Works	Temporary Works		
Neutral unimproved grassland	4.2	1.0	0ha	<i>Net loss of 5.2ha</i>
Semi-improved neutral grassland	14.4	7.6	37ha	<i>Net gain of 15ha</i>
Marshy grassland	0.7	0.5	19ha	<i>Net gain of 17.8ha</i>
Arable	83.1	78.6	0ha	<i>Net loss of 161.7ha</i>
Amenity grassland	0	0.4	11.6ha	<i>Net gain of 11.2ha</i>
Scrub	2.2	1.9	13.35ha	<i>Net gain of 9.25ha</i>
Bare Ground	0.1	0.02	0ha	<i>Net loss of 0.12ha</i>
Hedgerow (species poor)	0.64	0.041	0ha	<i>Net loss of 0.68ha</i>
Native Hedgerow (species rich)	0	0	8.72ha	<i>Net gain of 8.72ha</i>
Scattered trees	0	0	2ha	<i>Net gain of 2ha</i>

8.10. Assessment of likely significant residual effects

- 8.10.1. An assessment of the residual ecological effects predicted following the implementation of mitigation outlined within Table 8-11 and 8-12 is presented within Table 8-14.
- 8.10.2. The mitigation section of this report sets out measures to mitigate all potential effects on ecological receptors and includes the measures which would need to be applied in order to ensure that legal obligations are met with respect to protected habitats and species.

Table 8-14 Predicted significance of residual effects on biodiversity resources following implementation of committed mitigation.

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs	National	<p>Construction</p> <p>Potential of indirect impacts through the pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages.</p>	Moderate adverse	Temporary	No residual effects expected.	No change	Neutral
		<p>Operation</p> <p>No direct impacts.</p> <p>Indirect impacts during operation from surface water run-off, sedimentation, water level changes and air quality.</p>	Major adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants.</p> <p>Once the Proposed Scheme is operational, there will be no significant effect from pollution and no further mitigation will be required.</p>	No change	Neutral
Ancient Woodland (Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood) and four unnamed parcels	National	<p>Construction</p> <p>Indirect impacts during construction through increased air pollution.</p>	Negligible adverse	Temporary	No residual effects expected.	No change	Neutral
		<p>Operation</p> <p>No direct impacts.</p> <p>Indirect impacts during operation through increase air pollution.</p>	Minor adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants.</p> <p>Once the Proposed Scheme is operational, there will be no significant effect from pollution and</p>	No change	Neutral

⁴ Temporary and permanent impacts are characterised by using knowledge of the nature of the impact of the works. Table 3.11 of LA 108 (Biodiversity) gives further descriptions used to aid this characterisation.

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
					no further mitigation will be required.		
County Wildlife Sites (16 sites) and one proposed CWS	County	<p>Construction</p> <p>Potential of indirect impacts upon all CWSs from pollution of habitat from air quality and surface water runoff, water level changes, sedimentation and accidental spillages</p>	Moderate adverse	Temporary	No residual effects expected.	No change	Neutral
		<p>Operation</p> <p>Indirect impacts during operation from surface water run-off, sedimentation, water level changes, air pollution gradually degrading habitats.</p>	Major adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants.</p> <p>Once the Proposed Scheme is operational, there will be no significant effect from pollution and no further mitigation will be required.</p>	No change	Neutral
NERC Act (2006) S41 priority habitats present within the 2km study area: arable field margins, good quality semi-improved grassland, lowland fens, traditional orchards, intact hedgerows, standing and running water,	National	<p>Construction</p> <p>Permanent loss of hedgerows, ponds, deciduous woodland, good quality semi-improved grassland and coastal and floodplain grazing marsh (adjacent to Mattishall Lane and the River Tud).</p> <p>Indirect effects on arable field margins, lowland fens, traditional orchards, coastal and floodplain grazing marsh, ponds, rivers, deciduous woodland and hedgerows from pollution of habitat, air quality, surface water</p>	<p>Major adverse (hedgerows, deciduous woodland, good quality semi-improved grassland, ponds, coastal and floodplain grazing marsh)</p> <p>Moderate adverse (all</p>	Permanent (habitat loss) and temporary (pollution and surface water run-off)	<p>Through the landscape design, measures have been taken to mitigate the loss of habitat through compensation of similar or higher quality habitat across the Proposed Scheme.</p> <p>It will take several years for deciduous woodland and hedgerows to reach their full former maturity and these habitats need protection from damage whilst they are becoming established.</p> <p>Grassland habitats and ponds mature quickly, pond habitat will</p>	<p>Moderate adverse (hedgerows, deciduous woodland, floodplain grazing marsh).</p> <p>Minor beneficial (good quality</p>	<p>Moderate adverse (hedgerows, deciduous woodland, floodplain grazing marsh)</p> <p>Slight beneficial (good quality</p>

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
coastal and floodplain grazing marsh and lowland mixed deciduous woodland.		runoff, sedimentation and accidental spillages.	other biodiversity resources)		gain more species, but floodplain wetland replacement takes longer. For the reasons set out above the significance of the residual effects for hedgerows deciduous woodland and floodplain grazing marsh has been set out at moderate not large. Similarly, the benefits to semi-mature grasslands and ponds has been evaluated as slight rather than neutral.	semi-mature grassland, ponds).	semi-mature grassland, ponds).
		Operation Indirect impacts from pollution of habitat from air quality, water level changes, surface water runoff, sedimentation and accidental spillages.	Major adverse	Permanent	Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants. Once the scheme is operational, no significant effect from pollution is anticipated.	No change	Neutral
Norfolk priority habitats within the 2km study area; hedgerows and defunct hedgerows, arable field margins, ponds, lowland mixed deciduous woodland, wet woodlands, fens, coastal and floodplain	County	Construction Permanent loss of hedgerows and defunct hedgerows, ponds, lowland meadow and pasture, coastal and floodplain grazing marsh, fens, wet woodland and lowland deciduous woodland. No direct impacts on arable field margins and churchyards and cemeteries. Indirect impacts through the pollution of habitats from air quality and surface water runoff, sedimentation, water level	Major adverse Moderate adverse	Temporary	Hedgerows to be recreated will be more species diverse than the ones lost they will take years to mature. Woodland will take many years to mature. Grassland habitats and ponds mature quickly, pond habitat will gain more species, but floodplain wetland replacement takes longer.	Moderate adverse	Slight adverse

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
grazing marsh, churchyards and cemeteries and lowland meadow and pasture		changes and air pollution gradually degrading habitats.					
		<p>Operation</p> <p>Indirect impacts through the pollution of habitats from air quality and surface water runoff, sedimentation, water level changes and air pollution gradually degrading habitats</p>	Moderate adverse	Permanent	Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants. No residual effects anticipated	No change	Neutral
Botanical	County	<p>Construction</p> <p>Permanent loss of habitat (old woodland, floodplain grassland and good quality grassland) resulting in loss of botanical composition.</p> <p>Damage to existing habitat from construction traffic driving over sensitive botanical areas.</p> <p>Indirect effects from pollution of habitat, air quality, surface water runoff, water level changes, sedimentation and accidental spillages</p>	Major adverse	Temporary	Woodland will take many years to mature to current level. Grassland habitats will be quick and easy to achieve, but floodplain recreation will take longer. As the amount of good-quality grassland is expected to increase the residual effect has been evaluated as slight not neutral.	Moderate adverse (woodland and floodplain) Minor beneficial (Grasslands)	Slight adverse (woodland and floodplain) Slight beneficial (Grasslands)
		<p>Operation</p> <p>Indirect impacts upon on botanical composition during operation from surface water run-off, sedimentation, water level changes, air pollution gradually degrading habitats.</p>	Minor adverse	Permanent	Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants. No residual effects from pollution are anticipated	No change	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
Terrestrial invertebrates	Local	<p>Construction</p> <p>Removal of habitat.</p> <p>Risk of population decline through habitat fragmentation. Habitat degradation through pollution events from dust and accidental spills.</p> <p>Disturbance from light pollution.</p>	Minor adverse	Permanent (habitats removal) and temporary (light and ground pollution).	<p>Mature trees which are to be removed will be relocated to nearby suitable woodland parcels where they will be constructed into habitat piles to provide suitable habitat for invertebrates. There will be a time lag for new tree planting to achieve maturity. Most invertebrates will benefit from other habitat planting and enhancement.</p> <p>For the reasons set out above the significance of the residual effects has been set out at neutral not slight.</p>	Minor adverse	Neutral
		<p>Operation</p> <p>Reduction in abundance due to the presence of a physical barrier which will reduce dispersal of species.</p> <p>Potential risk of mortality of individuals through pollution from air quality and surface water runoff, sedimentation, water level changes and habitat suitability for common aquatic invertebrates. Disturbance from light pollution.</p>	Minor adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants.</p> <p>No residual effects anticipated from pollution.</p>	No change	Neutral
Aquatic invertebrates	Local	<p>Construction</p> <p>Removal of habitat.</p> <p>Risk of mortality of individuals through pollution from accidental spills, changes to water levels</p>	Minor adverse	Permanent (habitat removal) and temporary (light pollution).	<p>Two wetland areas are to be created and replacement ponds. The ponds will mature quickly and gain more species, the wetland areas will take longer to recreate.</p>	Minor adverse	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		and habitat suitability for common aquatic invertebrates. Disturbance from light pollution.			For the reasons set out above the significance of the residual effects has been set out at neutral not slight.		
		<u>Operation</u> Potential risk of mortality of individuals from pollution from air quality and surface water runoff, sedimentation, water level changes and habitat suitability for common aquatic invertebrates. Disturbance from light pollution (permanent).	Minor adverse	Permanent	Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants No residual effects anticipated from pollution.	No change	Neutral
White-clawed crayfish	Local	<u>Construction</u> Risk of mortality of individuals through pollution from dust, accidental spills, changes to water levels and habitat suitability for common aquatic invertebrates. Crayfish are not present in parts of river to be disturbed and the individual recorded is likely a remnant individual from the translocation of this species into an Ark Site. Out competition from the increased spread of invasive signal crayfish Disturbance from light pollution.	Minor adverse	Temporary	No residual effects anticipated from pollution.	No change	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		<p><u>Operation</u></p> <p>Reduction in abundance due to the decline in habitat quality through pollution events from surface water run-off, sedimentation, water level changes and changes in air quality.</p>	Minor adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants</p> <p>No residual effects anticipated from pollution.</p>	No change	Neutral
Great-crested newt	County	<p><u>Construction</u></p> <p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment.</p> <p>Loss of supporting and breeding habitat.</p>	Major adverse	Temporary	<p>Direct mortality would be avoided by mitigation.</p> <p>Suitable breeding and terrestrial habitats would be enhanced and increased under licence. No change in population is predicted.</p> <p>No residual effects from pollution anticipated.</p>	Negligible adverse	Neutral
		<p><u>Operation</u></p> <p>Pollution of breeding ponds from surface water run-off carrying contaminants and pollutants due to increased area of hard-standing.</p> <p>Loss of terrestrial and breeding habitat leading to reduction in abundance. Any newts remaining have less resource by which to increase the population. New road forming a barrier to newt dispersal.</p>	Major adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants</p> <p>No residual effects anticipated from pollution.</p>	Negligible adverse	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		Changes to habitat suitability through pollution.					
Reptiles	County	<p>Construction</p> <p>Direct mortality of individuals during vegetation clearance and from collisions with construction traffic, entrapment in excavations, disturbance of places of shelter leading to abandonment. Loss of supporting and breeding habitat.</p>	Minor adverse	Temporary	<p>Direct mortality would be avoided by mitigation. Suitable grassland and scrub habitats to be remediated would not take long to mature.</p> <p>No change in population is predicted.</p> <p>No residual effects from pollution anticipated.</p>	No change	Neutral
		<p>Operation</p> <p>Reduction in abundance due to the presence of a physical barrier which will reduce dispersal of species.</p> <p>Changes to habitat suitability for reptiles through air pollution and surface water run-off.</p>	Minor adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants</p> <p>No residual effects anticipated from pollution.</p>	No change	Neutral
Breeding birds	Regional	<p>Construction</p> <p>Direct mortality of individuals from site clearance of vegetation during breeding season, disturbance of nesting locations from water, noise and light pollution.</p> <p>Collisions with construction traffic.</p> <p>Direct disturbance through noise and light pollution of schedule 1 nest site near compound 3 may</p>	Major adverse	Temporary	<p>No direct mortality or disturbance of breeding birds during construction with mitigation. Breeding habitats are to be remediated but there will be a time lag before maturity is achieved. Arable habitat cannot be fully remediated.</p> <p>Compound 3 (south of Honingham roundabout) is located near a schedule 1 nest site. Disturbance will be likely from light and noise.</p> <p>Installation of nest boxes across</p>	Minor adverse	Slight adverse

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		<p>result in nest abandonment. Suitable mitigation will be required during compound set and up and the nest site should be checked by suitably licensed ECoW daily.</p> <p>Loss, obstruction and disturbance of foraging and loafing habitat of breeding individuals from the fishing lake, streams and river, noise and light pollution leading to abandonment of area.</p>			<p>the Proposed Scheme will help mitigate loss of habitat</p> <p>Tall habitat near new road to encourage birds to fly higher will take time to mature.</p>		
		<p>Operation</p> <p>Direct mortality of individuals through traffic collisions due to wider junctions and road.</p> <p>Disturbance of nesting locations from noise and light pollution. Water pollution may also affect nesting and feeding for wildfowl species.</p> <p>Degradation of habitat and obstruction and disturbance of foraging and loafing on individuals from water and light pollution leading to abandonment of area.</p>	Minor adverse	Permanent	<p>Number of birds breeding in the area will reduce slightly.</p> <p>No residual effects from pollution predicted.</p>	Minor adverse	Slight adverse
Barn owl	County	Direct mortality of individuals from site clearance of vegetation during breeding season, disturbance of nesting locations from noise and light pollution.	Major adverse	Temporary	Creation of areas of long grassland where possible as part of the landscape plans to mitigate the loss of suitable foraging habitat.	Major adverse Once landowner agreement for the mitigation boxes are in	Moderate adverse Once landowner agreement for the mitigation

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		Loss of foraging habitat and suitable roosting habitat.			<p>Installation of eight barn owl boxes close to suitable rough grassland in the wider landscape will help mitigate the loss of the existing nest site and enhance the wider area for the species and provide additional nesting capacity. This mitigation measure will require landowner agreement and will be greater than 1.5km from the road. This mitigation cannot be assumed effective until landowners have been identified and agreements are in place.</p> <p>Low-flight prevention screening should be installed to help prevent barn owl road casualties. This would consist of high hedges or tree screens being planted on raised banks (bunds) at locations where barn owls regularly cross the road.</p>	place the residual effect would be downgraded to Moderate adverse	boxes are in place the residual effect would be downgraded to slight adverse
		<p>Operation</p> <p>Disturbance of nesting locations from noise and light pollution. Mortality from the increased potential for collisions with traffic.</p> <p>Loss, obstruction and disturbance of foraging habitat of breeding individuals from noise and light pollution leading to abandonment of area.</p>	Major adverse	Permanent	Disturbance will be decreased once created habitats reach maturity.	Moderate adverse	Slight adverse
Wintering birds	Regional	Construction	Major adverse	Temporary	Foraging and loafing habitats are to be remediated but there will be	Minor adverse	Slight adverse

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		<p>Direct mortality of individuals from site clearance of vegetation, disturbance of foraging and loafing locations from fishing lake, river and streams, noise and light pollution. Collisions with construction traffic.</p> <p>Loss, obstruction and disturbance of key foraging and loafing habitat such as cereal crop and wintering crops leading to abandonment of area.</p>			<p>a time lag before maturity is achieved, arable habitat cannot be remediated fully, so predicted residual effect of permanent deterrence of some individual birds.</p> <p>No residual effects from pollution predicted.</p> <p>Tall habitat near new road to encourage birds to fly higher will take time to mature.</p>		
		<p>Operational</p> <p>Direct mortality of individuals through traffic collisions due to wider junction and road.</p> <p>Disturbance of foraging and loafing locations from noise and light pollution.</p> <p>Degradation of habitat and the obstruction and disturbance of foraging and loafing areas from water and light pollution leading to abandonment of area.</p>	Minor adverse	Permanent	<p>Attenuation ponds for infiltration will be designed as a SuDS feature to reduce run-off and filter the water from contaminants</p> <p>No residual effects anticipated from pollution.</p>	Minor adverse	Slight adverse
Bats	National	<p>Construction</p> <p>Direct mortality through roost destruction during removal of 14 tree roosts. Disturbance of known bat roosts from noise, vibration and light.</p> <p>Permanent loss of foraging habitat, severance of commuting</p>	Major adverse	Permanent (habitat loss) and temporary (noise and light disturbance)	<p>After mitigation included in the licence, residual effects to roosts will be neutral.</p> <p>Disturbance from loss of habitat during construction will not be remediated immediately as there will be a time lag between loss and the remediated habitats reaching</p>	Major adverse	Large adverse

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		<p>routes and foraging areas, resulting in avoidance and abandonment of habitats and roosts. Culverting and bridging across watercourses causing disturbance.</p> <p>Indirect impacts from lighting, vibration and noise.</p>			<p>maturity.</p> <p>Disturbance from noise, vibration and light spill is not predicted to cause residual effects.</p> <p>Unknown whether mitigation at underpasses, overpasses and the River Tud Crossing to enable bats to fly safely across the new road will work until monitoring surveys complete. No published data available. As such, on a precautionary basis the impact has been concluded to be major adverse due to the potential for permanent damage to populations.</p>		
		<p>Direct mortality through traffic collisions due to wider road.</p> <p>Pollution of water courses could lead to reduction in prey availability.</p> <p>Disturbance for noise, vibration or light spill resulting in permanent avoidance and abandonment of foraging habitats, commuting routes and roosts.</p>	Major adverse	Permanent	Mortality through traffic collisions is predicted to be less likely once remediated road side trees mature.	Major adverse	Large adverse
Otter	County	<p>Construction</p> <p>Direct mortality or injury of individuals from construction traffic and being trapped in excavations.</p> <p>Pollution risk of mortality of individuals from dust and</p>	Major adverse	Temporary	<p>Works within the River Tud will be supervised by the onsite ECoW and habitat all suitable habitat will be checked prior to construction works.</p> <p>No residual effects from pollution are anticipated.</p>	No change	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		accidental spills and changes to habitat suitability from sedimentation and water level changes. Disturbance from noise and light pollution leading to abandonment of foraging areas and resting places.					
		<p>Operation</p> <p>Direct mortality of individuals through traffic collisions due to wider road.</p> <p>Potential risk of mortality of individuals from air pollution and surface water runoff, sedimentation, water level changes and decreased habitat suitability for otters.</p> <p>Disturbance from light pollution.</p>	Major adverse	Permanent	Direct mortality would be avoided by on site mitigation during operation with fences and ledges under culverts and bridges to deter them from the road.	No change	Neutral
Water vole	County	<p>Direct mortality of individuals during vegetation clearance, ditch dredging and realignment, installation of outfalls, culverts and bridges and collisions from construction traffic, and loss of habitat in fenland area.</p> <p>This population will incur a pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes. Disturbance from noise and light pollution (temporary).</p>	Major adverse	Temporary	<p>Direct mortality would be avoided by mitigation outlined within the method statement of the water vole licence.</p> <p>Habitat enhancement and an increase of suitable habitat will be undertaken for this species as part of the licence.</p>	Negligible adverse	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		<p>Potential risk of mortality of individuals from air pollution, pollution through increase surface water runoff, sedimentation, water level changes and decreased habitat suitability for water voles.</p> <p>Avoidance and abandonment of burrows due to bridge over river causing shading. Reduced breeding habitat available will reduce population.</p> <p>Disturbance from light pollution.</p>	Major adverse	Permanent	<p>After mitigation, translocation and habitat creation under a licence from Natural England, no residual effects are predicted once the compensatory habitats have matured to a condition and abundance that is greater than pre-construction.</p> <p>No residual effects from pollution are anticipated.</p>	Negligible adverse	Neutral
Badger	Local, Legal constraints apply	<p>Construction</p> <p>Permanent loss of a sett and commuting and foraging habitat. Temporary exclusion from one sett and disturbance to another sett. Disturbance from noise and light levels. Potential of death or injury of individuals from falling in excavations.</p>	Major adverse	Permanent (sett loss) and temporary (excavation risk)	<p>Direct mortality would be avoided by on site mitigation such as covered working trenches at night.</p> <p>No change in population is predicted.</p> <p>No residual effects from pollution anticipated.</p>	Negligible adverse	Neutral
		<p>Operation</p> <p>Direct mortality of individuals through traffic collisions due to wider junction and new roads.</p> <p>Disturbance from noise and light levels.</p>	Major adverse	Permanent	<p>Direct mortality would be avoided by mitigation outlined within the method statement of the badger licence and the provision of two badger tunnels and fencing.</p>	No change	Neutral
Invasive species	Negligible	<p>Construction</p> <p>Introduction and spread of diseases during construction</p>	Major adverse	Permanent (disease) and temporary (INNS)	Mitigation will prevent the introduction of INNS to a negligible level of impact during construction	No change	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁿ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		could result in death of plants and animals (examples: Ash dieback, ranavirus). Introduction and assisted spread of invasive species during construction may result in squeezing out of native habitats and species.			and no change in operation. No residual effects predicted.		
		Operation No operational impacts anticipated	No change	N/A	N/A	N/A	N/A
Other notable species (brown hare, common toad, hedgehog)	Local	Construction Permanent loss of commuting routes and areas of shelter and foraging. Direct mortality of individuals from collisions with construction traffic, entrapment in excavations, disturbance from noise and light pollution of places of shelter leading to abandonment. Pollution risk of mortality of individuals from dust and accidental spills and changes to habitat suitability from sedimentation and water level changes.	Minor adverse	Permanent (loss of habitat) and temporary (all other factors)	Direct mortality during construction to be mitigated. Habitats to be remediated and some suitable habitat for these species will grow back quickly as not dependent on mature trees and hedgerows. For the reasons set out above the significance of the residual effects has been set out at neutral not slight.	Minor adverse	Neutral
		Operation Direct mortality of individuals through traffic collisions due to wider junction and road. Risk of mortality of individuals from air pollution, surface water runoff, sedimentation, water level changes and reduction in	Minor adverse	Permanent	Residual effects from barrier of new road and mortality from collisions likely to stay similar to that of present road. New underpasses in the design will provide safe access to the other side of the road. No residual effects from pollution	Minor adverse	Neutral

Ecological receptor and valuation	Value	Summary of potential impacts	Level of impact pre-mitigation	Impact characterisation ⁴	Summary of proposed mitigation/ compensation	Residual effect	Significance of residual effect
		habitat suitability. Disturbance from light pollution (permanent).			predicted		

8.11. Monitoring

- 8.11.1. Monitoring during vegetation clearance and during construction where required will be undertaken by an Ecological Clerk of Works (ECoW).
- 8.11.2. A pre-construction badger survey shall be undertaken to assess whether the species have moved within the DCO boundary and further mitigation is required.
- 8.11.3. Habitats, bird and bat boxes will be monitored and managed for five years after they have been created. Details are included in the EMP (TR010038/APP/7.4). Although the initial monitoring period is 5 years, there will be significant monitoring beyond this and that information is in the oLEMP and secured via the DCO.
- 8.11.4. Further barn owl surveys should be conducted in 2021 and years 1, 3 and 5 post development undertaking monitoring of the existing barn owl nesting sites and the proposed barn owl boxes. Surveys will also establish whether there has been a reduction in current population size from the works. If a reduction is observed, further mitigation will be required, if the proposed works are determined to be responsible.

Great-crested Newt

- 8.11.5. Great crested newt presence or absence (eDNA) surveys will be undertaken for two years post construction as part of the monitoring required in the mitigation licence. Pond habitats created for this species will be monitored as part of the EMP. If absence is observed, further mitigation will be required if the proposed works are determined to be responsible.

Bats

- 8.11.6. As part of the bat mitigation licence, monitoring emergence surveys are not required because only single or low numbers of common species are using trees to be felled as day roosts. The Schwegler 1FF bat boxes recommended in the licence are self cleaning, but the bat boxes will be checked for bat use by a licensed ecologist for the first five years of operation. Monitoring surveys of bat crossing points at the four locations where the full eight surveys were undertaken in 2020, plus the new bridge over the River Tud and the three underpasses and the overbridge to be created will be undertaken in years 1, 3 and 5 of operation. If a reduction in numbers crossing is observed, further mitigation will be required.

Water Vole

- 8.11.7. As part of the water vole licence, post relocation of the water voles into the on-site receptor area, water vole monitoring surveys will commence the same year

for a minimum of three years, or longer if necessary, to confirm an overall conservation benefit. If a reduction is observed, further mitigation will be required, if the proposed works are determined to be responsible.

Badger

- 8.11.8. Badgers will be surveyed after operation commences to ensure all the licence conditions are met.

8.12. Summary

- 8.12.1. The likely significant effects for each biodiversity resource is reliant on the mitigation measures within Section 8.9 being implemented.
- 8.12.2. It is anticipated that the Proposed Scheme would have a Neutral effect on the European Designated Sites during construction and operation.
- 8.12.3. The Proposed Scheme is anticipated to have a Neutral residual effect on River Wensum, Hockering Wood and Rosie Curston's Meadow SSSIs.
- 8.12.4. It is anticipated that there would be a Neutral residual effect on Hockering Wood, Park Grove, Harman's Grove, Mouse Wood and Holly Wood and four unnamed parcels of ancient woodlands and all 16 county wildlife sites and the one proposed CWS.
- 8.12.5. The priority habitats of intact hedgerows, deciduous woodland and coastal and floodplain grazing marsh will have direct impacts and additional indirect impacts will occur on lowland fens, traditional orchards, coastal and floodplain grazing marsh, ponds, rivers, deciduous woodland and hedgerows. It will take several years for deciduous woodland and hedgerows to reach their full former maturity. Grassland habitats and ponds mature quickly and pond habitat will gain more species, but the floodplain grazing marsh wetland replacement will take longer. The long time lag until maturity has been assessed as a significant moderate adverse residual effect for woodland, hedgerows and grazing marsh. Grasslands and ponds will have a slight beneficial effect.
- 8.12.1. Protected species that are to be licensed (loss of bat roosts, water vole, GCN and badger) would have neutral residual effects as mitigation within the licence method statements would remove any harm from occurring to them and they would have to include increased habitat for them.
- 8.12.2. Bats have a significant large adverse residual effect overall, due to the time lag between loss of habitat and the remediated habitats reaching maturity which could lead to loss of foraging and commuting habitat and traffic mortality and also due to the presence of rare bats leading to a national level of importance in the area. Currently, there is no data available that proves whether or not the

proposed mitigation (bridge and fencing over the River Tud, overbridge and hop-overs) to help them cross the Proposed Scheme safely works. Underpasses are known to be successful when placed directly on the current flight paths of bats (Berthinussen and Altringham, 2015). The underpasses on the Proposed Scheme are not directly on existing flight paths as that could not be designed into the Proposed Scheme but will have planting to encourage bats to use them. Bat crossing points will be monitored and managed as in section 8.11.

- 8.12.3. The Proposed Scheme is anticipated to have a Slight adverse effect on breeding birds, barn owl and wintering birds due to the loss of arable habitat that is not being replaced and the time lag until some of their wooded habitats and hedgerows mature.
- 8.12.4. The significance of effect on barn owl is Moderate adverse until landowners have been identified and agreements are in place to install suitable nest boxes 1.5km from the Proposed Scheme. Once these agreements are signed the residual effect will decrease to slight adverse.
- 8.12.5. The significance of effects on bats as a result of the Proposed Scheme is Large Adverse.
- 8.12.6. A Neutral residual effect is anticipated for all other biodiversity resources.

8.13. References

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8.14. Glossary

Table 8-15 Definitions of terms and abbreviations

Term or abbreviation	Definition
Biodiversity	The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and of ecosystems.
Biodiversity resources	Biodiversity resources that are present in the surrounding environment.
DAFOR	Method of assessing habitat composition. Species found in a habitat are classified as being Dominant, Abundant, Frequent, Occasional or Rare.
Designated sites	Internationally, nationally, or locally designated sites for species and/or habitats.
Biodiversity resource	Habitats, species or ecosystems which for the purposes of this document are collectively referred to as biodiversity resources.
Enhancement	Enhancement is improved management of a biodiversity resource or provision of new biodiversity resources which result in a net benefit to biodiversity. Enhancement is 'over and above' that required to mitigate or compensate for a negative impact.
Habitat	The place or type of site where an organism or population naturally occurs. Often used in the wider sense referring to major assemblages of plants and animals found together.
Priority habitats and species	Those species and habitats which are defined in CIEEM's Guidelines for Preliminary Ecological Appraisal as: <ol style="list-style-type: none"> 1) listed as a national priority for conservation (such as those listed as habitats and species of principal importance for the conservation of biodiversity) 2) listed as a local priority for conservation, for example in the relevant local Biodiversity Action Plan (BAP) 3) Red Listed using International Union for the Conservation of Nature (IUCN) criteria or, where a more recent assessment of the taxonomic group has not yet been undertaken, listed in a Red Data Book 4) listed as Near Threatened or Amber Listed 5) listed as a Nationally Rare or Nationally Scarce species or listed as a Nationally Notable species where a more recent assessment of the taxonomic group has not yet been undertaken 6) endemic to a country or geographic location
Significant effect	An effect that either supports or undermines biodiversity conservation objectives for biodiversity resources or for biodiversity in general. These are, for example, impacts on structure and function of defined sites, habitats, or species and the conservation status of habitats and species (including extent, abundance and distribution).
Zone of influence	The area(s) over which biodiversity resources can be affected by biophysical changes as a result of the proposed project and associated activities.
BAP	Biodiversity Action Plan

Term or abbreviation	Definition
CIEEM	Chartered Institute of Ecology and Environmental Management
CWS	County wildlife site
EcIA	Ecological impact assessment
IUCN	International Union for Conservation of Nature
LNR	Local nature reserves.
SAC	Special Areas of Conservation.
SPA	Special Protection Area.
SSSI	Sites of Special Scientific Interest.