

A47/A11 Thickthorn Junction Preliminary Environmental Information Report

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1. Introduction

1.1. The A47/A11 Thickthorn Junction

- 1.1.1. The A47/A11 Thickthorn Junction, comprising a roundabout and slip roads to and from the A47 and A11 trunk roads (as shown on figure A.1 in Appendix A) is located south west of Norwich and forms part of the Strategic Road Network (SRN). The A47/ A11 Thickthorn Junction currently experiences high levels of congestion that is predicted to get worse in the future.
- 1.1.2. It is proposed to create two link roads between the A47 and A11 with the aim of rerouting traffic away from Thickthorn Junction, relieving congestion, improving the environment and improving journey times. In addition, a new link road will be located between Cantley Lane South and the B1172, maintaining access to Thickthorn Junction. A new bridge for walkers, cyclists and equestrians across the A47 along with other planned changes to the Thickthorn Junction comprise the Proposed Scheme.
- 1.1.3. The Proposed Scheme is a Nationally Significant Infrastructure Project (NSIP) under the Planning Act 2008 and therefore requires a Development Consent Order (DCO), issued by the Secretary of State, before construction and operation can commence.
- 1.1.4. Subject to successfully passing through the DCO process, the key timescales for the Proposed Scheme are as follows:
 - Start of construction work – 2021
 - Open for traffic 2023

1.2. The purpose of the preliminary environment information report

- 1.2.1. The purpose of this Preliminary Environmental Information Report (PEIR) is firstly to meet the requirements of the Infrastructure Planning (Environmental Impact Assessment) EIA Regulations 2017, but also to inform the public, landowners, prescribed bodies and other stakeholders about the ongoing Environmental Impact Assessment (EIA) work and the preliminary information on the environmental impacts of the development proposals.
- 1.2.2. Preliminary Environmental Information is defined by the Infrastructure Planning EIA Regulations 2017, Regulation 12(2) with advice updates to some chapters (Biodiversity, Climate, Materials, People and communities – Social and Geology & soils) in Advice Note Seven (EIA: Process, Preliminary Environmental Information and Environmental Statements –The Planning Inspectorate,

December 2017). This is defined as ‘information referred to in regulation 14(2) which:

- *(a) has been compiled by the applicant; and*
- *(b) is reasonably required to assess the environmental effects of the development (and of any associated development)*

1.2.3. This PEIR therefore provides a preliminary assessment of the potential environmental impacts and known receptors within each of the environmental topic study areas. This document gives stakeholders an understanding of the potential environmental impacts of the Proposed Scheme and of the measures proposed to reduce those impacts at this early stage of the EIA.

1.3. Availability of the PEIR

1.3.1. Copies of the PEIR will be available as part of the consultation material produced for the A47/A11 Thickthorn Junction statutory public consultation to be carried out from June 2019. Details of the consultation events are available in the Statement of Community Consultation (SoCC).

1.4. Summary of the environmental impact assessment process

1.4.1. Environmental Impact Assessment (EIA) is a process that identifies the likely environmental effects (both adverse and beneficial) of a proposed development. Environmental effects are assessed through understanding of the potential impacts and the sensitivity of receptors for a given scheme. It ensures that the importance of these impacts is properly considered and that the opportunity for reducing any adverse effects are considered as part of the design development process.

1.4.2. EIA also ensures effects considered during the design development process are understood by the public, the relevant competent authorities, statutory authorities and other interested parties. The EIA will be undertaken in accordance with relevant legislation and guidance and will include a spatial and temporal scope for its assessment.

1.4.3. Scoping is an important part of the EIA process and determines which environmental topics are to be examined during assessment. The scoping report describes how the EIA will be undertaken and identifies the technical environmental disciplines that will be considered. Defining the environmental scope is one of the most critical parts of the EIA as it sets out the method for the detailed assessment.

1.4.4. An EIA scoping report was submitted to the Planning Inspectorate (PINS) on 8 February 2018 to inform its scoping opinion. Highways England received the

scoping opinion from PINS on 21 March 2018. The scope of the EIA has been adjusted to take into account comments received from both PINS and relevant consultees.

1.4.5. The Proposed Scheme is defined as a Nationally Significant Infrastructure Project (NSIP) under Section 14(1)(h) and Section 22 of the Planning Act 2008 (PA 2008) (as amended) by virtue of the fact that:

- it comprises the alteration of a highway
- the highway to be altered is wholly in England
- the Secretary of State will be the highway authority for the highway
- the speed limit for any class of vehicle on the highway is to be 50mph or greater, and the area of development is greater than 12.5 hectares

1.4.6. In accordance with the legislation, a DCO is therefore required to allow the construction and operation of the Proposed Scheme.

1.4.7. Following the completion of the EIA Scoping Report, the subsequent scoping opinion from PINS and the EIA work undertaken to date, the EIA for a DCO is reported in two stages:

- the PEIR, prepared to inform the consultation with the public and other stakeholders on the characteristics of the Proposed Scheme
- the Environmental Statement (ES), prepared to accompany the DCO application

1.4.8. Each environmental topic chapter of this PEIR describes the local environment and identifies any sensitive receptors such as Sites of Special Scientific Interest (SSSI), people living in the vicinity of the Proposed Scheme and local environment management areas such as Air Quality Management Areas (AQMA) or Noise Important Areas (NIA).

1.4.9. Environmental surveys that have been carried out for each topic are included along with detail of the consultation with the Statutory Environmental Bodies, Local Authorities and other stakeholders. Any likely impacts of the Proposed Scheme on the local environment are then described.

1.4.10. The significance of environmental impacts is not addressed within the PEIR however this will be considered in the ES.

2. The proposed scheme

2.1. Overview

2.1.1. Currently, the existing Thickthorn Junction experiences delays and high levels of congestion during peak hours. The situation is predicted to get worse with proposed growth in residential development.

2.1.2. The Proposed Scheme comprises:

- creation of two link roads between the A11 and A47 with associated underpasses and maintenance laybys
- changes to the existing Thickthorn Junction and slip roads
- provision of a new link road connecting Cantley Lane South with the B1172 to the north including construction of two new overbridges
- provision of a new turning head on Cantley Lane South to provide turning opportunities for vehicles
- realignment of the Cantley Stream and nearby access track including modification of a new underpass
- widening of the existing Cringleford rail bridge on the west side including demolition of the existing adjacent crib wall retaining structures and construction of new retaining walls to support the widened highway embankment
- provision of a new footbridge across the A47 for walkers, cyclists and equestrians and subsequent demolition of the existing footbridge
- provision of new drainage systems including a pump system to protect the underpass, an attenuation basin and tank and retention of existing drainage systems where possible

2.2. Roads

A47 / A11 link roads

2.2.1. Two link roads will be constructed between the A11 to A47 and the A47 to A11 directing traffic away from Thickthorn Junction. Once travellers have left the main carriageway, both link roads will allow travellers to merge and diverge to and from the A47 or A11 without the need to stop.

2.2.2. The A11 to A47 link road will include provision of a maintenance layby and require the construction of three new underpasses and one new overbridge. An additional maintenance layby will also be required to allow access to land between the A47 and A11 link road.

- 2.2.3. The existing Cringleford Railway Bridge will require widening to accommodate the diverge layout from the A47.

Fencing, barriers and road signage

- 2.2.4. Boundary fencing will be provided to delineate the highway boundary.
- 2.2.5. Safety barriers and road signage will be provided to suit the layout of the Proposed Scheme.

Changes to the existing Thickthorn roundabout

- 2.2.6. The southern half of Thickthorn Junction will be widened to provide 4 lanes and the road markings across the whole junction will be repainted to suit the revised layout.
- 2.2.7. The existing A47 westbound exit slip road towards Thickthorn Junction, and the existing left turn into Cantley Lane South will be realigned and the left turn onto Cantley Lane South removed.
- 2.2.8. The existing slip road from Thickthorn Junction that merges onto the A47 eastbound, approaching Cringleford Rail Bridge will be retained in its current form with only road marking improvements to provide two lanes.
- 2.2.9. All the A11 and A47 entry arms onto the existing Thickthorn Junction will have traffic signal control with two pedestrian crossings to the north of the roundabout and two equestrian crossings to the south of the roundabout.
- 2.2.10. Improvements are to be made to the traffic signals around the roundabout circulatory at the:
- A47 westbound exit slip road entry
 - roundabout exit to the A47 eastbound entry slip road
 - approach from the B1172 will be signalised
- 2.2.11. Old Newmarket Road is not traffic signal controlled and will remain as currently exists.
- 2.2.12. The current signal arrangement at Thickthorn Junction will be improved to suit the proposed works.

Cantley Lane South to B1172 Norwich Road link road

- 2.2.13. The Proposed Scheme severs the existing access between Cantley Lane South and Thickthorn Junction. A new link road between Cantley Lane South and the B1172 Norwich Road to the north will be constructed.

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- 2.2.14. The new Cantley Lane South link road curves west-northwest before first crossing the A47 to A11 link road, the A11 main carriageway and finally the A11 to A47 link road, all via two new overbridges. The link road curves north before joining the B1172 to the west of Thickthorn Junction.
- 2.2.15. The existing access to Cantley Lane South (from the existing A47 westbound exit slip road) will be removed and all Cantley Lane South traffic to and from Thickthorn Junction will use the new link road to reach the B1172, A11 and A47.
- 2.2.16. A new turning head will be provided at the northern terminus of Cantley Lane South.

Cantley Stream realignment

- 2.2.17. The new link road will require the existing Cantley Stream to be realigned by approximately 550m. The adjacent access track will also require to be diverted.

2.3. Structures

- 2.3.1. The Proposed Scheme includes a variety of new, modified, existing, demolished and replaced structures. These include underpasses, bridges, retaining walls and culverts that are detailed in the following sections. The new and existing structures are numbered (e.g. S01) as shown on figure A.1 in Appendix A.

Cantley Lane South culvert

- 2.3.2. A new culvert will be required to carry the diverted Cantley Stream beneath the existing Cantley Lane South carriageway. The size of this culvert is yet to be determined but is likely to be constructed with a combination of reinforced and precast concrete.

New underpasses

- 2.3.3. There are three new underpasses proposed on the A11 to A47 link roads. The Racecourse Copse Underpass at the south west edge of the scheme will carry the new Cantley Lane South link road over the existing Cantley Stream and an existing farm access track.
- 2.3.4. The Ward's Wood underpass will carry the existing A11. The Cantley Lane South slip road underpass will carry a proposed A47 diverge slip road and the Cantley Lane underpass will carry the existing A47 over the new link road. All three underpasses are carrying the new A11 to A47 link under the existing A11, A47 diverge and A47.

- 2.3.5. The underpass at Cantley Stream is likely to be constructed with reinforced concrete. It is anticipated that the remaining underpasses will all be constructed top down from reinforced concrete.

Cantley Lane South link road overbridges

- 2.3.6. A single span steel composite and reinforced concrete bridge is proposed to carry the new Cantley Lane South link road over the A11 carriageway. Immediately north of this bridge a second bridge will carry the Cantley Lane South link road over the proposed A11 eastbound to A47 southbound link road.
- 2.3.7. The A47 dual carriageway crosses the Breckland railway line to the south-east of the Proposed Scheme on the existing Cringleford rail bridge. The carriageway is proposed to be widened on the west side of the existing rail bridge. Two adjacent existing crib walls will be partially demolished to below proposed ground level and new reinforced concrete retaining walls will be constructed.

Existing Cantley Stream underpass, Cantley culvert and Cringleford culvert

- 2.3.8. Two existing culverts to the north and south of Cringleford rail bridge will not be affected by the rail bridge widening proposals. The proposed reinforced concrete retaining walls constructed as part of the Cringleford rail bridge widening will be designed to span over the culverts.

Existing Cantley Stream Underpass

- 2.3.9. An existing underpass carrying the A11 over Cantley Stream will need to be extended to accommodate a widened carriageway where the A47 to A11 link road merges with the A11 westbound carriageway. The proposed extension will match the existing in appearance.

Existing and proposed Cantley Lane footbridges

- 2.3.10. The existing Cantley Lane footbridge that crosses the A47 between Cantley Lane South and Cantley Lane will be demolished under the Proposed Scheme and replaced with a new footbridge approximately 200m east of the existing bridge location. The replacement bridge will be suitable for walkers, cyclists and horse riders. Approach ramps will be constructed on earthwork embankments.

2.4. Lighting

Thickthorn Junction replacement lighting

- 2.4.1. The replacement of road lighting is proposed at the southern half of the existing Thickthorn Junction. The existing road lighting will be retained on the northern

half of the junction. A section of lighting will also be provided from the northbound A47 to Thickthorn Junction slip road.

Underpass lighting

- 2.4.2. New lighting is also proposed within the planned underpasses on the A11 to A47 link roads. The proposed underpasses will be lit along with a short length of lighting leading into and exiting from the underpasses.

A47/A11 link roads

- 2.4.3. It is proposed to light the exit from the northbound A47 to A11 slip road and the slip road to Thickthorn Junction.

Lighting Design

- 2.4.4. The lighting design is ongoing, and the current indications are that a mix of 10 and 12m tall columns with lanterns will be located in verges (or at the back of footways where applicable). Lanterns will be mounted to minimise upward light spill and light spill beyond the Proposed Scheme highway boundary.
- 2.4.5. Lanterns will be oriented toward the carriageway and will, as far as is reasonably practicable, minimise light spilled beyond the highway boundary. Lanterns within the underpasses are proposed to be mounted to the ceiling of the structure.

2.5. Drainage

Existing and new drainage

- 2.5.1. The proposed drainage strategy will retain existing drainage systems where they will be unaffected by the Proposed Scheme and use the existing outlets where possible.
- 2.5.2. The existing drainage system will be modified where required to meet design criteria of no flooding for a one in five-year event plus 20% climate change allowance. In the case of roads to be maintained by Norfolk County Council, no flooding for a one in 30-year event plus 20% climate change allowance and extended to one in 50-year event plus 20% climate change allowance for the low point at the underpass on the A11 to A47 link road.
- 2.5.3. Where road widening is required, existing drainage will be relocated to match the new road alignment. Link roads at the tie-ins to the A47 and the A11 will connect into existing drainage outlets.
- 2.5.4. The existing drainage network between the north end of Cantley Lane South and the new A47 to A11 link roads will be retained to provide a suitable destination

for some of the drainage from the new slip road and part of the A47 northbound slip road. This existing drainage is connected into new drainage further downstream.

- 2.5.5. Drainage from the existing A47 that is severed by the new underpasses will be routed around the structures to convey the existing catchment runoff and maintain original outlets.
- 2.5.6. An attenuation tank will be located at a low point on the A11 to A47 link road beneath a maintenance layby and will be serviced by a pumping station. The new Cantley Lane connection will be drained by kerb and gully.

Drainage of A47/A11 link roads

- 2.5.7. A proposed new attenuation basin (located to the west of the A11) will hold surface water discharges from the new A11 to A47 link road and from the northern end of the new Cantley Lane South link road. Run off from the link roads will be pumped whereas runoff from the northern part of the Cantley Lane link road north will drain by gravity to the basin.
- 2.5.8. It is proposed to increase in size and relocate into land assigned as Flood Zone 1, an existing attenuation trench located to the east of the A47 which accepts significant existing surface water discharges from the A47 and new A47 to A11 link road.
- 2.5.9. The new A11 to A47 slip road and link roads will drain to combined drains in the cut verges, providing a first level of treatment for the surface water run-off. Where the roads are on embankment, surface water runoff will be collected by kerb and gully.
- 2.5.10. The discharge rates from the attenuation basin will be restricted to match existing outlet discharge rates. Some of the existing drainage, where this may be severed by the new slip roads, will be connected into the new drainage system that leads to the attenuation basin.
- 2.5.11. Oversized pipes will hold and release at a controlled rate surface water discharges from the new A47 to A11 link road that drains to Cantley Stream east of the A11. The use of a tank system is proposed for the catchment runoff from the southern end of the new Cantley Lane South link road that also discharges to Cantley Stream.
- 2.5.12. Peak discharge rates at outlets will be controlled to match the existing discharge rates. Outlet areas are designed to attenuate peak discharge rates up to a one in 100-year event plus 20% climate change allowance. A sensitivity check will be made using a 40% climate change allowance.

Drainage of underpasses or overbridges

- 2.5.13. Where overbridges or underpasses are proposed to cross under the A47 and A11, these may not provide sufficient space to maintain existing drainage in places. If the existing drainage cannot remain in place, it will be directed into the proposed new road drainage networks, ensuring attenuation treatment prior to discharge.
- 2.5.14. The existing surface drainage on the A47 mainline and slip road is conveyed by surface water channels. Over the new underpass, it is intended to replace these channels to match existing.
- 2.5.15. The existing surface drainage on the A11 mainline is directed by surface water channels in the central reserve only and filter (combined) drains are present within the verges. On the new underpass, it is intended in the central reserve to replace the channel to match the existing. In the northbound nearside channel, a kerb drainage system will connect to existing drainage at the downstream end. Drainage pipes severed by the underpass will be rerouted and connected to the proposed A11 – A47 link road drainage.
- 2.5.16. Where the A47 westbound slip road crosses the underpass, a kerbed drainage system will be utilised to maintain acceptable kerbside flows.

3. Context of the proposed scheme and consideration of alternatives

3.1. The need for the proposed scheme

- 3.1.1. Thickthorn Junction connecting traffic between the A11 and A47 experiences high levels of congestion, acting as a bottleneck and leading to longer and unreliable journey times.
- 3.1.2. There are a number of reasons for these delays and investigations to date have highlighted these issues as:
- Thickthorn Junction traffic capacity
 - Increasing traffic is outgrowing the capacity of the road, causing tailbacks and delays
 - Development in the local areas, which can lead to more vehicles on the road
- 3.1.3. If nothing is done to improve capacity and connectivity, these delays are forecast to get worse in future years. In developing the Proposed Scheme, Highways England aim to address these issues by improving the traffic flow, reducing journey times on the route, increasing the route safety and resilience and improving the environment. The Proposed Scheme is also intended to support economic growth by making journeys safer and more reliable.

3.2. Background to the proposed scheme

- 3.2.1. The Road Investment Strategy (RIS) announced in December 2014 includes a package of six schemes along the A47 to be developed and constructed by Highways England during Roads Period 1 (2015- 2020) and the early part of Roads Period 2 (2020- 2025). The proposed six schemes are:
- A47 Wansford to Sutton
 - A47/A141 Guyhirn Junction
 - A47 North Tuddenhum to Easton
 - A47/A11 Thickthorn Junction
 - A47 Blofield to North Burlingham
 - A47 Great Yarmouth Junction
- 3.2.2. The schemes have been branded as the A47 Corridor Improvement Programme, and together the proposals will relieve congestion and improve the reliability of

journey times for drivers on the 115-mile section of the A47 between Peterborough and Great Yarmouth.

Objectives of the proposed scheme

3.2.3. The objectives of the proposed scheme are:

A safe and serviceable network

3.2.4. The safety of the junction should be improved through the creation of high quality and safe interchange links resulting in a KSI (killed and seriously injured) reduction of 1 fatal, 3 serious and 86 slight incidents over the 60-year appraisal period.

A more free-flowing network

3.2.5. Journey times shall demonstrate savings specifically:

- from A11 South to A47 East, a reduction in morning peak journey times from 510 seconds to 144 seconds
- from A47 East to A11 South, a reduction in morning peak journey times from 193 seconds to 141 seconds

Improved environment

3.2.6. The scheme shall mitigate the air quality impacts to ensure they are limited to “slight adverse” under WebTAG guidance.

3.2.7. The scheme shall mitigate noise quality impacts to ensure local sensitive receptors are limited to moderately adverse under WebTAG guidance regardless of the side road strategy employed.

3.2.8. Opportunities shall be sought to improve the biodiversity such as the planting of native habitat.

3.2.9. The scheme will improve connectivity for local residents and improve amenities for cyclists and pedestrians with removal and replacement of the existing footbridge with an alternative accessible solution

An accessible and integrated network

3.2.10. Ensuring the Proposed Scheme takes in to account local communities and access to the road network, providing a safer route between communities for cyclists, walkers, equestrians and other non-motorist groups.

3.3. Alternatives considered

- 3.3.1. In seeking to resolve the transport problem at Thickthorn Junction, 26 potential options were developed and assessed to identify their performance against safety, environmental, engineering, transportation and economic criteria so that they could be compared and contrasted. These options can be reviewed in the Scheme Assessment Report (SAR) at the following link;

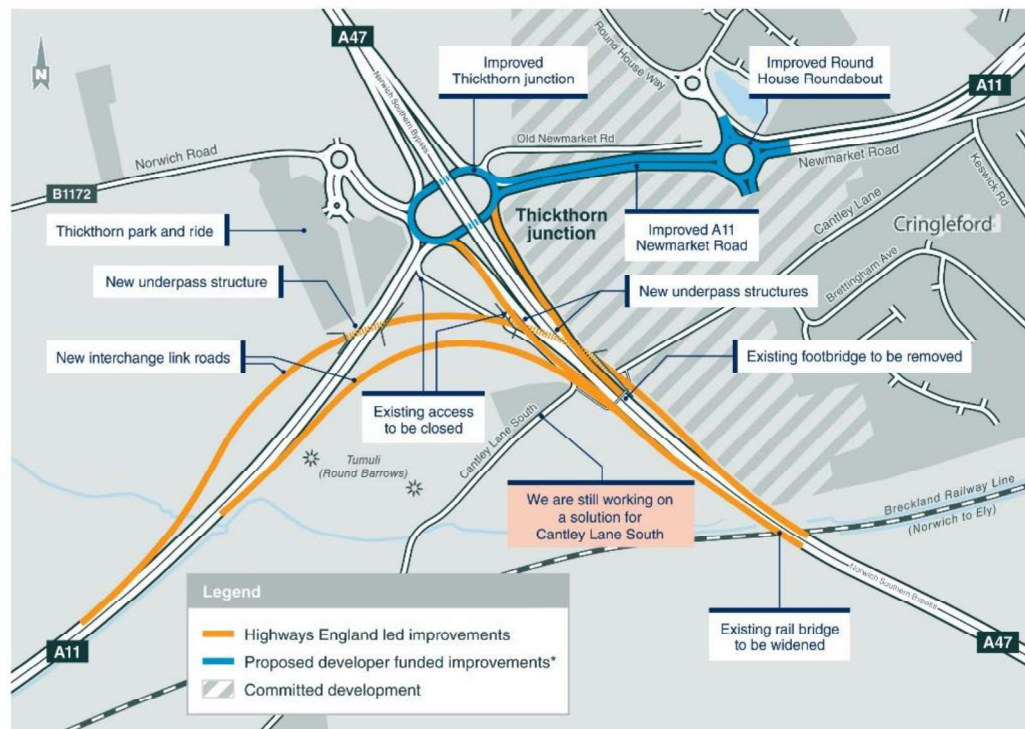
<https://highwaysengland.citizenspace.com/he/a47-a11-thickthorn-junction-improvement/results/schemeassessmentreport2018.pdf>

- 3.3.2. Comparative assessments between the options were made and the 26 options were reduced to one. Option 22 became the preferred route that was taken to non-statutory consultation in 2017.

3.4. Preferred route announcement

- 3.4.1. The preferred route announcement (PRA) comprised an A11 east to A47 south offline two-way bypass with an additional link to the B1172. The amended option 22 that had been developed as a result of a value management exercise was determined by the criteria set out by the Roads Investment Strategy and appeared to be economically viable while also solving the transport problem.
- 3.4.2. It should be noted that proposed developer funded improvements shown in blue on figure 3.1 is not the subject of the DCO application and is therefore not assessed as part of this Preliminary Environmental Information Report (PEIR).
- 3.4.3. At non-statutory consultation, a number of concerns were raised over the proposed reconnection of Cantley Lane South to Cantley Lane including potential increased traffic flows on Cantley Lane, potential rat-running, the environmental impacts along Cantley Lane and unacceptable land severance.

Figure Error! No text of specified style in document. 1: Preferred route (option 22)



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*A local scheme progressed by developers with South Norfolk District Council

3.4.4. Having reviewed the feedback following the non-statutory consultation and from members of the public at the public exhibition information events, a number of alternative options were assessed for the severance of Cantley Lane South.

3.4.5. As a result of the high-level assessment, potential solutions for Cantley Lane South were considered to provide potentially suitable designs that will fulfil the scheme objectives and were progressed for assessment. A single solution for Cantley Lane South has been chosen as detailed in Section 2.2.

3.5. Design Intervention

3.5.1. The design of the Proposed Scheme is an iterative process that evolves with technical and engineering considerations and with environmental constraints. To better describe the decision-making process, this PEIR makes a distinction between mitigation and design intervention.

3.5.2. In the context of this PEIR and the subsequent Environmental Statement (ES), a design intervention is defined as a change to the design of the Proposed Scheme to reduce or remove an identified environmental effect or improve or introduce an environmental benefit. Examples of this include:

- moving a sustainable urban drainage system (SuDS) pond location away from existing vegetation to allow the retention of the vegetation
- changing the alignment of the design to avoid an identified receptor
- introducing a noise bund to protect and identified receptor

3.5.3. Mitigation is defined as an action or future intent to reduce an identified effect. Examples of this include:

- A Construction Environmental Management Plan (CEMP)
- Specific operational and maintenance measures
- Aspects of the design that will reduce / avoid identified impacts that have not been detailed at the application submission stage.

4. Consultation

4.1. Consultation undertaken to date

Non- Statutory consultation

- 4.1.1. An extensive stakeholder mapping exercise was undertaken to identify relevant stakeholders and their key interests. This list was used to inform the participants of a six-week non-statutory public consultation, which was held between 13 March and 21 April 2017 and included public information exhibition events (PIE) held on 25, 27 and 28 March 2017. On conclusion of the non-statutory consultation period, a consultation report was completed that can be accessed via the following link;

<https://highwaysengland.citizenspace.com/he/a47-a11-thickthorn-junction-improvement/results/public-v2-a47-thickthorn-cons-report.pdf>

Scoping

- 4.1.2. A Scoping Report was submitted to the Planning Inspectorate (PINS) on 9 February 2018. PINS subsequently issued the scoping report to statutory consultees, with a deadline to respond with comments. The resulting Scoping Opinion from PINS with consultee responses was received by Highways England on 22 March 2018, a copy of which can be accessed via the following link;

<https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010037/TR010037-000010-THIC%20-%20Scoping%20Opinion.pdf>

Responses

- 4.1.3. Responses received from the non-statutory consultation and Scoping Opinion will be considered in the ongoing assessment and design processes.

Proposed consultation

- 4.1.4. A consultation strategy has been developed which outlines the organisations who will be consulted as part of statutory consultation under sections 42, 47 and 48 of the Planning Act 2008. We are consulting prescribed and statutory bodies in line with the requirements of section 42 of the Planning Act 2008. We are also consulting the local community in the manner specified in our Statement of Community Consultation (SoCC). The SoCC sets out methods through which community consultation will occur and the proposed timeline for the consultation. Methods for promoting the consultation include the Consultation Zone (CZ) which outlines an area within which all properties will directly receive information

about the consultation and the public exhibitions. The SoCC has been agreed with the relevant statutory consultees.

- 4.1.5. Consultation required to support individual assessments is set out within each technical chapter of this report.

Engagement with hard to reach groups

- 4.1.6. It is anticipated that the Proposed Scheme's Equality Impact Assessment will identify the relevant hard to reach groups. Host local authorities will be consulted about identification of relevant groups. Categories identified and contacted include walker, cyclist and horse rider groups, organisations that work with specific groups, local Traveller communities', disability groups and groups representing children and the elderly.
- 4.1.7. Policy guidance documents and other relevant technical documents will be available online and at various information points stationed at local community venues. These documents will be added to throughout the course of the project. The project web site address is:

<http://highwaysengland.co.uk/projects/a47-thickthorn-junction/>

5. Air quality

5.1. Introduction

5.1.1. This chapter presents the preliminary findings of the air quality assessment. This comprises a review of the existing environment and identification of potential impacts of the Proposed Scheme upon air quality. Potential impacts are discussed considering relevant policy and legislation, and in the context of existing air quality in the study area.

5.2. Guidance and best practice

Legislation

5.2.1. In the UK, the presence of pollutants in ambient air is managed through legislation (including that transposed from EU Directives) and government policy. Air quality limit values and air quality objectives (AQO) specify the ambient concentration of a pollutant, a time period over which that concentration is measured, and a date by which compliance with the limit value or objective should be achieved.

5.2.2. The AQO and limit values relevant to the Proposed Scheme are summarised in Table 5.1.

Table 5.1 Air Quality Objectives

Pollutant	Averaging Period	Air Quality Objectives and Limit Values		Attainment Date	
		Concentration	Allowance	Air Quality Objectives	EU Limit Values
Nitrogen dioxide (NO ₂)	Annual	40 µg/m ³	-	31 December 2005 ^{(a)(b)}	1 January 2010 ^(c)
	1 Hour	200 µg/m ³	18	31 December 2005 ^{(a)(b)}	1 January 2010 ^(c)
Nitrogen Oxides (NO _x) ^(d)	Annual	30 µg/m ³	-	1st January 2001 ^(c)	-
Particulates (PM ₁₀)	Annual	40 µg/m ³	-	31 December 2004 ^{(a)(b)}	1 January 2005 ^(c)
	24 Hour	50 µg/m ³	35	31 December 2004 ^{(a)(b)}	1 January 2005 ^(c)

Notes: ^(a) Air Quality (England) Regulations 2000 as amended in 2002 (Statutory Instrument 2002)

^(b) Air Quality Strategy 2007 (Defra,2007)

^(c) EU Directive 2008/50/EEC on ambient air quality and cleaner air for Europe and The Air Quality Standards Regulations 2010. Derogations (time extensions) have been agreed by the EU for meeting the NO₂ limit values in some zones/agglomerations. (European Commission, 2008)

(d) Designated for the protection of vegetation and ecosystems and referred to as the 'critical level' for NO_x.

Policy

5.2.3. The National Policy Statement for National Networks (NPSNN) notes that the applicant should undertake an assessment of the impacts of the Proposed Scheme describing;

- Existing air quality levels
- Forecasts of air quality at the time of opening, assuming that the scheme is not built (the future baseline) and taking account the impact of the scheme
- Any significant air quality effects, their mitigation and any residual effects, distinguish between the construction and operation stages and taking account of the impact of road traffic generated by the project

Guidance

5.2.4. The air quality assessment follows the guidance provided by the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1 (HA 207/07), the Department for Environment, Food and Rural Affairs (Defra) technical guidance for undertaking air quality assessments (LAQM-TG (16)) (Defra 2016), and the Interim Advice Notes (IANs) relevant to air quality (IAN 170/12 (Highways Agency 2012), IAN 174/13 (Highways Agency 2013), IAN 175/13 (Highways Agency 2013) and IAN 185/15 (Highways Agency, 2015)).

5.2.5. The Highways Agency IAN 174/13 (Highways Agency, 2013) and 175/13 (Highways Agency, 2013) informs decision making on the judgements of air quality impacts and determining whether the Proposed Scheme will affect the UK's reported ability to comply with the Air Quality Directive, in line with the requirements of the NPSNN.

5.3. Study Area

Local assessment

5.3.1. The air quality study area is determined based on changes in traffic flows on the local road network. For this report, traffic data is not available and therefore affected roads have not been identified. For the Environmental Statement (ES), the traffic data will be available and the affected road network (ARN) will be determined based on DMRB Volume 11, Section 3, Part 1 (HA 207/07). Affected roads are defined where at least one of the following criteria is met:

- road alignment will change by 5m or more

- daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) flow or more
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more
- daily average speed will change by 10kph or more
- peak hour speed will change by 20kph or more

5.3.2. The assessment work undertaken to date comprises of a qualitative review of the potential impacts on air quality at sensitive receptors based on:

- existing baseline conditions (based on publicly available information)
- the location of receptors
- changes to road layout and potential traffic changes

Regional assessment

5.3.3. The regional air quality assessment assesses the change in total emissions resulting from the Proposed Scheme. This is required as emissions not only affect local air quality, but also have an impact on a regional, national and international scale.

5.3.4. DMRB Volume 11, Section 3, Part 1 (HA 207/07), is used to determine the regional affected road network and is used to determine the changes in regional emissions. The criteria are defined as:

- a change of more than 10% in AADT
- a change of more than 10% to the number of HDVs
- a change in daily average speed of more than 20kph

5.3.5. As no traffic data is currently available, the assessment provides a qualitative review of the potential impacts on regional air quality.

5.4. Assumptions and limitations

5.4.1. Assessment work to date has been undertaken qualitatively as traffic data for the Proposed Scheme is not yet available. Assessment work to date has been based on an understanding of the baseline conditions, location of sensitive receptors and potential changes in emissions due to the road layout and traffic flows.

5.5. Baseline

Human Health

- 5.5.1. A range of potentially sensitive receptors have been identified within the Thickthorn Junction study area. In the immediate vicinity of Thickthorn Junction is a hotel, approximately 50m from the A11. There is also a petrol station and two fast food restaurants at the junction both approximately 25m from the A11.
- 5.5.2. Small groups of residential properties are located at East Lodge/Thickthorn Cottages on the B1172 (six properties approximately 140m to 260m from the A47). On Cantley Lane South there is one group of 12 properties (approximately 55m to 160m from the A47) and a further five properties (ranging from 250m to 500m) southwest of the A47. An individual residential property (the Round House) is located to the east of Thickthorn Junction approximately 50m north of the A11.
- 5.5.3. A large number of residential properties are concentrated in Cringleford to the east of the A47, both to the north and south of the A11. The western edge of Cringleford is a minimum of approximately 170m from the A47. Residential properties in Cringleford extend to within approximately 15m of the A11. There are also a number of non-residential sensitive receptors in Cringleford, including a primary school. None of these are located in close proximity to the junction or adjoining roads.
- 5.5.4. There are a large number of planned developments close to the junction, including 650 residential dwellings to the east of the A47 and north of A11 and another 600 residential units close to the Round House roundabout towards Cringleford.

Designated ecological sites

- 5.5.5. There are no internationally or nationally designated ecological sites in the study area. The nearest designated site is the Eaton Chalk Pit Sites of Special Scientific Interest (SSSI), designated for its inland rock habitat, which is located approximately 1.9km to the east-northeast of the proposed site and is therefore unlikely to be significantly affected by the Proposed Scheme for air quality.

Local air quality

- 5.5.6. There are currently no declared Air Quality Management Areas (AQMAs) within the South Norfolk District Council administrative area. The closest AQMA is located over four kilometres to the northeast within Norwich city centre declared by Norwich City Council for exceedances of the annual nitrogen dioxide (NO₂) objective.

- 5.5.7. Each local authority collects monitoring data within its area. The data are collected through a combination of automatic monitoring stations and passive NO₂ diffusion tubes. This data has been used to inform this air quality assessment.

Defra projected background concentrations

- 5.5.8. In addition to the data above, Defra provides estimates of background pollution concentrations for NO_x, NO₂ and PM₁₀ across the UK for each one kilometre grid square, for every year from 2015 to 2030. Future year projections have been developed on the base year for the background maps, which is currently 2015. This data can be used to provide specific background pollutant concentrations at receptors included within the assessment and to supplement local monitoring data.
- 5.5.9. The maximum background concentrations for the areas covered by the Proposed Scheme alignment for the year 2015 are presented in Table 5.2 and demonstrate that background concentrations are well below the relevant objectives and expected to reduce further in future years as older vehicles are replaced with newer ones which meet more stringent standards.

Table 5.2 Defra Background Data

NO _x	NO ₂	PM ₁₀
14.91	11.0	16.6

Note: The results presented above are taken from the grid squares which have the greatest pollutant concentrations for 2015. Grid squares used = 618500, 305500

EU limit value compliance

- 5.5.10. Defra's Pollution Climate Mapping (PCM) is used to report compliance with the EU limit values and provides NO₂ concentrations for a number of roads across the UK for a selection of future years. The most up to date PCM model outputs were released in August 2017, following the release of the UK Plan for tackling nitrogen dioxide concentrations (Defra, 2017).
- 5.5.11. The PCM link closest to the Proposed Scheme, (on the A11) is located approximately 2km to the northeast from the Proposed Scheme and has a reported annual mean NO₂ concentration in 2015 of 35.8µg/m³, which is below the annual mean limit value of 40µg/m³ for NO₂.

5.6. Consultation

- 5.6.1. Further to the consultation already completed (Chapter 4), consultation with South Norfolk District Council will be undertaken on the choice of receptors included in this assessment, once the affected road network can be defined.

5.7. Design Interventions

- 5.7.1. At the time of writing this report, no design interventions have been included for air quality. Any future iterative design as a result of environmental considerations will be reported in the ES.

5.8. Potential mitigation measures

Construction

- 5.8.1. No additional mitigation measures during the construction phase other than those in accordance with the Best Practicable Means (BPM), as described in Section 79 (9) of the Environmental Protection Act 1990 are likely to be required to reduce air quality impacts.

Operation

- 5.8.2. At the time of writing this report, no operational air quality specific mitigation measures have been designed into the Proposed Scheme. Any proposed mitigation in the future will be reported in the ES.

5.9. Potential impacts

Construction

- 5.9.1. An indicative construction assessment has been undertaken following best practice guidance using a risk-based approach which takes into account the dust raising potential of the likely construction activities, the embedded mitigation and the location of potentially sensitive receptors. Implementation of appropriate good practice mitigation measures will reduce air quality impacts.

Operation

- 5.9.2. The redistribution of traffic as a result of the Proposed Scheme is likely to have an impact on air quality, depending on where the changes in flows occur.
- 5.9.3. The Proposed Scheme will move the road alignment closer to the receptors on Cantley Lane, however, the closure of the access to Cantley Lane South from the existing A47 westbound off slip will reduce flows along Cantley Lane South. Considering the existing concentrations in the study area and the distance from the new slip roads and the receptors along Cantley Lane South, these impacts are not expected to be significant in accordance with IAN174/13.
- 5.9.4. Any affected road network links identified that overlap with the PCM model will assess compliance with the Air Quality Directive in accordance with IAN 175/13. Considering the location of these links and the current reported concentrations,

the Proposed Scheme is unlikely to cause a non-compliance with the Air Quality Directive.

5.10. Chapter Summary

- 5.10.1. This chapter has summarised the current understanding of the baseline conditions, mitigation and likely anticipated qualitative impacts upon air quality. The Proposed Scheme will impact air quality around the A47/A11 Thickthorn Junction as a result of changes in the road layout and redistribution of traffic. A review of existing ambient monitoring data, and the likely changes in traffic flows as a result of the Proposed Scheme suggests that there is the potential for both positive and negative air quality impacts however, the annual mean air quality objective for NO₂ will not be exceeded.
- 5.10.2. Further work will be undertaken to develop design interventions to limit or reduce impacts and promote opportunities for the environment within the study area wherever possible. Design development and potential mitigation will be reported in the ES as well as further detailing of baseline conditions and likely changes during both construction and operation for all identified receptors.

6. Cultural Heritage

6.1. Introduction

6.1.1. This chapter presents the preliminary findings of the cultural heritage assessment. This comprises a review of the existing environment and identification of the potential impacts of the Proposed Scheme upon surrounding cultural heritage receptors. The chapter also outlines proposed design measures to help mitigate these potential impacts and relevant consultation.

6.2. Guidance and best practice

6.2.1. This overarching legislation in relation to the historic environment in the UK is provided by:

- the Ancient Monuments and Archaeological Areas Act 1979
- the Planning (Listed Buildings and Conservation Areas) Act 1990

6.2.2. The assessment is undertaken in accordance with the published standards and guidance:

- *National Planning Policy Framework*, Section 16 Conserving and enhancing the historic environment (Ministry of Housing, Communities and Local Government (MHCLG) (2019)
- National Planning Policy Guidance (NPPG) MHCLG (2013)
- *Design Manual for Roads and Bridges, Environmental Assessment* (Volume 11, Section 3, Part 2 – Cultural Heritage) Department for Transport (Highways Agency 2007)
- *Conservation Principles*, (Historic England, 2008)
- *Historic Environment Good Practice Advice in Planning note 2 (GPA2) – Managing significance in decision taking in the historic environment* Historic England (2015)
- *Historic Environment Good Practice Advice in Planning Note 3 (GPA3) – The setting of heritage assets*, Historic England (2017)
- *Standard and Guidance for historic environment assessment* Chartered Institute for Archaeologists (2014) (updated 2017)

6.2.3. The local planning policies for the historic environment presented in the Joint Core Strategy for Broadland, Norwich and South Norfolk (Greater Norwich Development Partnership 2014) include policy 1: addressing climate change and protecting environmental assets, policy 2: promoting good design and objective nine: to protect, manage and enhance the natural, built and historic environment,

including key landscapes, natural resources and areas of natural habitat or nature conservation value.

6.3. Study area

- 6.3.1. The study area comprises a 1km buffer surrounding the land within the Proposed Scheme boundary (referred to hereafter as 'the Site').

6.4. Assumptions and limitations

- 6.4.1. A geophysical survey was undertaken in 2018 that identified anomalies of possible archaeological origin, detailed in Section 6.5.4. Further investigation will help determine the archaeological potential within the Site.
- 6.4.2. Information provided by Historic Environment Records (HER) can be limited because it depends on available opportunities for research, fieldwork, and discovery. Where nothing of historic interest is shown in a particular area, this can be down to a lack of targeted research or investigation rather than the genuine absence of heritage assets.
- 6.4.3. The only non-designated buildings of local heritage interest presented within this assessment are those identified within the HER. Further assessment will need to take into consideration any such assets.
- 6.4.4. Documentary sources are rare before the medieval period, and many historic documents are inherently biased. Older primary sources often fail to accurately locate sites and interpretation can be subjective.
- 6.4.5. Where archaeological sites have been identified solely from aerial imagery without confirmation from archaeological excavation or supporting evidence in the form of find-spots etc., it is possible the interpretation may be revised in the light of further investigation.

6.5. Baseline

Topography and geology

- 6.5.1. The Site is largely situated on the eastern side of the shallow valley of the Cantley Stream, a tributary of the River Yare. The western end of the Site, at Station Farm, is sited at around 30m above ordnance datum (AOD), descending to around 15m AOD at the bottom of the Cantley Stream valley, then rising again to 30m AOD adjacent to the Thickthorn park & ride site.
- 6.5.2. The British Geological Survey (NERC 2017) identified that the underlying bedrock comprises Lewes Nodular Chalk Formation overlain by alluvium of clay

and silt in the area of the Cantley Stream, Sheringham Cliffs Formation sand and gravel along the valley sides and Lowesoft Formation Diamicton on the higher ground.

- 6.5.3. One soil type dominates: slightly acid loamy and clayey with impeded drainage. This soil type is moderately to highly fertile with arable and grassland landcover and a wide range of pasture and woodland types (Cranfield Soil and Agrifood Institute 2017).

Archaeological and historic overview

Geophysical survey

- 6.5.4. The site of the Proposed Scheme was assessed for suitability for geophysical survey. A total of eight areas were surveyed (Archaeological Services WYAS 2018). The results identified two main areas of archaeological and possible archaeological activity (see figures in Appendix A).
- 6.5.5. Area 1 - Cantley Lane, north of the A11 – a possible area of intense burning, possibly a kiln, was identified within a rectilinear enclosure with internal and external pit like features. A series of field boundaries were identified.
- 6.5.6. Area 2 - south of the A47/A11 Thickthorn Junction, possible curvilinear trends, tentatively described as ring ditches or barrows.
- 6.5.7. An earlier geophysical survey was undertaken as part of another development and revealed a pair of parallel ditches and small cluster of archaeological features comprising a boundary ditch and pits to the south-west of the Cantley Lane north diversion (Northamptonshire Archaeology, 2011).

Documentary evidence

- 6.5.8. A previous evaluation of the Historic Environment Record (HER) has been undertaken for the Proposed Scheme. This identified that there is high potential for archaeological remains dating to the prehistoric and medieval periods, within the Site.
- 6.5.9. References used in this section refer to the National Heritage List for England list entry numbers (NHLE numbers) and Norfolk HER reference numbers (NHER numbers).

Designated Assets

- 6.5.10. The one kilometre study area around the Site has one grade II* listed building (Church of All Saints, NHLE 1373136, 640m south-east of the Site) and 15 grade II listed buildings.

-
- 6.5.11. One scheduled monument (NHLE 1003977) is situated adjacent to the Site and comprises two Bronze Age round barrows surviving as earthworks surrounded by an area of former landfill, that subsequently became a plantation, known as Big Wood. The exact location of the barrow is uncertain. Modern mapping, aerial photograph analysis and the Historic England asset location do not correlate, though it is an upstanding earthwork and clearly visible.
- 6.5.12. The grade II* listed registered park and garden, Intwood Hall (NHLE 1000320), is situated approximately 400m south-east of the Site. The parkland consists of c.16th century walled gardens and surrounding c.18th to c.19th century parkland.
- 6.5.13. Cringleford Conservation Area is situated around 300m east of the Site.

Non-designated assets

- 6.5.14. A borehole log (BGS borehole reference TG10SE/96; NERC 2017) in the area of the Cantley Stream, on the north-western side of the A11, records a 0.5m thick peaty gravel deposit at a depth of around 1m below the ground level. Further along Cantley Stream, to the south-east, peat deposits are also recorded to a depth of 2.6m and 0.4m from the ground surface (BGS borehole reference TG10SE/106 and TG10SE/130 respectively). This indicates that pockets of peat are potentially present within the Site. Peat deposits have the potential to contain evidence related to the paleo-environment, and well-preserved archaeological remains, specifically organic remains such as wood, leather, hair and skin.
- 6.5.15. In addition to the scheduled monument, a number of prehistoric finds have been recorded within the study area. Of these, 11 are recorded within the Site: A Mesolithic flint blade and Neolithic flint flakes were found along the route of the A11, prior to its construction, at the western end of the Site (NHER 22814). Prehistoric flint implements were recorded in the Cantley Stream Culvert during the construction of the A11 (NHER 22758). Further flint tools and flakes were recorded to the east, within the route of the A11 (NHER 22812, 22813). Cropmarks on the northern side of the A11, in the area of the Cantley Lane South diversion, indicate the presence of ditches possibly forming a prehistoric field system (NHER 59885, 65378). A geophysical survey in the northern half of this field revealed a small number of ditches aligned roughly east to west, a cluster of pits was also identified on the western perimeter of the central part of the Cantley Lane South diversion (Northamptonshire Archaeology 2011).
- 6.5.16. Fieldwalking, in an area towards the eastern end of the Site, has revealed prehistoric finds, including three Bronze Age socketed axes, flint tools and a small quantity of Neolithic, Bronze Age and Iron Age pottery (NHER 16229, 16230). Geophysical survey that covered this area revealed no archaeological finds or features, however the survey did not pick up known boundary ditches,

indicating factors such as the natural geological substrate have affected the results (Archaeological Services WYAS 2013). A Late Neolithic/Early Bronze Age flint scatter was identified during field walking prior to the construction of the South Norwich Bypass (A47) (NHER 14273), at the eastern end of the Site.

- 6.5.17. Roman activity in the area was focused upon the town at Caistor St Edmund – Venta Icenorum – around 3.7km s to the south-east of the Site. There are a number of Roman roads to the south of the study area, though none are known to extend into the study area. However Roman remains are recorded, for example a Roman brooch, along with an early 17th century post-medieval cloth seal, was found during metal detecting of a spoil heap from road construction works. This was at the western end of the Site, within the route of the A11 (NHER 22755).
- 6.5.18. The deserted medieval village (DMV) of Cantley (NHER 9469) is situated 100m south of the proposed Cantley Stream diversion. Medieval pottery sherds (NHER 25511) are recorded around the area of the abandoned medieval village. A double-ditched enclosure to the north of the DMV suggests that medieval remains could be present beyond the area identified as the DMV (NHER 54614). A medieval moat is recorded at Thickthorn Park, on the northern side of the A11, around 200m west of the Site and was incorporated in the later formal design of the parkland (NHER 9352). The former hall, which was situated within the interior of the moat, dates to around 1240 and was replaced in 1812 by Thickthorn Hall (NHER 33732). Thickthorn Park is a post-medieval landscape park dating to the early c.19th century surrounding Thickthorn Hall. The Cantley Lane South diversion extends into the eastern part of Thickthorn Park.
- 6.5.19. Post-medieval evidence within the study area indicates that the landscape was largely agricultural; field boundaries are identified to the east (NHER 36138) and features associated with country estates such as Thickthorn Park (NHER 33732) and Intwood Hall (NHER 9473) are recorded. Remains of industrial activities are also identified within the study area, around 800m to the north of the Site: a clay extraction pit (NHER 9407); and, a possible kiln site (NHER 62390).
- 6.5.20. The Norfolk Railway was opened in 1844 (NHER 13571). A bank running roughly north-east to south-west, to the north of and parallel to the railway, is described as an undated Holloway (NHER 9409). The Norwich Road (A11) and Cantley Lane are both shown on the Tithe Map of 1840 and many of the field boundaries remain unaltered, though some fields have been widened, through the removal of field boundaries.
- 6.5.21. Modern assets include limekilns and a tramway (NHER 16685) within the Site. They were in use during the 1930s and 1940s. This area was later used as

landfill during the 1960s. World War Two defences are represented by a possible rail block on the line of the railway (NHER 53252).

- 6.5.22. The historic landscape character of the area surrounding the Site is largely described as 20th century agriculture with pockets of 18th to 19th century enclosure surviving. An area of inland managed wetland is identified around the Cantley Stream. The central area of the Proposed Scheme is not categorised through the Norfolk Historic Landscape Characterisation project (Norfolk Landscape Archaeology 2009).

6.6. Consultation

- 6.6.1. Consultation has been undertaken to date with the Norfolk County Council Environment Team and Historic England in relation to the Proposed Scheme. Table 6.1 summarises the consultation to date. Further consultation with Norfolk Environment Team and Historic England will be undertaken and reported in the Environmental Statement (ES).

Table 6.2 Consultation detail

Consultee	Comment	Date	Response
Norfolk Environment Team	Suggested possible metal detecting survey around the area of the scheduled monument to determine whether there is any evidence of later re-use of the monument.	22 January 2018	Subsequent walkover survey and documentary research established that this area was part of the landfill site which was later capped and planted with trees in the late 20th century. As such metal detecting survey will not yield archaeological results.
Historic England	Concern expressed regarding proximity of scheme to scheduled monument and its impact upon the monument's setting.	26 February 2018	Proposed Scheme will be designed as far away from the scheduled monument as possible, within the small space available between the monument and the A11.
Historic England, Norfolk County Council Environment Service	Site meeting to discuss further investigation. Lidar and aerial photograph analysis to be undertaken to be supplemented with detailed archaeological topographic survey if necessary. Trenching in area specifically surrounding the scheduled monument discussed. Concerns raised regarding timeframe in relation to carrying out archaeological	26 June 2018	Aerial photography and lidar analysis to be undertaken. Trench plan to include trenching to the north-west of the westernmost barrow of the scheduled monument. Acknowledgement that timeframe is tight but results of surveys will be considered in relation to scheme.

Consultee	Comment	Date	Response
	assessment in time to feed into scheme design.		

6.7. Design interventions

6.7.1. Design intervention is mitigation embedded into the design of the Proposed Scheme and is achieved through an iterative process. Mitigation is currently being developed for Cultural Heritage assets and any relevant developments will be reported in the ES.

6.8. Potential impacts

Construction

6.8.1. Construction impacts may arise as a result of the following activities:

- temporary and permanent land take
- demolition and site clearance
- excavation, ground disturbance and compaction
- use of plant and machinery
- building up site levels with made-ground
- construction of new infrastructure or modification of existing infrastructure
- diversion / alteration of existing services or installation of new services
- landscaping and planting

6.8.2. These activities could lead to the following impacts on the historic resource:

- loss/ damage or long-term burial archaeological remains
- structural damage to historic buildings due to proximity of works
- severance or loss of features such that, the physical or visual integrity of a site is compromised and the ability to understand and appreciate the remaining elements is diminished
- temporary alteration and / or visual intrusion into the historic setting/character of a designated asset or undesignated site of national or regional significance
- temporary impact on the access to, and amenity of, designated sites or undesignated sites of national or regional significance

6.8.3. Cumulative effects are also a consideration and will be reported accordingly in the ES.

6.9. Potential mitigation measures

- 6.9.1. Construction will be carried out using industry best practice and in accordance with a Construction Environmental Management Plan (CEMP) to reduce any potential adverse impacts. Mitigation measures for the historic environment will be reported in the ES and incorporated throughout the design and construction stages.
- 6.9.2. In addition to the identified scheme mitigation measures, archaeological investigation (such as excavation of buried remains) will be undertaken if required to help understand the value of assets where there is a potential loss.
- 6.9.3. Mitigation recommendations which have been put forward through the early design phases, are:
- Alter the drainage design to the north-west of the westernmost barrow forming the scheduled monument to minimise the impact of the asset.
 - Tree planting along the embankment for the Cantley Lane South Diversion to retain the current setting of the scheduled monument.
 - Sensitive vegetation screening to be planted in order to screen the non-designated historic parkland Thickthorn Park from the Proposed Scheme.
 - Alter the proposed location of the compound to the south-east of the scheme to avoid impact to the grade II listed Lodge to Intwood Hall, as well as to the grade II* listed Church of All Saints, the grade II listed Gazebo circa 60m east of Intwood Hall, and to the grade II* listed Intwood Hall, registered park and garden.
 - Ensure the proposed compound to the east of the Proposed Scheme is not built up to provide a level surface. Building up this land will potentially introduce a visual intrusion to the setting of grade II listed North House TG 192 049 The Farmhouse TG 192 049 –two residential properties that historically formed on farmhouse.
 - Limit impact to historic hedgerows and boundaries by restricting permanent loss to the footprint of the Proposed Scheme, with no loss for temporary purposes such as haul routes and compounds.
 - Limit impact to buried archaeological features across the site by avoiding ground disturbance in areas of temporary use, such as haul routes and compounds, using tank matting as an alternative.
 - Ensure the veteran trees within the areas of the proposed compounds either side of the Cantley Lane South Diversion are retained and not damaged. This will avoid permanent impacts to the historic parkland for temporary uses.
 - Keep lighting levels the same as current levels, or lower, in order to reduce impact to the nearby designated assets and to the historic landscape.

Sensitive receptors during construction

6.9.4. Table 6.2 sets out the key sensitive receptors that could potentially be affected by construction of the Proposed Scheme. The ES will assess the impacts of the Proposed Scheme on the identified receptors and provide recommendations for mitigation.

Table 6.2 Sensitive receptors during construction

Receptor	Location	Description
Two Tumuli in Big Wood, scheduled monument	TG 618133, 304979 (westernmost barrow)	Two round barrows, upstanding earthworks each one surrounded by a ditch. Construction of the proposed A11/A47 slip north of the westernmost barrow would bring the road and associated drainage considerably closer to the edge of the barrow. This has the potential to impact remains associated with the feature and will detrimentally impact its setting. There is a concern that the monument is not accurately mapped and that its physical position could be closer to the proposed scheme than currently expected, therefore the proposed scheme also has the potential to physically impact the scheduled monument. Construction of the proposed Cantley Lane diversion will impact the setting of the asset. The construction of the embankment upon which the road will run, will separate the barrow further from Cantley Stream, a watercourse that is likely to have been one of the reasons, if not the main reason, for the barrows' placement. Planting trees upon the embankment will potentially minimise the effect of this by retaining its current setting, however this will not have been the barrows' original setting. It is probable that this area was cleared land affording a view over the watercourse and possibly towards a pair of smaller round barrows near Ketteringham Hall, 1.7km to the south-west.
Thickthorn Hall, grade II listed building	TG 617498, 305241	1812 house. Construction will introduce potential temporary noise impacts to the setting of this designated asset.
Kitchen garden walls and attached octagonal building c.60m north-east of Thickthorn Hall q.v. 2/42, grade II listed building	TG 617564, 305272	Early 19th century. Adjoining octagonal building included for group value. Construction of the Proposed Scheme will introduce potential temporary noise impacts to the setting of this designated asset.
The Round House at TG 188 056, grade II listed	TG 618880, 305632	c. 1805 cottage. Construction of the Proposed Scheme will introduce potential temporary noise impacts to the setting of this designated asset.
North House TG 192 049 The Farmhouse TG 192 049, grade II listed building	TG 619258, 304953	Late 18th and early 19th century farmhouse, now two residential properties. Use of the proposed construction compound location to the north-west will introduce temporary visual and noise impacts to the setting of this designated asset.

Receptor	Location	Description
Intwood Hall, grade II* listed registered park and garden	TG 619447, 304044 (centred)	Manor House with walled gardens of 16th century origins, with small mid-18th century park. Use of the construction compound to the north-east of the park will introduce temporary visual and noise impacts to the setting of this designated asset.
Lodge to Intwood Hall c.100 Metres North of Church of All Saints, grade II listed building	TG 619713, 304264	Lodge cottage dated c. 1844. Use of the construction compound to the north-east of the park will introduce temporary visual and noise impacts to the setting of this designated asset.
Church of All Saints, grade II* listed building	TG 619689, 304182	Parish church first built in 12th century restored in the 19th. Use of the construction compound to the north-east of the park will introduce temporary visual and noise impacts to the setting of this designated asset.
Gazebo c.60 metres east of Intwood Hall, grade II listed building	TG 619447, 304230	16th century gazebo, possibly repositioned in 1852. Use of the construction compound to the north-east of the park will introduce temporary noise impacts to the setting of this designated asset.
Garden walls, gazebo and urn to north and north west of Intwood Hall, grade II listed building	TG 619392, 304260	16th century garden walls, shortened and restored c. 1850. 16th to 17th century gazebo. Use of the construction compound to the north-east of the park will introduce temporary noise impacts to the setting of this designated asset.
Buried archaeological remains identified through aerial photography. Prehistoric to post-medieval in date. Across the scheme.	Throughout the study area	Non-designated assets. Cropmarks identify field systems of prehistoric to Roman date and geophysical survey identified features of unknown date. Construction of the Proposed Scheme will partially or totally destroy these assets.
Unknown buried archaeological remains. Prehistoric to post-medieval in date. Across the scheme.	Throughout the study area	Non-designated assets. Construction of the Proposed Scheme will partially or totally destroy these assets.
Historic landscape character	Throughout the study area	The historic landscape character is largely 20th century enclosure, with some enclosed meadow of unknown date. Construction of the Proposed Scheme will require partial loss of field boundaries and, if present, historic hedgerows.
Thickthorn Park, non-designated historic park.	TG 617932, 305296	19th century landscape park. Cantley Lane South Diversion is proposed to run through the eastern part of the parkland, which contains veteran trees shown on 19th century historic mapping. Construction of the new road through this field impact the setting of the historic park.

Operation

6.9.5. The Proposed Scheme could lead to the following impacts on the historic resource:

- increased visual intrusion both to and from sites / buildings of national or regional importance
- alteration to the historic setting / character of a designated site or undesignated site of national or regional significance
- increase or decrease in noise, vibration or dust such that the amenity or physical fabric of a nationally or regionally important site is either adversely impacted or improved
- opportunities to enhance the character and setting of a designated site or undesignated site of national or regional significance
- opportunities for heritage related education and tourism.

Sensitive receptors during operation

6.9.6. Table 6.3 sets out the key sensitive receptors that could potentially be affected by the Proposed Scheme. The ES will set out to assess the potential impacts of the Proposed Scheme on the identified receptors and provide recommendations for mitigation.

Table **Error! No text of specified style in document.** Sensitive receptors during operation

Receptor	Location	Description
Two Tumuli in Big Wood, scheduled monument	TG 618133, 304979 (westernmost barrow)	Two round barrows, upstanding earthworks each one surrounded by a ditch. Operation of the proposed Cantley Lane diversion and A47/A11 slip road could impact the setting of the monuments. Additional lighting along the new road will impact the setting of the monument.
Thickthorn Hall, grade II listed building	TG 617498, 305241	1812 house. Operation will introduce potential noise and lighting impacts to the setting of this designated asset.
Kitchen garden walls and attached octagonal building c.60m north-east of Thickthorn Hall q.v. 2/42, grade II listed building	TG 617564, 305272	Early 19 th century. Adjoining octagonal building included for group value. Operation will introduce potential noise and lighting impacts to the setting of this designated asset.
Historic landscape character	Throughout the study area	The historic landscape character is largely 20 th century enclosure, with some enclosed meadow of unknown date. Operation will introduce potential noise and lighting impacts to the landscape setting.
Thickthorn Park, non-designated historic park.	TG 617932, 305296	19 th century landscape park. Cantley Lane diversion is proposed to run through the eastern part of the parkland, which contains veteran trees shown on 19 th century

Receptor	Location	Description
		historic mapping. Operation will introduce potential noise and lighting impacts to the setting of this asset.

6.10. Chapter Summary

- 6.10.1. The chapter has summarised the current understanding of the baseline conditions, mitigation and likely anticipated impacts upon Cultural Heritage. The Site is situated in an area with a diverse archaeological record, ranging from prehistoric funerary monuments, Roman field systems, medieval settlement, post-medieval historic parkland and modern industrial activities.
- 6.10.2. There are a number of designated assets, including a scheduled monument, that are likely to be adversely impacted by the Proposed Scheme as they are likely to experience permanent visual and / or noise intrusion which would adversely impact their settings.
- 6.10.3. Further work will be undertaken to develop design interventions to limit or reduce impacts and promote opportunities for the environment within the study area wherever possible. Design development and potential mitigation will be reported in the ES as well as further detailing of baseline conditions and likely changes during both construction and operation for all identified receptors.

7. Landscape

7.1. Introduction

7.1.1. This chapter presents the preliminary findings of the Landscape and Visual Impact Assessment (LVIA). This comprises a review of the existing environment and identification of the potential impacts of the Proposed Scheme upon surrounding landscape and visual receptors. The chapter also outlines proposed design measures to help mitigate potential landscape and visual impacts.

7.2. Guidance and best practice

- 7.2.1. No single prescribed methodology exists for assessing landscape and visual impact; however, the assessment follows best practice guidelines as set out in:
- Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 5 Landscape Effects (Highways Agency, 1993)
 - DMRB Interim Advice Note 135/10 (IAN 135/10) Landscape and Visual Effects Assessment (Highways Agency, 2010)
 - Guidelines for Landscape and Visual Impact Assessment Third Edition (Landscape Institute & Institute of Environmental Management and Assessment, 2013)
 - An Approach to Landscape Character Assessment (Natural England and Department for Environment, Food and Rural Affairs, 2014)

7.3. Study area

7.3.1. The land within the Proposed Scheme site boundary is hereafter referred to as 'the Site'. In recognition of the guidance given in DMRB Volume 11 Section 3 Part 5 Landscape Effects, the study area for the LVIA extends 1km from the boundary of the Site. The focus of the assessment on key issues typically associates more locally with the immediate setting of the Site.

7.4. Assumptions and limitations

- 7.4.1. Visual impacts have been considered based on a site visit to publicly accessible areas, therefore it has not been possible to validate the potential for views from all receptors.
- 7.4.2. Existing vegetation survey data was not available at the time of the Preliminary Environmental Information Report (PEIR) assessment therefore assumptions have been made about the potential extent of vegetation loss associated with the Proposed Scheme.

7.5. Baseline

Landscape character

- 7.5.1. The study area lies within National Character Area (NCA) 84; Mid Norfolk. The broadly flat, rural landscape is an ancient countryside with a long settled agricultural character but with pressures for change posed by growth, especially around Norwich. Key characteristics relevant to the study area include; the river valleys to the west of Norwich which create a more intricate landscape relative to the more typically flat, glacial till plateau; the patchwork of fields with sinuous lanes and mixed hedges with hedgerow oaks; and the fragmented mixed deciduous and pasture woodlands.
- 7.5.2. In terms of local landscape character, the study area lies within Land Use Consultants (LUC) (2008) South Norfolk Landscape Character Assessment 'C1 Yare Tributary Farmland with Parkland' and 'F1 Yare Valley Urban Fringe' Landscape Character Areas (LCA). The LUC landscape character assessment describes the Yare Tributary Farmland with Parkland LCA (which coincides with the mid and western extents of the Site) as associating with a shelving landform with a gently undulating topography created by the presence of small tributary stream valleys. It is described as being a sparsely settled landscape at an area of transition between the rural and urban landscape with small farm woodlands and intermittently wooded tributary valleys which create a quiet, rural atmosphere.
- 7.5.3. The eastern extents of the Site associate with the Yare Valley Urban Fringe local LCA characterised by areas of recent residential settlement on the perimeter of the City of Norwich at a point of transition between the Yare valley and surrounding landscape. The area is characterised by a broad semi-enclosed valley with a wide, flat flood plain and enclosing valley sides, occasionally opening up to adjoining tributary river valleys. The area is strongly influenced by modern transportation corridors, in particular the Norwich southern bypass.

Landscape features

- 7.5.4. Physical features in the immediate vicinity of the existing A47 corridor which contribute to the landscape character of the wider area include agricultural fields bounded by hedgerows and linear belts of trees. The main trunk roads, including the A47 and A11 are typically bounded by linear belts of trees and shrubs. Notable blocks of mature woodland are also located immediately adjacent to the A47 / A11 Thickthorn Junction.

Landscape designations

- 7.5.5. The majority of the context of the Site coincides with the local planning policy defined 'Norwich Southern Bypass Protection Zone' which places expectation on the preservation and enhancement of the landscape setting of the southern bypass and its associated strategic view and gateway relationships with the City of Norwich ('South Norfolk Local Plan Development Management Policies Document' adopted October 2015).
- 7.5.6. In terms of landscape designations, Intwood Hall grade II Registered Park and Garden is located to the south-east of the existing A47/A11 Thickthorn Junction, however the main visual setting associations of the hall and grounds orientate in a southerly direction, away from the Site.

Visual

- 7.5.7. The southern, eastern and western extents of the study area associate with an undulating topography and extensive areas of tree cover along the main highway corridors, within field boundaries and forming distinct blocks of woodland. Consequently, the extent of views is relatively limited and includes glimpsed views of highway infrastructure associated with the existing Thickthorn Junction, service area, park & ride facilities, high voltage overhead power lines and residential edge of Norwich. The northern extents of the study area include the potential for more extensive, open views across agricultural fields, though again influenced by the notable visual presence of high voltage overhead power lines.
- 7.5.8. The potential to experience views of the Proposed Scheme associates with occupiers of residential properties and users of the local Public Rights of Way (PRoW) network. The PRoW network includes the Tas Valley Way long distance route associated with the south-eastern extents of the Proposed Scheme area.
- 7.5.9. The potential for views from residential properties includes those on the western edge of Cringleford, a smaller grouping of residential properties at the eastern end of Cantley Lane South, residential properties at Thickthorn Hall, residential properties on Intwood Road east of Intwood Hall and more widely dispersed individual properties on Cantley Lane South and Norwich Road.
- 7.5.10. PRoW footpaths affording views across the study area include; the footpath alongside the Norwich to Ely railway line; the footpath crossing the A47 via a footbridge and linking Cantley Lane South with Cantley Lane; the footpath between Cantley Lane and Round House Park on the western edge of Cringleford; and the Tas Valley Way PRoW to the east of Intwood Hall.
- 7.5.11. Views of the Proposed Scheme will also be experienced by users of the Thickthorn Junction services and park & ride facilities, workers at Station Court

and by road users of the A47, A11, B1172, Cantley Lane / Cantley Lane South, Intwood Road and Station Lane.

7.5.12. Table 7.1 lists the main visual receptors with potential to experience views of the Proposed Scheme.

Table **Error! No text of specified style in document.** Main visual receptors

Receptor
Residential properties on the western edge of Cringleford
Residential properties at the eastern end of Cantley Lane South
Residential properties at Thickthorn Hall
Dispersed residential properties on Cantley Lane South
Dispersed residential properties on Norwich Road
Residential properties on Intwood Road east of Intwood Hall
Residents of the gatehouse and users of the vehicular entrance to Intwood Hall Registered Park and Garden
Users of the PRoW adjacent to the Norwich to Ely railway line (Hethersett footpath 6)
Users of the PRoW linking Cantley Lane to Cantley Lane South (Cringleford footpath 4)
Users of the PRoW between Cantley Lane and Round House Park (Cringleford footpath 1)
Users of the Tas Valley Way PRoW east of Intwood Hall
Users of Thickthorn Junction services and park & ride
Indoor workers at Station Court
Users of the A47 road
Users of the A11 road
Users of the B1172 road
Users of Cantley Lane/Cantley Lane South
Users of Intwood Road
Users of Station Lane

7.6. Consultation

7.6.1. Non-statutory public consultation on the Proposed Scheme was undertaken in March and April 2017. Where relevant, points arising are carried forward in the development of mitigation measures for the Proposed Scheme and will be reported in the Environmental Statement (ES).

7.6.2. A Scoping Report was submitted in February 2018, the outcome of which will guide the development of the methodology and focus of the assessment to be reported in the ES.

7.6.3. Representative viewpoints to inform the assessment of visual impacts are to be discussed and agreed in consultation with the Local Planning Authority and consequently reported in the ES.

7.7. Design interventions

7.7.1. The current Proposed Scheme layout does not accommodate any specific landscape and visual design interventions. The scope to incorporate design interventions will be considered as part of the on-going design development process and will be presented in the ES. Typical landscape and visual related interventions include minor changes in highway alignment to assist integration with existing features, the adaptation of earthworks to contribute to screening, and input to the positioning of highway elements such as lighting or signage to minimise their visual impacts.

7.8. Potential mitigation measures

7.8.1. A comprehensive environmental masterplan and subsequent detailed planting design would be produced to develop a robust landscape mitigation strategy. Potential mitigation measures would seek to reduce impacts during both the construction and operation phases. Measures would potentially include the following:

Construction

- sensitive colouring of welfare facilities and temporary office units within site compounds
- keeping a tidy and organised site
- materials delivered on an 'as needed' basis to prevent unnecessary stockpiles
- protection of retained vegetation in accordance with BS 5837:2012

Operation

- advance planting where possible
- use of screening vegetation to limit views of the Proposed Scheme
- use of native species appropriate to the local environment to aid integration with neighbouring landscape
- design of ponds for landscape and ecological enhancement
- smoothly profiled cuttings and embankments to soften earthwork grading with the surrounding landscape

7.9. Potential impacts

Construction

Landscape impacts

- 7.9.1. The removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting would potentially result in local landscape elements and character being impacted upon during construction.
- 7.9.2. The removal of existing vegetation would include a number of 'veteran trees' associated with the historic extents of the grounds of Thickthorn Hall. There would also be loss of existing mature woodland to the north of the A11 (immediately south of the Thickthorn park & ride facility) and loss of existing A47 highway boundary tree and shrub cover between Cantley Lane and the Norwich to Ely railway line. Agricultural land immediately south of the Thickthorn Junction will be lost to the footprint of the A47 to A11 link road. The construction of the A11 to A47 link road in cutting would generate a notable volume of excavated material, which would be incorporated where possible within the Proposed Scheme mitigation earthworks.
- 7.9.3. The establishment of outlying traffic management satellite construction compounds at Station Farm and Intwood would result in the temporary stripping and storage of soils and the potential localised loss of field boundary vegetation to afford access to the compounds.
- 7.9.4. The removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting, would potentially result in visual impacts on; occupiers of residential properties, recreational users of PRow, users of local service facilities and vehicle travellers.
- 7.9.5. Receptors with potential to experience visual impacts during construction include:
- residential properties on the western edge of Cringleford
 - residential properties at the eastern end of Cantley Lane South
 - residential properties at Thickthorn Hall
 - dispersed residential properties on Cantley Lane South
 - dispersed residential properties on Norwich Road
 - users of the PRow adjacent to the Norwich to Ely railway line (Hethersett footpath 6)

- users of the PRow linking Cantley Lane to Cantley Lane South (Cringleford footpath 4)
- users of the PRow between Cantley Lane and Round House Park (Cringleford footpath 1)
- users of Thickthorn Junction services and park and ride
- users of the A47 road
- users of the A11 road
- users of the B1172 road
- users of Cantley Lane/Cantley Lane South

7.9.6. The outlying traffic management satellite compounds at Station Farm and Intwood would also potentially result in localised visual impacts on receptors in the immediate vicinity of each location. This would include the potential for visual impacts on:

- residential properties on Intwood Road east of Intwood Hall
- residents of the gatehouse and users of the vehicular entrance to Intwood Hall Registered Park and Garden
- users of the Tas Valley Way PRow east of Intwood Hall
- indoor workers at Station Court adjacent to the A11
- users of Intwood Road
- users of Station Lane

Operation

Landscape impacts

7.9.7. At year one of operation, there would potentially be impacts on landscape character due to the relative prominence of Proposed Scheme infrastructure (including overbridges associated with the Cantley Lane South diversion) prior to the establishment of integrating Proposed Scheme mitigation planting. The impact would also be associated with the initial year one loss of mature tree and hedgerow landscape elements relative to the existing baseline and to the localised loss and fragmentation of agricultural land.

7.9.8. By year 15 of operation, the establishment of Proposed Scheme landscape mitigation would contribute to a reduction in the extent and magnitude of the landscape impacts. There would however remain the potential for localised landscape impacts as an outcome of the relative increase in the extent of road infrastructure.

Visual impacts

- 7.9.9. At year one of operation, prior to the establishment of Proposed Scheme landscape mitigation, there would be potential for visual impacts associated with views of the road infrastructure, including overbridges and vehicles from; occupiers of residential properties; recreational users of PRow; users of local service facilities and vehicle travellers.
- 7.9.10. Receptors with potential to experience visual impacts during year one of operation include:
- residential properties on the western edge of Cringleford
 - residential properties at the eastern end of Cantley Lane South
 - residential properties at Thickthorn Hall
 - dispersed residential properties on Cantley Lane South
 - dispersed residential properties on Norwich Road
 - users of the PRow adjacent to the Norwich to Ely railway line (Hethersett footpath 6)
 - users of the PRow linking Cantley Lane to Cantley Lane South (Cringleford footpath 4)
 - users of the PRow between Cantley Lane and Round House Park (Cringleford footpath 1)
 - users of Thickthorn Junction services and park and ride
 - users of the A47 road
 - users of the A11 road
 - users of the B1172 road
 - users of Cantley Lane/Cantley Lane South
- 7.9.11. By year 15 of operation, the establishment of Proposed Scheme landscape mitigation would contribute to a reduction in the extent and magnitude of visual impacts. There would however remain the potential for visual impacts on residential properties at the eastern end of Cantley Lane South.
- 7.9.12. There would also be potential for night time visual impacts as a result of the influence of vehicle headlights and Proposed Scheme lighting. Night time lighting impacts would reduce over time following establishment of screening afforded by Proposed Scheme mitigation planting.

7.10. Chapter summary

- 7.10.1. This chapter has summarised the current understanding of the baseline conditions, mitigation and likely anticipated impacts upon landscape character and visual amenity. Impacts on local landscape character are likely during the construction and operational phases due to the relative prominence of Proposed Scheme infrastructure (including overbridges associated with the Cantley Lane South diversion).
- 7.10.2. Visual impacts on occupiers of residential properties and recreational users of PRow are likely during both the construction and operational phases. Visual impacts during construction would be associated with the removal of existing vegetation, earthworks and construction activity. Visual impacts during operation would be associated with views of road infrastructure and vehicles.
- 7.10.3. Further work would be undertaken to develop design interventions to limit or reduce impacts and promote opportunities for the environment within the study area wherever possible. Design development and potential mitigation would be reported in the ES as well as further detailing of baseline conditions and likely changes during both construction and operation for all identified receptors.

8. Biodiversity

8.1. Introduction

8.1.1. This chapter presents the preliminary findings of the ecological impact assessment. This comprises a review of the existing environment and identification of the potential impacts of the Proposed Scheme upon surrounding ecological receptors. Consultation is identified where relevant to the content and focus of the chapter. The chapter also outlines proposed design measures to help mitigate potential ecological impact.

8.2. Guidance and best practice

8.2.1. Surveys and assessment will follow the best practice guidelines set out in:

- Surveying for Bats in Trees and Woodland – Guide, British Standards Institute (2015)
- A method for censusing upland breeding waders, Bird Study, Brown, A. F. & Shepherd K.B., (1993).
- Important Arable Plant Areas: identifying priority sites for arable plant conservation in the United Kingdom, Byfield, A. J. & Wilson, P. J. (2005).
- Ecology of the European Otter. Conserving Natura 2000, Series No. 10, English Nature,
- Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd edition. The Bat Conservation Trust, London.
- The Water Vole Mitigation Handbook (The Mammal Society Guidance Series) Mammal Society Mitigation Guidance Series.
- Bird census techniques (2nd ed.), BIBBY, C.J. et al,
- Hedgerow Survey Handbook – A Standard Procedure for Local Surveys in the UK. (2nd Ed) Defra London.
- Design Manual for Roads and Bridges: Volume 11 Section 3 Part 4: Ecology and Nature Conservation,
- Great Crested Newt Mitigation Guidelines, English Nature (2001).
- Froglife Advice Sheet 10 ‘Reptile Survey – An introduction to planning, conducting and interpreting surveys for snake and lizard conservation’. Froglife. London.
- Herpetofauna workers’ manual. Joint Nature Conservation Committee, 2003
- Surveying Badgers, An occasional publication of the mammal society Harris, S. Cresswell, P. and Jefferies, D. (1989).

- Handbook for Phase 1 Habitat Survey: A Technique for Environmental Audit, Joint Nature Conservation Committee (2010).
- BTO common bird census instructions, Marchant, J.
- Natural England, (2007). Surveying terrestrial and freshwater invertebrates for conservation evaluation (NERR005).
- Evaluating the suitability of habitat for the Great Crested Newt (*Triturus cristatus*), Herpetological Journal 10 (4), 143-155, Oldham, R. S, Keeble, J. Swan, M. J. S. and Jeffcote, M. (2000).

8.3. Study area

8.3.1. Due to the variability of species, the distance in which the Proposed Scheme could affect species can be different. The study areas used for specific ecological surveys therefore differs dependant on the survey. The study area for specific surveys can be found in Table 8.1.

Table **Error! No text of specified style in document.** Study area for each ecological receptor

Receptor	Study Area (including areas not surveyed)
International and nationally designated sites (including Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Wetlands of International Importance (Ramsar Sites), National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs).	2km from the Site.
SACs designated for bats	30km from the Site.
Statutory sites designated for birds.	10km from the Site.
Locally designated conservation sites (including Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and RSPB reserves).	2km from the Site.
Breeding and wintering birds	100m from the Site.
Habitat Suitability Index (HSI) for great crested newts <i>Triturus cristatus</i> .	500m from the Site.
Water vole <i>Arvicola amphibius</i> and otter <i>Lutra lutra</i> .	250m from the Site.
Aquatic invertebrates from within wetland sites that could be directly impacted by the Proposed Scheme.	50m from the Site.
Other preliminary ecological assessments (including badger <i>Meles meles</i> , polecats <i>Mustela putorius</i> and reptiles), hedgerows for trees and buildings that may support roosting bats.	50m from the Site.

8.4. Assumptions and limitations

8.4.1. It should be noted that the absence of certain protected or rare species from the Phase 1 habitat survey does not preclude their presence on a site. There is

always the risk of protected or rare species not being identified, either owing to the timing of the survey or the scarcity of the species at the Site.

- 8.4.2. Ecological surveys were undertaken during 2018 and will continue to be undertaken throughout 2019. An updated assessment will be included within the environmental statement (ES) once survey results have been received. Pre-construction surveys will commence in 2020 where appropriate.
- 8.4.3. Field surveys are confined to locations where landowner permission has been obtained.
- 8.4.4. During the Preliminary Roost Feature (PRF) inspection for bats, trees covered by ivy were assessed but not climbed because it was not practical to do so (i.e. the action of climbing is likely to be damaging or destructive to the potential roost locations). Where trees were considered unsafe to climb, a conservative roost suitability or risk assessment was ascribed to them.
- 8.4.5. During the badger survey, no access was made to private gardens as these are unlikely to be directly impacted by the Proposed Scheme. No access was obtained to Network Rail land in the vicinity of the A11 bridge which, where possible, was viewed from adjacent land (excluding areas of dense scrub).
- 8.4.6. During the polecat surveys, various issues may have caused cameras to miss a proportion of mammal passes. These included: condensation on lens spoiling photographs; wind blowing vegetation causing camera shutter activation and premature discharge of camera batteries; and the camera failing to capture fast moving subjects. Trail cameras can be subject to vandalism and therefore had to be securely located out of sight of the public. For this reason, no camera was deployed on the Cantley Lane footbridge over the A47.
- 8.4.7. No garden ponds within 500m of the Site (e.g. in large residential areas in Norwich) were surveyed. The possibility of a population of Great Crested Newts (GCN) within a garden pond in Norwich cannot be entirely ruled out; however, the risk is low given their absence within the Study Area. Possible garden populations of GCN are unlikely to be directly impacted by the Proposed Scheme and general precautions would be applied during construction in the unlikely event this species is encountered. There were no other limitations that may have impacted the results.

8.5. Baseline

- 8.5.1. A number of nationally and locally designated sites occur within the study area, which are presented in Table 8.2.

Table **Error! No text of specified style in document.** Summary of existing nature conservation designation sites

Designated Site	Distance from Site
Norfolk Valley Fens SAC	15km upstream but hydrologically connected via River Yare
Eaton Chalk Pit SSSI	1.5km to the east
Eaton Common LNR	1.4km to the east
Earlham Park Woods LNR	1.9km to the north
Marston Marshes LNR	1.6km to the east
Meadow Farm Meadow County Wildlife Site (CWS)	Adjacent to the Proposed Scheme
Intwood Carr CWS	400m to the east
Foxburrow Meadow CWS	1.4km to the south
Softley Drive Meadow CWS	1.4km to the north east
Riding School Meadow CWS	1.2km to the east
Eaton Island CWS	1.3km to the east
Eaton Street Meadow CWS	1.5km to the east
Bluebell Marsh CWS	1.2km to the north east
Eaton Common CWS	2.3km to the east
Marston Marshes CWS	2.5km to the east
Eaton Chalk Pit CWS	2km to the east
The Carrs Woodland CWS	2.6km to the south
Swardeston Common CWS	2.1km to the south
The Heronry and Violet Grove CWS	2.1km to the north
UEA Marsh CWS	1.6km to the north
UEA Butterfly Meadow CWS	1.6 km to the north
UEA Broad CWS	1.6km to the north
Braymeadow CWS	1.5km to the north west
Ketteringham Hall Lake CWS	1.4km to the south west

8.5.2. Cantley stream at Thickthorn flows through the Site and is a tributary of the River Yare which is hydrologically linked to Eaton Common LNR and Marston Marshes LNR. Given the links between the Proposed Scheme and Eaton Common and

Marston Marshes LNRs, these two sites have been scoped in for further assessment.

- 8.5.3. With the exception of Meadow Farm Meadow and Intwood Carr County Wildlife Sites (CWS), all of the CWSs were 700m or more from the Proposed Scheme and have been scoped out due to distance and lack of hydrological or habitat connectivity. Meadow Farm Meadow CWS is adjacent to the Proposed Scheme whilst Intwood Carr is potentially ecologically linked to the Site via a tributary of the River Yare and the habitats along the railway line and adjacent to the A47.
- 8.5.4. No SACs designated for bat populations are located within 30km of the Proposed Scheme.
- 8.5.5. Table 8.3 shows the habitats found during the extended Phase 1 habitat survey undertaken in 2017, and the species that could potentially be supported on site.

Table **Error! No text of specified style in document.** A summary of the habitats found on site during the Extended Phase 1 habitat survey and the species that may be supported on site that required further survey in 2017.

Survey Type	Date Undertaken	Habitats Found	Potential Species	Further Species Survey Date
Extended Phase 1 Habitat Survey	Mar- 16	Arable	Bats	2017
		Semi-improved grassland	Breeding birds	
		Improved grassland	Overwintering birds	
		Including semi-natural and plantation broadleaved woodland	GCN	
		Mixed plantation woodland	Badgers	
		Coniferous plantation	Reptiles	
		Scrub	Otters	
		Introduced shrub	Water voles	
		Tall ruderal	Polecat	
		Standing water	Terrestrial Invertebrates	
		Marshy grassland	Aquatic invertebrates	
		Running water	Rare and scarce flora	
		Hedgerows	Hedgehog	
Veteran trees	Terrestrial invasive non-native species			

		Ephemeral/short perennial	Aquatic invasive non-native species	
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8.5.6. A map showing ecological constraints is provided in Appendix A to show the species on site and the designated sites within 2km that have the potential to be affected by the scheme.

8.5.7. Further surveys will be undertaken to inform production of the ES.

Botanical

8.5.8. The botanical surveys have confirmed the value of the grassland of Meadow Farm Meadows CWS. This grassland is of county value, although not located within the Study Area. However, it is potentially vulnerable to surface or ground water interception and air quality impacts. Therefore, the CWS retains relevance until such time it is determined that the Proposed Scheme would be unlikely to be impacted from changes in hydrology and air quality.

8.5.9. Strong populations of two Nationally-Scarce plant species, hoary mullein *Verbascum pulverulentum* and bearded fescue, were identified in a field to the west of Meadow Farm. These populations are considered to be of district nature conservation value. These species are not dependent on long-standing, undisturbed or species-rich habitats, and instead are relatively tolerant of disturbance.

8.5.10. The margins of two arable fields can be considered to support arable plant assemblages of district nature conservation value based on established criteria. The species contributing to this are likely to be widespread in the surrounding landscape.

8.5.11. No further survey recommendations have been made regarding botany.

Hedgerows

8.5.12. The richest hedgerows surveyed contained a mean of five to six native woody species per 30m survey section, with nine of the 20 hedgerows surveyed (45%) supporting a combined total of at least six woody species. Three hedgerows contained a combined total of seven woody species in total, and one hedgerow contained eight species. The poorest hedgerows surveyed contained a mean of just two to three woody species per 30m survey section, encompassing eight hedgerows out of 20. When assessed in terms of the total number of woody species recorded, only one hedgerow had less than three species.

- 8.5.13. Four hedgerows were assessed as being important under the criteria of the Hedgerows Regulations 1997 and two hedgerows were assessed as species-rich. No further survey recommendations have been made regarding hedgerows.

Aquatic invertebrates

- 8.5.14. Four sites were sampled over the site which were directly to be impacted by the Proposed Scheme. These sites were the balancing pond, tributary of the River Yare, fishing lake and Meadow Farm Meadow Pond.
- 8.5.15. The biological quality of each site is detailed below:
- Balancing Pond – moderate.
 - Tributary of the River Yare – good.
 - Fishing Lake – moderate to good.
 - Meadow Farm Meadow Pond – moderate
- 8.5.16. The sites at the balancing pond, tributary of the River Yare and fishing lake do not meet the criteria established for the identification of sites of county value based on the aquatic macroinvertebrate assemblage. The highest overall Community Conservation Index (CCI) score indicates that the stream is of moderate conservation value and is therefore judged to be of local value.
- 8.5.17. The site at Meadow Farm Meadow Pond may meet the criteria established for the identification of sites of county value based on the aquatic macroinvertebrate assemblage and the presence of the scarce species, *Odontomyia ornate*. The overall CCI score indicates that this pond is of high conservation value and is therefore judged to remain at County value at this stage.

Bats

Preliminary roost appraisal and aerial tree inspection

- 8.5.18. Aerial tree inspections were undertaken by Highways England on 27 trees. In summary, of the 27 trees inspected, there was one tree with a confirmed roost, nine trees with moderate risk, 13 with low risk and four with negligible risk.
- 8.5.19. Dusk emergence and dawn return to roost surveys were undertaken on all features with medium and high potential to support roosting bats, and on those features with confirmed roosts.

Dusk emergence and dawn return to roost survey

- 8.5.20. No further surveys were required for trees assessed as negligible or low risk.

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- 8.5.21. Bat surveys previously undertaken, including bat emergence and re-entry surveys of trees and activity surveys have confirmed two tree roosts that are either within, or in the near vicinity to the site.
- 8.5.22. A further emergence and return to roost survey will be undertaken between May and August 2019 for one tree with a confirmed bat roost that would need to be removed. The other tree identified is 80m outside of the site boundary, would not be impacted and would not require further survey. The further survey will characterise the roost and inform the Biodiversity Chapter of the ES, an application to Natural England for a European Protected Species mitigation licence to destroy or disturb the roost and mitigation measures required.
- 8.5.23. Two transect routes were surveyed between April and October 2017 covering representative habitats within the site and a 50m buffer zone (i.e. woodland, field margins, hedges, grassland and wetlands), and static monitors were deployed at two locations per transect route.
- 8.5.24. Four areas consistently had relatively higher activity with multiple bats and a greater range of species. These were:
- woodland west of the Thickthorn services
 - Cantley Lane both north and south of the A47
 - woodland edge, track and stream east of A11
 - fishing lakes
- 8.5.25. Seven species of bats were recorded using the Site. These comprised common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle *Pipistrellus pygmaeus*, Daubenton's *Myotis daubentonii*, noctule *Nyctalus noctula*, brown long-eared *Plecotus auritus*, serotine *Eptesicus serotinus* and barbastelle *Barbastella barbastellus*. There were possibly other *Myotis* bat species and Leisler's *Nyctalus leisleri* present based on static detector records, but these could not be confirmed based on the recordings made (e.g. a few faint recordings and the difficulty of separating *Myotis* bat species from echolocation alone) and also their absence during the transect surveys. There was a range of activity (including foraging, commuting and socialising) with mainly individual bats recorded throughout the Site.
- 8.5.26. Large numbers of bats were recorded commuting from housing to the east of Cantley Lane to forage along Cantley Lane. Bats were recorded flying through the A11 underpass and foraging in woodland either side of the A11 and the A47. The track from the A11 underpass to Cantley Lane South adjacent to the mature woodland was regularly used by bats including a few records of barbastelle (the rarest species recorded). All these habitats should be retained where possible and kept unlit at night.
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Badgers

- 8.5.27. The surveys previously undertaken in January 2017 resulted in no evidence of badger activity being found. However, a disused badger sett was found during the polecat survey in January 2018 in an area adjacent to the site.
- 8.5.28. Camera trapping surveys are currently ongoing in various locations on Site. One camera recorded one badger on Site, giving evidence that badgers do utilise the Site.
- 8.5.29. Badger surveys will be updated in 2019 to inform the ES. Where appropriate, preconstruction surveys for badger will be undertaken from 2020. Should a badger sett be found within the site or within 30m of it, it may be necessary to apply for a licence to interfere with a badger sett for the purpose of development from Natural England, in order for works to continue.

Breeding bird surveys

- 8.5.30. Breeding bird surveys were undertaken from April to June in 2017. A total of 50 species were recorded as likely to be breeding within or close to the site, of which:
- seven were Birds of Conservation Concern (BoCC) red list species
 - seven were BoCC amber list species
 - seven of the above were NERC Act Section 41 species
- 8.5.31. Thirty-three species were birds of conservation concern (BoCC) green list, and three species are not assigned a conservation status.
- 8.5.32. Bird surveys have identified the Schedule 1 barn owl *Tyto alba* breeding close to Thickthorn Hall approximately 500m to the west of the Site. It is likely that the Site is used by hunting barn owls. Red kite *Milvus milvus* has been recorded on the Site and kingfisher *Alcedo atthis* is breeding at the fishing lake close to the rail line. In addition, hobby *Falco subbuteo* was recorded on three occasions during the surveys and breeding may have occurred in the vicinity of Lilac Plantation to the south-east of the Proposed Scheme.
- 8.5.33. Depending on timing of works a breeding bird survey update would be required for Schedule 1 species, red kite, hobby, barn owl and kingfisher in the year prior to and during the year of construction to inform stand-off buffer zones for these species found breeding in specific areas of the Site.

Overwintering birds

- 8.5.34. Surveys were undertaken between January and March 2017 in all accessible land within the site, plus a 100m buffer.
- 8.5.35. Forty-six species were recorded during the three wintering bird surveys between January and March 2017 of which:
- Nine were BoCC red list species
 - Nine were BoCC amber list species
 - Five of the above were NERC Act Section 41 species
- 8.5.36. Twenty-seven species were birds of conservation concern (BoCC) green list, and one species is not assigned a conservation status.
- 8.5.37. Bird numbers and the species recorded are mostly typical woodland and farmland species, although the Schedule 1 species, redwing *Turdus iliacus*, was seen in each month of survey.
- 8.5.38. Overwintering bird surveys took place over the winter of 2018/19 in order to complete the data set so that data is collected in each winter month. The survey methodology (times, durations, survey locations, recording methods, acceptable weather conditions etc.) will replicate that used to date.

Great Crested Newt

- 8.5.39. Habitat Suitability Index (HSI) assessments indicated that there are five ponds within the ZOI that were potentially suitable for breeding GCN. However, subsequent environmental DNA (eDNA) surveys returned negative results.
- 8.5.40. GCN are therefore likely absent from the survey area and have been scoped out of further detailed assessment.

Reptiles

- 8.5.41. Reptile surveys undertaken throughout 2017 have confirmed the presence of a low population of grass snake on Site with adults found in fields to the west of the A11. Common lizard has been found to the east of the A11.
- 8.5.42. No further surveys are recommended for reptiles as a full and up-to-date data set has previously been collected.

Water voles and otters

- 8.5.43. Water vole surveys have confirmed the presence of this species with extensive water vole activity along Cantley Stream between A11 underpass and Cantley Lane. Evidence of otter *Lutra lutra* activity has also been found.
- 8.5.44. The mobile nature of these species (particularly otter), the high levels of protection, and the need for dedicated mitigation and potential licensing means that surveys will be undertaken from April to September 2019.

Polecats

- 8.5.45. During the Extended Phase 1 habitat survey, a dead European polecat was found approximately 1.5km north of the Site along the A47.
- 8.5.46. Surveys for polecats were then undertaken, which occurred in areas of suitable polecat habitat within the Zone of Influence (ZOI) from August – September 2017.
- 8.5.47. Polecat surveys during August and September 2017 have not found any evidence of presence.
- 8.5.48. However, the limitations outlined in Section 1.3 mean that these surveys should be repeated so that presence or likely absence can be determined. Surveys are currently on-going.

Terrestrial invertebrates

- 8.5.49. Surveys for terrestrial invertebrates recorded 596 species from seven survey visits. Four species of category Nationally Rare (Red Data Book) status were recorded; the ground beetle *Omophron limbatum*, the rove beetles *Cypha seminulum* and *Tachinus flavolimbatus* and the Five-banded Weevil-wasp *Cerceris quinquefasciata*. The last species is also a Biodiversity Action Plan (BAP) Priority Species, covered under Section 41 of the NERC Act (2006) and it prefers sparsely-vegetated ground with exposed sandy tracts. In addition, 18 species of Nationally Scarce status were identified.
- 8.5.50. Noteworthy invertebrate assemblages were identified in the rabbit-grazed short sward grassland areas of the site. Other noteworthy fauna were also identified from smaller, less significant habitat-blocks in the survey such as the wetland areas and the hedge-lines. The plantation blocks, semi-natural woodland and improved grassland and pasture were found to be unexceptional for their invertebrate interest.

8.5.51. Overall, the Site significance for invertebrates is only of local significance, but the presence of the scarce species assemblages and their associated habitats will be considered in the Biodiversity Chapter within the ES.

Invasive non- native species

8.5.52. Invasive non-native species results will be updated during other ecological surveys undertaken in 2019.

8.5.53. No invasive species have been found to date within the Site.

8.5.54. Invasive non-native species results will be updated during other ecological surveys undertaken in 2019.

Habitat Regulations Assessment

8.5.55. A Habitats Regulations Assessment (HRA) Screening Report was undertaken in July 2017 to determine whether any adverse impacts on International or European Designated Sites (the Norfolk Valley Fens SAC via the River Yare). The HRA screening concluded that there is not the potential for an adverse impact on the habitats and species which are a qualifying reason for selection of the European site due to distance from the Proposed Scheme.

Valuation of ecological receptors

8.5.56. A summary of the valuation of ecological receptors relevant to the Proposed Scheme is provided in Table 8.4.

Table **Error! No text of specified style in document.** Summary of valuation of ecological receptors

Ecological receptor	Valuation
Norfolk Valley Fens SAC	International
Eaton Chalk Pit SSSI	National
Eaton Common LNR, Earlham Park Woods LNR, Marston Marshes LNR	Local
Meadow Farm Meadow CWS, Intwood Carr CWS, Foxburrow Meadow CWS, Softley Drive Meadow CWS, Riding School Meadow CWS, Eaton Island CWS, Bluebell Marsh CWS, Eaton Street Meadow CWS, Eaton Common CWS, Marston Marshes CWS, Eaton Chalk Pit CWS, The Carrs Woodland CWS, Swardston Common CWS, The Heronry and Violet Grove CWS, UEA Marsh CWS, UEA Butterfly Meadow CWS, UEA Broad CWS, Braymeadow CWS, Ketteringham Hall Lake CWS	County/Unitary Authority Area
UKBAP Priority habitats – Coastal and floodplain grazing marsh, deciduous woodland, lowland fens, lowland meadows, traditional orchard, wood-pasture and Parkland, no main habitat but additional habitats present, semi-natural broadleaved woodland standing water, sp. rich and important hedgerows, arable field margins and good-quality semi-improved grassland within and adjacent to Site Boundary.	National

Ecological receptor	Valuation
Introduced shrub - within and adjacent to Site Boundary	Negligible
Ephemeral/short perennial - within and adjacent to Site Boundary.	Negligible
Scrub - within and adjacent to Site Boundary.	Negligible
Scattered trees – within and adjacent to Site Boundary.	Local
Grasslands (improved, marshy) – within and adjacent to Site Boundary.	Local
Tall ruderal – within and adjacent to Site Boundary.	Negligible
Running water - within and adjacent to Site Boundary.	Local
Hedgerows - sp. poor within and adjacent to Site Boundary.	Local
Plantation woodland – broadleaved, coniferous, within and adjacent to Site Boundary.	Local
Buildings - within and adjacent to Site Boundary.	Negligible
Plants – hoary mullein	Local
Terrestrial Invertebrates - within and adjacent to Site Boundary.	Local
Aquatic Invertebrates – within and adjacent to Site Boundary.	Local to County
Birds – within and adjacent to Site Boundary.	Local
Birds – within and adjacent to site boundary (Schedule 1)	County
Birds – Broadlands SPA; Breydon Waters SPA.	International
Bats - Paston Great Barn SAC.	International
Bats – within and adjacent to Site Boundary.	County
Badgers – within and adjacent to Site Boundary.	Negligible (Legal constraints apply)
Polecat - within and adjacent to Site Boundary.	County
Great Crested Newt – >500m outside Site Boundary	Negligible
Otters - within and adjacent to Site Boundary.	Local
Water vole – within the stream running through the Site	Local
Reptiles - within and adjacent to Site Boundary.	Local
Veteran trees - within and adjacent to Site Boundary.	Local

8.6. Consultation

8.6.1. Non-statutory public consultation on the Proposed Scheme was undertaken in March and April 2017. Where relevant, points arising are carried forward in the

development of mitigation measures for the Proposed Scheme and would be reported in the ES.

- 8.6.2. A Scoping Report was submitted in February 2018, the outcome of which will guide the development of methodology and focus of the assessment to be reported in the ES.
- 8.6.3. Detailed consultations have yet to be undertaken with various statutory and non-statutory bodies including Natural England, Environment Agency, Norfolk Council, Norfolk Wildlife Trust and the RSPB. These organisations will need to be consulted fully during the environmental impact assessment and their responses will be included in the associated reporting.
- 8.6.4. The Highways England project management team also consider that further engagement will be required with the following bodies before the application is submitted:
- Norfolk Biodiversity Information Service (NBIS).
 - Norfolk local bat recorder
 - Norfolk local badger recorder
 - Norfolk Amphibian and Reptile Group
 - Local Mammal Group
 - RSPB Norfolk Local Group
 - Bird Trust for Ornithology
 - Norfolk Ornithologists Association
 - Raptor Trust
 - Norfolk Biodiversity Partnership
 - Norfolk Amateur Entomologists Society
 - Norfolk Moths
 - Norfolk Flora Group
 - Norfolk County Council
 - The Barn Owl Trust
- 8.6.5. Consultation will be undertaken with Natural England to discuss the findings of the Habitats Regulations Assessment Screening Report that is to be updated in 2019.

8.7. Design interventions

8.7.1. A number of measures are included in the Interim Advice Notes to guide the design process and identify mitigation requirements. However, these measures are not an exhaustive list and the scope to incorporate design interventions will be considered as part of the ongoing design development and be reported in the ES.

- Badger fencing to ensure badgers can gain access to the wider surrounds without having to resort to the Highway estate (such as the A47 verges). This will be confirmed following the completion of the 2019 badger surveys. This could be augmented with the planting of hedgerows to direct the animals to other suitable habitat within the wider landscape.
- Providing compensatory habitat to replace and enhance upon what would be lost, including arable field margins, hedgerows and trees.
- Minimising loss of valuable semi natural habitats and maintain habitat connectivity where possible. Where habitat loss is inevitable, replacement habitats to be provided, providing habitat connectivity where possible, for example, using bat hops where roads sever known bat flight paths.
- Considerate design, such as the use of drainage infrastructure that is designed to avoid trapping amphibians and the design of balancing ponds to minimise risks to wildlife during the operational phase, as maintenance operations have potential to cause harm to animals that colonise the ponds.

8.7.2. Minimising illumination where possible and ensuring that any lighting that is necessary is directed and localised to prevent detrimental impact to habitat quality and function.

8.8. Potential mitigation measures

Construction

Habitats

8.8.1. Minimising loss of valuable semi-natural habitats and maintain habitat connectivity where possible. Where habitat loss is inevitable, replacement habitats to be provided, providing habitat connectivity where possible.

8.8.2. There is scope for the creation of habitats such as reptile refugia, a kingfisher nest, species-rich arable field margin vegetation and south-facing banks and sparse vegetation areas for invertebrates.

Breeding birds

- 8.8.3. Mitigation for breeding birds is likely to include scheduling the vegetation removal works to be outside of the breeding bird season (which spans from March to August inclusive).

Badger

- 8.8.4. Badger specific mitigation may be required and may include, but is not limited to (under a derogation licence where appropriate):
- covering trenches at night (or providing escape ramps)
 - no night working (or appropriate lighting restrictions)

Polecats

- 8.8.5. Polecat mitigation may be required and may include general mitigation for small mammals:
- covering trenches at night (or providing escape ramps)
 - no night working (or appropriate lighting restrictions)

Otter

- 8.8.6. Specific mitigation may be needed, mitigatory and compensatory measures such as:
- pollution prevention and sediment control measures to ensure a continued food source
 - covering trenches at night (or providing escape ramps)
 - no night working (or appropriate lighting restrictions)

Water vole

- 8.8.7. Specific mitigation may be needed under a Natural England Displacement Licence with mitigatory and compensatory measures such as:
- covering trenches at night (or providing escape ramps)
 - no night working (or appropriate lighting restrictions)

Terrestrial invertebrates

- 8.8.8. It may be necessary to work under protected species mitigation licences, for example for badger, water vole and bats. Other species not protected directly but considered priority species will require works to be undertaken in accordance with non-licensed mitigation strategies, for example reptiles.

Operation

Bats

8.8.9. Specific bat mitigation will likely be required to some extent, this may include (under derogation licence where appropriate):

- creating, restoring or improving roosts (i.e. bat boxes, bat bricks in new or existing bridges)
- creating, restoring or improving habitats including foraging areas and flight corridors

Over-wintering birds

8.8.10. Mitigation for wintering birds is likely to include retention of important habitats where possible such as favoured, open arable habitats, and the creation of lost habitats such as replacing woodland and hedgerows.

Badger

8.8.11. Badger specific mitigation may be required and may include, but is not limited to (under a derogation licence where appropriate):

- artificial setts (no active setts found within 50m to date)
- badger fencing
- maintaining badger foraging and watering areas
- creating new areas if needed

Polecats

8.8.12. Polecat mitigation may be required and may include general mitigation for small mammals:

- restoring or improving habitats to compensate for those that will be lost

Otter

8.8.13. Specific mitigation may be needed, mitigatory and compensatory measures such as:

- restoring or improving habitats to compensate for those that will be lost
- use of viaducts or underpasses to allow otters to cross barriers (i.e. the A47)
- installing mammal ledges on bridges and culverts
- constructing artificial holts to replace those that will be damaged or removed (none found to date)

Water vole

8.8.14. Specific mitigation may be needed under a Natural England Displacement Licence with mitigatory and compensatory measures such as:

- restoring or improving habitats to compensate for those that will be lost
- pollution prevention and sediment control measures to ensure a continued food source

Aquatic invertebrates

8.8.15. Specific mitigation may be needed, mitigatory and compensatory measures such as:

- Restoring or improving habitats to compensate for those that will be lost
- Pollution prevention and sediment control measures to ensure a continued food source

Terrestrial invertebrates

8.8.16. Mitigation for terrestrial invertebrates is likely to include retention of important habitats where possible such as favoured, open arable habitats, and sand and gravel pits, and the creation of lost habitats such as replacing woodland and hedgerows.

8.9. Potential impacts

8.9.1. No direct impacts are anticipated on any statutory designated sites.

8.9.2. Direct impacts are anticipated on a non-statutory designated site (Meadow Farm Meadow CWS). These include habitat loss and increased levels of disturbance to protected species associated with the CWS. This may be characterised as of certain, moderate adverse significance. The impact may be mitigated by measures such as:

- Habitat replacement and/or habitat improvement
- Timing of works to avoid sensitive periods for associated species

Construction

8.9.3. The construction impacts of the Proposed Scheme on ecological receptors after mitigation are described as follows:

- temporary loss and disturbance of hedgerows
- pollution of watercourses

- impact of natural habitats through construction of Site compounds and access tracks
- disturbance or destruction of bat roosts
- disturbance of farmland birds and their habitat
- potential loss of habitat connectivity due to the Proposed Scheme land take, and, in addition, some species finding it more dangerous to cross the new roads (birds, hedgehogs).

Operation

8.9.4. The operation impacts of the Proposed Scheme on ecological receptors after mitigation in Section 8.8 and their significance are described as follows:

- loss of bat foraging habitat with loss of arable land/ light disturbance
- potential loss of connectivity due to road being wider and some species finding it more dangerous to cross (birds, hedgehogs)
- permanent loss of other habitats
- change in hydrology to impact boundary features
- potential for direct mortality of badgers / loss of foraging habitat / light disturbance
- potential for direct mortality of otters
- disturbance and direct mortality of bats crossing the road

8.10. Chapter summary

- 8.10.1. This chapter has summarised the current understanding of the baseline conditions, mitigation and likely anticipated impacts upon ecological receptors. There are valuable habitats and species present of nature conservation importance which could be impacted by the Proposed Scheme.
- 8.10.2. The on-going ecological surveys will help identify mitigation measures to reduce the magnitude of impacts through sensitive design and construction methodologies, with a view to safeguard the conservation status of populations through both the construction and operational phases.
- 8.10.3. Mitigation in the form of pollution prevention, Ecological Clerk of Works (ECoW) presence during vegetation clearance and retained and enhanced habitat is recommended to reduce impacts to levels not considered to be significant. Specific mitigation measures for protected species will be finalised within the Biodiversity Chapter of the ES following the proposed protected species surveys.
- 8.10.4. A number of measures have been identified in the Interim Advice Notes to guide the design process and identify mitigation requirements. However, these

measures are not an exhaustive list and are likely to require a review and additional measures following completion of the survey and design work.

9. Geology and soils

9.1. Introduction

9.1.1. This chapter presents the preliminary findings of the geology and soils assessment. This comprises a review of the existing environment and identification of potential impacts of the Proposed Scheme upon surrounding land. The chapter also outlines proposed design measures to help mitigate these potential impacts and relevant consultation.

9.2. Guidance and best practice

9.2.1. The main legislative framework regarding geology and soils (including contaminated land) includes the following legislation, guidance and best practice:

- The Contaminated Land (England) (Amendment) Regulations 2012
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015
- The Environmental Permitting (England and Wales) Regulations 2016
- The Environmental Permitting (England and Wales) (Amendment) Regulations 2018
- The Environmental Protection Act 1990 (as amended by the Environment Act 1995)
- The Water Resources Act 1991 (England and Wales) (Amendment) Regulations 2009
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- Design Manual for Roads and Bridges (DMRB) Volume 11 Section 2 Part 5 Assessment and Management of Environmental Effects, Chapter 2 (Highways Agency, 2008)
- Code of Practice for the Sustainable Use of Soils on Construction Sites, Defra 2009
- Contaminated Land Risk Assessment – A Guide to Good Practice C552 (CIRIA, 2001)
- CLR 11: Model procedures for the management of land contamination. Environment Agency / Defra, 2004
- Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. Environment Agency, 2001;
- DMRB Volume 11, Section 3, Part 6 (Land Use) (Highways Agency 2001)

9.3. Study Area

- 9.3.1. The study area for this assessment considers all locations where physical works and ground disturbance will take place, and in addition extends to 1km beyond this in order to identify any past pollution incidents which may have affected soil within the works area.
- 9.3.2. DMRB guidance does not provide a set definition of the study area for assessing the effects on agriculture and farm viability. Therefore, the study area has been based on professional judgement and includes all farms, farm access routes, important agricultural infrastructure and agricultural land within the site.

9.4. Assumptions and limitations

- 9.4.1. With regards to land quality and contaminated land, it should be noted that there are uncertainties and data limitations concerning geochemical makeup, and the characteristics of surface water and groundwater.
- 9.4.2. There is limited data available concerning the operation of the former Cantley Lane landfill site. No information has been obtained in relation to the extent, depth, distribution and current condition of the deposited waste materials, leachate or ground gas concentrations, or the presence or otherwise of any pollution control measures.

9.5. Baseline

Determining baseline conditions

- 9.5.1. A desk top review of available geological, soils, historical Ordnance Survey and agricultural maps along with previously published reports and ground investigations were reviewed along with previous site walkover information. This includes evaluation of information from the Highways Agency Geotechnical Data Management System (HAGDMS).
- 9.5.2. A site walkover survey was undertaken in November 2017 to determine the accuracy of desk study information, and also to identify sites worthy of further investigation.

Designated sites

- 9.5.3. There are no designated sites, for example Site of Special Scientific Interest (SSSI) or Geological Conservation Review Sites, within the study area that are designated for their geological or geomorphological importance. However, the proposed road works do fall into the wider SSSI Impact Risk Zones designated

around a number of SSSIs mainly relating to chalk pits or ecological systems feeding from the Chalk aquifer.

Artificial ground

- 9.5.4. Artificial ground is likely to exist in a former gravel pit located within Cantley Wood, west of Cantley Lane. This was subsequently utilised as a landfill site (Landmark Information Group, 2017).
- 9.5.5. An historical landfill site at Cantley Wood (Cantley Lane Landfill) is recorded on old Ordnance Survey (OS) plans and by the Environment Agency north of Cantley Stream close to where it is culverted below the A11 adjacent to the eastern edge of the A11(618,161.75E; 304,971.25N). Cantley Lane landfill was operated between 1961 and 1969 receiving inert, industrial, commercial and household wastes. There are no records of any monitoring data or any details of environmental / pollution control measures (e.g. landfill liner or peripheral gas vent trench).

Superficial deposits

- 9.5.6. The anticipated superficial geology underlying the site is comprised of local deposits of alluvium overlying glacial deposits of the Lowestoft Formation - diamicton, and Sheringham Cliffs Formation - sand and gravel, (British Geological Survey (BGS, 2017).

Bedrock geology

- 9.5.7. The superficial deposits are underlain by chalk of the White Sub-Group, formerly known as the Upper Chalk Formation (BGS, 2017).

Mineral resource

- 9.5.8. There are no active mines or quarries within the study area. A review of historical maps has shown the presence of disused sand pits and gravel quarries (BGS, 2017).

Agricultural viability

- 9.5.9. Land use within the study area predominantly comprises agricultural uses (mainly arable production) and hardstanding. Smaller parcels of land are generally perceived to be used as permanent pasture, parkland and woodland and therefore these smaller spaces indicate little agricultural viability.
- 9.5.10. The quality of the agricultural land is yet to be determined as no detailed Agricultural Land Classification (ALC) surveys have been undertaken to date. There have been four ALC investigations into sites surrounding the Site which

can be used as a proxy to inform the baseline assessment. This approximation can be supported in part by information from Natural England's 1:250,000 ALC map for the eastern region.

- 9.5.11. The historic ALC surveys indicate that the baseline land classifications within the study area are likely to be Grades 2, 3a and 3b. Natural England's (2010) 1:250,000 ALC map for the eastern region indicates Grade 2 land in the area, supporting the historical investigations.
- 9.5.12. Grades 2 and 3a agricultural land is classified as 'best and most versatile' land by Defra standards and is considered a national resource.

Farm severance

- 9.5.13. There are several parcels of agricultural land, of differing size (mostly small fields and parcels of land), within the study area. Access tracks to these fields are also present and are predominately located off side roads. The identification of these features indicates that there is the potential for impacts from the Proposed Scheme where access routes are severed, as this may adversely affect the viability of farm holdings.

Contamination and contaminated land

- 9.5.14. The assessment of contaminated land takes account of the 'source-pathway receptor' (S-P-R) approach which seeks to establish the potential for a link between a source of contamination and a receptor which may constitute a risk.

Potential contamination sources

- 9.5.15. The following potential contamination source has been identified from a review of historical maps and other sources of information:
- S1: Cantley Lane landfill site located in a former gravel pit at Cantley Wood. Operational between 1961 and 1969.

Potential contamination transport pathways

- 9.5.16. The following potential migration pathways have been identified:
- P1: Horizontal and vertical migration of leachate through potentially permeable soils and geological formations
 - P2: Migration of contaminants along engineered preferential pathways, e.g. underground services, pipes, tunnels and drainage pathways both surface and culverted
 - P3: Surface runoff along roads, pavements, cutting faces etc.
 - P4: Root uptake
-