Norwich Western Link

Information to Inform a Habitats Regulations Assessment

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1 Introduction

1.1 Overview

1.1.1 This document provides an assessment of impacts and effects of the Norwich Western Link (NWL) scheme on statutory designated sites of internation importance, as mandated by the Conservation of Habitats and Species Regulations 2017.

1.2 Project background

1.2.1 NWL is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

1.2.2 The NWL, hereafter referred to as the Proposed Scheme, would comprise:

- Dualling the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 400m to the north-west.
- Construction of a new roundabout.
- Constructing a dual carriageway link from the new roundabout to a new junction with the A47 near Honingham.

1.2.3 As part of a separate planned scheme, National Highways proposes to realign and dual the A47 from the existing roundabout at Easton to join the existing dual carriageway section at North Tuddenham. The A47 scheme received development consent in August 2022 and National Highways will construct the Honingham junction and the Norwich Western Link would connect to the north-eastern side of that junction.

1.2.4 The Proposed Scheme would cross the River Wensum and its flood plain by means of a viaduct. In addition, six other structures are proposed to cross minor roads and to provide habitat connectivity. The Proposed Scheme would include ancillary works such as provision for non-motorised users, necessary realignment of the local road network, including the stopping up of some minor roads, and the provision of environmental mitigation measures.

1.2.5 The ‘Red Line Boundary’ is used throughout this document and refers specifically to the extent of land required for the construction of the Proposed Scheme. It covers all areas of land required temporarily or permanently for the construction and operational activities of the Proposed Scheme, and also includes off-site areas away from the main carriageway works to provide required environmental mitigation, and complementary measures for the Proposed Scheme. The Red Line Boundary is illustrated in Environmental Statement Appendix 3.3 Figure 3.1: Red Line Boundary and Site Boundary Plan.

1.3 Purpose of this report

1.3.1 The Proposed Scheme lies to the north-west of the city of Norwich and crosses one Special Area of Conservation (SAC), with further SACs in the wider area; these statutory designated sites of international importance are hereafter collectively known as ‘Habitats Sites’. There are no candidate SACs (those proposed for designation as SACs and submitted to the European Commission before the end of the Transition Period following the UK's exit from the EU, but not yet formally designated), proposed SACs, proposed SPAs or proposed Ramsar sites in the Study Area (see section 4.1 below).

1.3.2 Habitats Sites are statutory designated sites of importance to nature conservation that are protected by the Conservation of Habitats and Species Regulations 2017 (as amended). Under this legislation ‘Competent Authorities’ must assess Plans and Projects for their potential to cause ‘Likely Significant Effects’ (LSEs) on Habitats Sites in accordance with the recent December 2023 update of the National Planning Policy Framework (NPPF). The assessment process is commonly referred to as Habitats Regulations Assessment (HRA).

1.3.3 This report aims to provide the Competent Authority with the information it needs to inform an assessment of LSEs associated with the Proposed Scheme on Habitats Sites, to make an appropriate assessment of the implications of the Proposed Scheme on Habitats Sites in view of the sites’

conservation objectives, and whether mitigation balances these effects. HRA proceeds in stages which are described in Section 3.3. This report covers an initial screening assessment (Stage 1) followed by Appropriate Assessment (Stage 2), and also determines whether further HRA stages (Stage 3 and 4) need to be applied to achieve compliance with legislation.

1.3.4 This report supports a planning application to gain consent under the Town and Country Planning Act (1990) from the County Planning Authority (in its role as Competent Authority) for construction and operation of the Proposed Scheme.

2 Description of the Proposed Scheme

2.1 Overview

2.1.1 This section provides a description of the Proposed Scheme from north to south. Chapter 3 Description of the Scheme, describes key elements (such as structures, drainage etc.) in further detail.

2.1.2 The Proposed Scheme is illustrated on General Arrangement (GA) Plans (Document Reference 2.03.00).

2.1.3 An existing roundabout on the A1270 Broadland Northway will be upgraded and form the northern extent of the Proposed Scheme. In addition, approximately 340m of the A1067 Fakenham Road will be upgraded to dual carriageway standard and a new roundabout junction constructed on the A1067 from which the start of the new dual carriageway standard road. A shared pedestrian and cycle route is proposed alongside the A1067, between the A1270 roundabout and Attlebridge Restricted Byway 4 to the west.

2.1.4 Moving south from the A1067, the Proposed Scheme will be a dual carriageway standard of new road that will cross the River Wensum and its flood plain by means of a viaduct. The viaduct will span the River Wensum, a Special Area of Conservation, with the piers being sited at least 9m away from the top of the River Wensum riverbank. The design of the viaduct structure

would be a ten-span single-deck bridge with a reinforced concrete deck slab. The viaduct is approximately 490 metres in length and varies in height from approximately 6 – 13 metres from existing ground level to the underside of the deck. The viaduct will be constructed using a Temporary Works Platform in the construction phase. The Temporary Works Platform is described in Section 3.5.

2.1.5 A maintenance access track will run adjacent to the viaduct in the floodplain, to allow maintenance access to the viaduct structure once the Proposed Scheme is operational. A floodplain ditch will be culverted under the maintenance access track. The maintenance access track continues south in parallel to the new carriageway and joins Ringland Lane. The maintenance access track north of the river is accessed from the Proposed Scheme/A1067 roundabout for maintenance vehicles only.

2.1.6 In the floodplain to the west of the viaduct there will be essential environmental mitigation such as ditch improvement for water vole and improvements to the floodplain ditch network and River Wensum as part of the Water Framework Directive (WFD) requirement to improve the natural process of the water environment.

2.1.7 South of the viaduct, the north and southbound carriageways pass through the northern woodland (the northern woodlands are a complex of woodland areas that will be severed by the road) with a slight separation of the carriageways in this section. The carriageway will be in cutting at this location with a retaining wall in proximity to the Primrose Grove Ancient Woodland. An overbridge (the Nursery Woodland green bridge) will span the Proposed Scheme as it passes through the northern woodland to maintain wildlife connectivity between the woodland. The Nursery Woodland green bridge is located to be aligned to existing bat flightlines.

2.1.8 The existing single lane width side road Ringland Lane crosses below the Proposed Scheme via an underpass. This allows continued use during

operation and provides an underpass feature for bats, tying into landscape planting.

2.1.9 There will be a second green bridge between Ringland Lane and Church Hill Lane (known locally as Weston Road). This green bridge (known as the Morton green bridge) includes a Public Right of Way (PRoW) (a new Bridleway) and landowner vehicular access provision across the Proposed Scheme. Weston Road is to be severed at the point at which it is crossed by the Proposed Scheme, with turning heads provided to accommodate U-turns. Vehicular access will be maintained for existing properties, businesses, and agricultural land, with access restrictions at either end. Non-Motorised Users (NMUs) would be diverted across the Morton green ridge. The surface treatments for the NMU provision are outlined in the paragraph 6.2.27 of the Sustainable Transport Strategy (Document Reference: 4.02.00).

2.1.10 Moving south along the route as the Proposed Scheme crosses Breck Road (also known as Breck Lane) and The Broadway, these roads will be intersected by the Proposed Scheme. The Broadway and Breck Road will be closed to through traffic and NMUs will be diverted to a new green bridge (the Broadway green bridge) carrying a public bridleway crossing over the Proposed Scheme between Weston Road and Ringland Lane and providing access for landowner vehicles. Vehicular access will be provided to adjacent private land.

2.1.11 Further south the Proposed Scheme passes through Foxburrow Plantation where the fourth overbridge spans the Proposed Scheme (the Foxburrow Plantation green bridge). Adjacent to this, the Foxburrow stream (a tributary of the River Tud) will pass under the Proposed Scheme via a culvert. The Tributary of the Tud Culvert also serves as a bat underpass. The Proposed Scheme then connects to the new junction of the A47 dualling scheme being delivered by National Highways. The Proposed Scheme includes construction of the spur and connection to the A47 roundabout. The remainder of the junction is being constructed by National Highways under its A47 North Tuddenham to Easton DCO.

2.1.12 The Proposed Scheme would include ancillary works such as provision for NMUs, laybys, police observation platforms, necessary amendments to the local road network, including the stopping up of some minor roads, and habitat creation.

2.1.13 The Proposed Scheme is generally to remain unlit, with the exception of a minimal number of lighting columns at the southern extent of the Proposed Scheme, leading to the junction with the re-aligned A47. It is also proposed that signage lighting would be required at junctions.

2.1.14 Landscape Design Plans (Reference 2.07.00) have been developed for the highway verges to integrate the Proposed Scheme into the landscape and include environmental objectives such as landscape integration, habitat creation and visual screening. Sloped earth bunds between 2-5m high are included either side of the Proposed Scheme where appropriate to contribute to visual screening scheme from local receptors, these would feature landscape planting.

2.1.15 A Drainage Strategy (**Document Reference 2.08.00**) and illustrative drainage design (also **Document Reference 2.08.00**) has been developed as part of the Proposed Scheme to collect surface water from the carriageway. A combination of Sustainable Drainage Systems (SuDS) features would be designed into the Proposed Scheme to provide mitigation for the potential effect of increases in physical contamination (i.e. sedimentation) of surface water bodies. Whilst the drainage strategies would primarily aim to mitigate the potential impacts upon groundwater and surface water, a number of these features would also create valuable wetland habitats for notable and protected species.

2.2 Aims of the Proposed Scheme

2.2.1 The objectives of the Proposed Scheme, are as follows:

High-level objectives

- Support sustainable economic growth;

- Improve the quality of life for local communities;
- Promote an improved environment; and
- Improve strategic connectivity with the national road network.

Specific objectives

- Improve connectivity and journey times on key routes in Greater Norwich;
- Reduce the impacts of traffic on people and places within the western area of Greater Norwich;
- Encourage and support walking, cycling and public transport use;
- Improve safety on and near the road network, especially for pedestrians and cyclists;
- Protect the natural and built environment, including the integrity of the River Wensum SAC; and
- Improve accessibility to key sites in Greater Norwich.

3 HRA Process and Appropriate Assessment

3.1 Habitats regulations assessment

3.1.1 The National Planning Policy Framework (NPPF) as updated in December 2023 defines that any site within the definition at regulation 8 of the Conservation of Habitats and Species Regulations 2017 (hereafter referred to as the Habitats Regulations), including candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, Special Protection Areas and any relevant Marine Sites as a 'Habitats Site'. The Habitats Regulations also protect a National Site Network of these sites.

3.1.2 Maintaining a coherent network of protected sites with overarching conservation objectives is still, following the UK's departure from the European Union, required in order to:

- Fulfil the commitment made by government to maintain environmental protections; and
- Continue to meet the UK's international legal obligations, such as the Bern Convention, the Oslo and Paris Conventions (OSPAR), Bonn and Ramsar Conventions.

3.1.3 The NPPF sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development (for the purposes of this assessment the Proposed Scheme is considered to be a development) can be produced. It must be taken into account in preparing the development plan and is a material consideration in planning decisions.

3.1.4 The NPPF states, in paragraph 187, that listed or proposed Ramsar sites, potential SPAs (pSPA), possible SACs (pSAC) and any site identified, or required, as compensatory measures for adverse effects on any of the above should be given the same protection. For the purposes of this HRA, 'Habitats Site' is used as collective term to include all relevant designated sites as defined above.

3.1.5 Furthermore, NPPF paragraph 188 states that:

The presumption in favour of sustainable development does not apply where the plan or project is likely to have a significant effect on a habitats site (either alone or in combination with other plans or projects), unless an appropriate assessment has concluded that the plan or project will not adversely affect the integrity of the habitats site.

3.1.6 Regulation 63 (1) of the Habitats Regulations states that – "*A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which:*

(a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and

(b) is not directly connected with or necessary to the management of that site,

—must make an Appropriate Assessment of the implications for that site in view of that site's conservation objectives."

3.1.7 Where effects on a Habitats Site are likely to be significant, they must be subject to the second stage of the HRA process, Appropriate Assessment, where they are tested as to whether they would have adverse effects on the "integrity" (see 3.6 below) of the Habitats Site. Following this, the Habitat Regulations also make allowance for projects or plans to be completed if they satisfy 'imperative reasons of overriding public interest (IROPI)':

(a) reasons relating to human health, public safety or beneficial consequences of primary importance to the environment; or

(b) any other reasons which the competent authority, having due regard to the opinion of the appropriate authority [DEFRA, following the UK's departure from the European Union], consider to be imperative reasons of overriding public interest.

3.1.8 Regulations 64 and 68 of the Habitats Regulations regulates such situations.

3.1.9 Although the UK has now left the European Union, Court of Justice of the European Union (CJEU) decisions issued prior to 1st January 2021 in respect of the Habitats Regulations remain relevant until subsequent UK court decisions overrule them.

3.2 Stages of Habitats Regulations Assessment

3.2.1 Existing guidance on the assessment of effects of plans or projects on Natura 2000 sites issued by the European Commission (2018) has been used by this Appropriate Assessment. This sets out the step-wise approach which should be followed to enable Competent Authorities to discharge their duties under the Habitats Regulations. The process used is usually summarised in four distinct stages of assessment as outlined below and in **Figure 3-1**:

- **Screening (Stage 1):** the process to identify the likely effects of a plan or project upon the qualifying features and conservation objectives of a Habitats Site, either alone or in combination with other plans or projects and consider whether there would be an LSE.
- **Appropriate Assessment (Stage 2):** detailed consideration of LSEs and whether they would lead to adverse effects on the integrity of the Habitats Site, either alone or in combination with other plans and projects. Where there are adverse effects, mitigation may be considered to see whether it is possible to avoid them. Consent may only be granted at this stage if the Appropriate Assessment can conclude beyond reasonable scientific doubt that the plan or project would not have adverse effects (alone or in-combination with other plans or projects). If the mitigation options cannot avoid adverse effects, then development consent can only be given if Stages 3 and 4 are followed.
- **Assessment of Alternative Solutions (Stage 3):** the process which examines alternative ways of achieving the objectives of the plan or project that avoid or have lesser adverse effects on the integrity of the Habitats Sites.
- **Imperative Reasons of Overring Public Interest (IROPI) (Stage 4):** the assessment where no alternative solutions exist and where adverse effects remain: an assessment of whether the development is necessary for IROPI and, if so, of the compensatory measures needed to maintain the overall coherence of the site or integrity of the Habitats Sites.

3.2.2 There is no specific definition of what constitutes a LSE, however case law (European Court of Justice C-127/02) clarified that in the context of an HRA, a LSE is one whose occurrence cannot be excluded based on objective information.

3.3 Screening (Stage 1)

3.3.1 An initial broad screening of Habitats Sites to investigate the potential for effects pathways linking them to the Proposed Scheme has been undertaken and is referred to as 'screening'. The screening process was wide-ranging and took into consideration the sensitivity and mobility of Habitats Site Qualifying Features, e.g., fish, aquatic macroinvertebrates and bat species, as well as the nature of the proposed works and working methods.

3.3.2 Its purpose is to identify the likely impacts upon a Habitats Site of a project or a plan, either alone or in combination with other plans or projects and considers whether these impacts are likely to be significant. It includes:

- Determining whether the plan is directly connected with or necessary for the management of applicable sites (SAC, SPA, Ramsar);
- Describing the project/plan that may have the potential for significant effects upon applicable sites;
- Undertaking an initial scoping for potential direct and indirect impacts upon applicable sites;
- Assessing the likely significance of any potential effects identified as resulting from these impacts, both alone and in-combination with other plans and projects; and
- Excluding sites where it can be objectively concluded that there will be no significant effects.

3.3.3 Results of the screening assessment are set out in Section 6 and are also summarised through a matrix approach presented in Appendix 3 of this document.

3.3.4 Following the judgement handed down by the Courts of Justice for the European Union (CJEU) in Case C-323/17 (referred to as People Over Wind), it is no longer appropriate to consider measures taken specifically to reduce a projects potential impact on European designated sites into account at the

screening stage. Accordingly, no reference to mitigation is made or relied upon in screening for this assessment.

3.4 Appropriate Assessment (Stage 2) - Methodology

3.4.1 The precautionary principle is applied at all stages of the HRA process. In relation to screening this means that projects or plans where effects are considered likely and those where uncertainty exists as to whether effects are likely to be significant must adhere to further stages in the HRA process. Appropriate Assessment (Stage 2) follows screening and is found in Section 8. LSEs identified within Stage 1 are subject to detailed examination to determine whether they would have adverse effects on the integrity of Habitats Sites, via inhibiting the success of their conservation objectives, either alone or in combination with other plans or projects.

3.4.2 LSEs have been assessed with respect to the following sources of information to determine whether adverse effects on integrity would occur:

- Natural England Supplementary Advice on Conservation Objectives ('SACO'), where this is available;
- Baseline data from environmental surveys and desk-based studies such as modelling work; and
- Reasoned argument, professional judgement and experience from similar projects.

3.4.3 Results of the Appropriate Assessment are set out in Section 8 and are also summarised through a matrix approach as presented in Appendix 4 in this document.

3.5 Appropriate Assessment (Stage 2) - Integrity

3.5.1 The currently applied definition of integrity in relation to Habitats Sites comes from the Office of the Deputy Prime Minister (ODPM) Circular 06/2005 which states: "T*he integrity of a site is the coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the*

habitat, complex of habitats and/or populations of species for which the site has been designated" (ODPM, 2005). In addition, European Commission guidance (2018) on managing Natura 2000 sites emphasises that site integrity involves its ecological structure, function and ecological processes and that the assessment of adverse effects should focus on, and be limited to, the site's conservation objectives.

3.6 Appropriate Assessment (Stage 2) - Adverse effects

3.6.1 An adverse effect on site integrity is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of designation. In addition, an adverse effect would be one which caused a detectable reduction of the features for which a site was designated.

3.6.2 The Habitats Directive (92/43/EEC) defines the conservation status of species as 'favourable' when:

- Population dynamics of the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is predicted to be maintained for the foreseeable future; and
- There is, and will probably continue to be, a sufficient habitat to maintain its populations on a long-term basis.

3.6.3 'Favourable' conservation status of habitats is defined by the Habitats Directive as occurring when:

- Its natural range and areas it covers within that range are stable or increasing; and
- The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future.

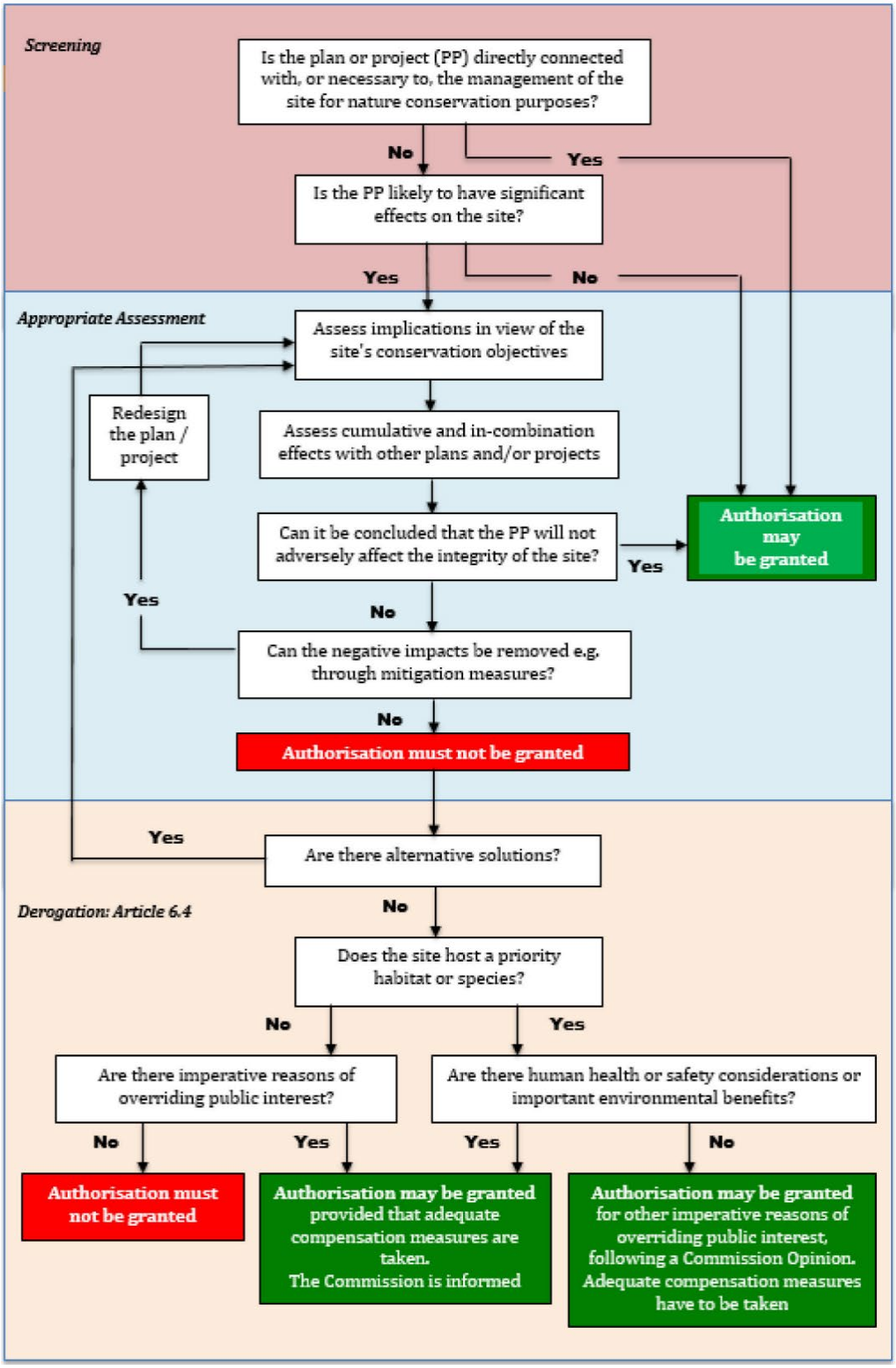
3.6.4 The European Commission guidance also recommends that, when considering the 'integrity of the site', it is important to take account of the possibility that effects can manifest over the short, medium or long-term (European Commission, 2018).

3.6.5 Where examination reveals adverse effects would arise as a result of the Proposed Scheme, options are considered that would avoid or mitigate effects and maintain the integrity of the Habitats Site and its Qualifying Features.

3.7 Further HRA Stages (Stage 3 and 4)

3.7.1 Stages 3 and 4 are outside of the purpose of this report as the Appropriate Assessment concludes that once appropriate mitigation measures have been considered the Proposed Scheme would not have adverse effects (alone or in-combination with other plans or projects) on the Habitats Sites.

Figure 3-1 Outline of the HRA process (European Commission, 2018)



4 Identification of Habitats Sites

4.1 Study Area

4.1.1 This defines the geographic limits from the Proposed Scheme used to identify Habitats Sites to be considered within the HRA process and be screened for LSEs. The Study Area reflects the high sensitivity of qualifying features of Habitats Sites and the fact they often support species that are mobile and wide ranging, such as birds.

4.1.2 The principal criterion defining the Study Area is a zone of 10 kilometres surrounding the Proposed Scheme, as measured from the RLB, a distance appropriate to encompass possible effect pathways from the Proposed Scheme to Habitats Sites, including those hydrologically connected by the River Wensum (no hydrological effects would occur beyond 10 kilometres from the Proposed Scheme; Section 7.3). All Habitats Sites within this zone have been included into the screening stage of the HRA process to identify potential LSEs.

4.1.3 In addition, further sites from a wider area were identified by traffic volume modelling to identify the extent of the Affected Road Network (ARN). Changes to traffic volumes would occur on the road network at some distance from the Proposed Scheme, potentially leading to LSEs on Habitats Sites outside the 10-kilometre Study Area as a result of air quality changes. Therefore, Habitats Sites identified as within the zone of air quality change of the ARN have also been included into the screening stage of the HRA process. The ARN comprises not only traffic changes as a result of the Proposed Scheme, but other schemes that are likely to be operational when the Proposed Scheme opens, including the A47 North Tuddenham to Easton scheme. The ARN is shown in Figure 1, **Appendix 1** in this document.

4.1.4 Following guidance in LA115 of the Design Manual for Road and Bridges sites within 30 kilometres of the Proposed Scheme, where bats are noted as one of the qualifying interests are also considered.

4.2 Sites Identified

4.2.1 Two Habitats Sites were identified that met the Study Area criteria as described above. Both River Wensum SAC and Norfolk Valley Fens SAC fall within the 10 kilometre Study Area. Norfolk Valley Fens SAC comprises a number of geographically separated areas united under one site designation, and four occur within the 10 kilometre Study Area. Two further areas of Norfolk Valley Fens SAC fall within the area of air quality change of the ARN. An additional site, Paston Great Barns SAC is included which although being 26 kilometres from the Proposed Scheme supports a bat qualifying feature. Their qualifying features are summarised below:

- **River Wensum SAC** – The Wensum is a naturally enriched, calcareous lowland river. The upper reaches are fed by springs that rise from the chalk and by run-off from calcareous soils rich in plant nutrients. This gives rise to beds of submerged and emergent vegetation characteristic of a chalk stream. *Ranunculus* vegetation occurs throughout much of the river's length. The river supports an abundant and rich invertebrate fauna including the native freshwater white-clawed crayfish *Austropotamobius pallipes* as well as a diverse fish community, including bullhead *Cottus gobio* and brook lamprey *Lampetra planeri*. The site has an abundant and diverse mollusc fauna which includes Desmoulin's whorl-snail, which is associated with aquatic vegetation at the river edge and adjacent fens.

- **Norfolk Valley Fens SAC** - This site comprises a series of valley-head spring-fed fens. Such spring-fed flush fens are very rare in the lowlands. The individual fens vary in their structure according to intensity of management and provide a wide range of variation. There is a rich flora associated with these fens, including species such as grass-of-Parnassus *Parnassia palustris*, common butterwort *Pinguicula vulgaris*, marsh helleborine *Epipactis palustris* and narrow-leaved marsh-orchid *Dactylorhiza traunsteineri*. In places the calcareous fens grade into acidic flush communities on the valley sides. Within the

Norfolk Valley Fens there are a number of marginal fens associated with pingos – pools that formed in hollows left when large blocks of ice melted at the end of the last Ice Age. These are very ancient wetlands and several support strong populations of Desmoulin's whorl snail as part of a rich assemblage of rare and scarce species in standing water habitat. At Flordon Common a strong population of narrow-mouthed whorl snail *Vertigo angustior* occurs.

- **Paston Great Barns SAC** - the citation for Paston Great Barn SAC states it was the only known example of a maternity roost of barbastelle bats *Barbastella barbastellus* in a building, however there are now others known in Norfolk (see for example Figure 11.07 presented as part of the **Chapter 11: Bat Ecology** of the Environmental Statement). The Barn is a 16th century thatched barn with associated outbuildings. A maternity colony of barbastelles utilises a range of cracks and crevices in the roof timbers for roosting.

4.2.2 Since the publication of the Norfolk Valley Fens SAC citation 'narrow-leaved marsh orchid' is now referred to as Pugsley's march orchid *Dactylorhiza traunsteinerioides* (see for example Cole and Waller, 2020).

4.2.3 Details of Qualifying Features are provided in **Table 4-1** (River Wensum SAC), **Table 4-2** (Norfolk Valley Fens SAC) and **Table 4-3** (Paston Great Barn SAC).

Table 4-1 Habitats Sites and their Qualifying Features: River Wensum SAC

Detail	Supporting Information
Reasons for designation	The SAC supports the following Habitats Directive Annexe 1 habitats: • Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. (Rivers with floating vegetation often dominated by water-crowfoot). The SAC supports the following Habitats Directive Annexe 2 species: • White-clawed (or Atlantic stream) crayfish. • Bullhead. • Brook lamprey. • Desmoulin's whorl snail.
Threats and pressures	Based on detail within the SAC's Supplementary Advice on Conserving and Restoring Site Features and Site Improvement Plan the following threats and pressures have been identified: • Shading of in-channel and emergent marginal vegetation; • Restriction of ground water flows leading to reduced river discharge; • Pollution from chemical and sediment entry to the channel during construction; • Pollution from chemical and sediment entry to the channel during operation; • Noise and vibration leading to disturbance of in-channel species; and • Air quality changes leading to deposition of atmospheric nitrogen.

Detail	Supporting Information
Conservation objectives	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats and habitats of qualifying species; • The structure and function (including typical species) of qualifying natural habitats; • The structure and function of the habitats of qualifying species; • The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely; • The populations of qualifying species; and, • The distribution of qualifying species within the site. Detailed Supplementary Advice on Conserving and Restoring Site Features is available for River Wensum SAC and has informed the HRA process carried out for the NWL (Natural England, 2022), alongside the Site's Improvement Plan (Natural England, 2014a).

Table 4-2 Habitats Sites and their Qualifying Features: Norfolk Valley Fens SAC

Detail	Supporting Information
Reasons for designation	The SAC supports the following Habitats Directive Annexe 1 habitats: • Alkaline fens. • Northern Atlantic wet heaths with *Erica tetralix*. • European dry heaths. • Semi-natural dry grasslands and scrublands facies on calcarerous substrates (*Festuco-Brometalia*) (important orchid sites). • *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*). • Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae.* • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Anion incanae*, *Salicion albae*). The SAC supports the following Habitats Directive Annexe 2 species: • Narrow-mouthed whorl snail. • Desmoulin's whorl snail.

Detail	Supporting Information
Threats and pressures	Based on detail within the SAC's Supplementary Advice on Conserving and Restoring Site Features and Site Improvement Plan the following threats and pressures have been identified: • Inappropriate water levels, scrub control and cutting / mowing; • Hydrological changes; • Water pollution; • Water abstraction; • Undergrazing and overgrazing; • Invasive species; • Change in land management; • Changes in species distributions; and • Air Pollution and the impact of atmospheric nitrogen deposition.

Detail	Supporting Information
Conservation objectives	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; The extent and distribution of qualifying natural habitats and habitats of qualifying species; • The structure and function (including typical species) of qualifying natural habitats; • The structure and function of the habitats of qualifying species; • The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely; • The populations of qualifying species; and, • The distribution of qualifying species within the site. Detailed Supplementary Advice on Conserving and Restoring Site Features is available for Norfolk Valley Fens SAC and has informed the HRA process carried out for the NWL (Natural England, 2019a), alongside the Site's Improvement Plan (Natural England, 2014b).

Table 4-3 Habitats Sites and their Qualifying Features: Paston Great Barn SAC

Detail	Supporting Information
Reasons for designation	The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following species listed in Annex II: • Barbastelle bat *Barbastella barbastellus*
Threats and pressures	Based on detail within the SAC's Supplementary Advice on Conserving and Restoring Site Features and Site Improvement Plan the following threats and pressures have been identified: • Distribution of supporting habitat; • Water quantity / quality • Changes in air quality; and • Disturbance from human activity.

Detail	Supporting Information
Conservation objectives	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species; • The structure and function of the habitats of qualifying species; • The supporting processes on which the habitats of qualifying species rely; • The populations of qualifying species, and • The distribution of qualifying species within the site. Detailed Supplementary Advice on Conserving and Restoring Site Features is available for Paston Great Barn SAC and has informed the HRA process carried out for the Proposed Scheme (Natural England, 2019b), alongside the Site's Improvement Plan (Natural England, 2014c).

5 Environmental Baseline

5.1 Description of Supporting Studies Undertaken

5.1.1 Habitat survey work was undertaken covering both the River Wensum SAC and its adjacent floodplain, as well as Potter and Scarning Fens, East Dereham, (the component of Norfolk Valley Fens SAC that overlaps with the Proposed Scheme's ARN). UK Habitat Survey classification (version 1) was used to broadly map habitats, with National Vegetation Classification (NVC) used to provide a more detailed analysis of important vegetation communities.

5.1.2 Additionally, for the River Wensum SAC, the following targeted surveys were undertaken to capture details of the qualifying features present:

- Desmoulin's whorl snail;
- Brook lamprey;
- Bullhead;
- Aquatic macrophytes; and
- River Condition Assessment.

5.1.3 To support surveys, information from desk study investigations, the River Wensum Geomorphology Assessment and Water Framework Direct Assessment have been used to describe the River Wensum SAC and its floodplain.

5.1.4 Detailed descriptions of the surveys undertaken is provided below. Other than the habitat survey work identified above, no further survey work was undertaken at Potter and Scarning Fens, East Dereham or other components of Norfolk Valley Fens SAC. No survey work was undertaken for qualifying features of Paston Great Barn SAC as sufficient desk-based information was available to draw robust conclusions about likely significant effects on this site.

5.2 River Wensum SAC and its Floodplain – Habitats, Macrophyte Community and Results of River Condition Assessment

5.2.1 The introduction of anthropogenic pressures midway through the last 10,000-year period and extensive deforestation and land clearing from around 5,000 years before the present day, resulted in mobilisation of fine sediment which ultimately deposited across valley floors, blocked multiple channels, and led to the creation of the stable, single-thread, passively meandering system evident today within the River Wensum. Evidence of former channels can be found across the valley floor, many of which have been exploited for land drainage purposes (widened, deepened and straightened). Contemporary alteration of the hydrological functioning of the system throughout the last few centuries, by means of water milling and extensive land drainage, has further reinforced the inactive, modified character of the River Wensum observable today (Detailed Wensum Geomorphology Assessment; **Document Reference 3.12.04**).

5.2.2 At the observed section of the River Wensum, the watercourse flows through rough pasture and showed evidence of agricultural pressures, such as bank reprofiling, nutrient input and livestock poaching. The river along the upstream reach of the Study Area appeared to have been artificially widened and deepened, as evidenced by a mean width of 8m and a mean depth of over 1m. The river corridor was moderately vegetated with several willow trees and tall herbs on both banks shading the channel. The wetted channel was uniform in flow type (deep glide) and substrate (silt). Within the Survey Area, as shown in **Figure 32** of the Aquatic Ecology Survey Report 2022 (Aquatic Ecology Survey Report 2022; **Document Reference 3.10.12**), the River Wensum contained a high diversity of aquatic plant species, the channel dominated by submerged broadleaved macrophytes such as pondweed. On both sides of the channel, bank margins were dominated by willow trees, dense stands of reeds and emergent broadleaved macrophytes. Where vegetation was not present, extensive poaching and degradation of the bank profile was evident from livestock accessing the watercourse.

5.2.3 The observations made support the condition assessment made by Natural England of the River Wensum SSSI in 2010 (Unit 53, Lenwade Mill – Taverham Mill): Unfavourable – No Change. "*The River Wensum Restoration Strategy has concluded that the channel in unit 53 consists of a significant length of free-flowing river between Lyng and Ringland, with sluggish over-widened, over-deepened and impounded river reaches upstream of Taverham Mill. The sampling point on Unit 53 exhibited the following characteristics: Slow, deep section through improved grassland on left hand bank and improved grassland / rank vegetation on the right. The left hand bank is extensively poached and grazed. Channel over widened and deepened, with silt now building up along the edges starting to form berms. Some patches of gravel pebble substrate evident but it appears to be predominately silt, however extensive macrophyte growth makes this difficult to determine*."

5.2.4 The River Wensum Water Framework Directive (WFD) waterbody ("Wensum Upstream Norwich"), is monitored for macrophytes / phytobenthos, fish and invertebrates, which were classified as Moderate, High, and High, respectively (Environment Agency, 2022).

5.2.5 The reasons for the macrophytes / phytobenthos combined quality element not achieving Good status within the WFD are listed as:

- Diffuse source pollution from poor nutrient management;
- Diffuse source pollution from poor livestock management; and
- Point source pollution from continuous sewage discharge.

5.2.6 Additional reasons for unfavourable conditions with the River Wensum as per Natural England River Wensum SSSI condition assessment (Unit 53, Lenwade Mill – Taverham Mill) are:

- Inappropriate water levels;
- Inappropriate weirs, dams and other structures; and
- Invasive freshwater species.

5.2.7 Targeted macrophyte surveys were carried out on the River Wensum and its floodplain ditch network in summer 2022 (Aquatic Ecology Survey Report 2022; **Document Reference 3.10.12**).

5.2.8 A total of 25 macrophyte taxa were recorded in the 2022 macrophyte survey ^of the River Wensum, 12 of which are LEAFPACS (the River Predictions and Classifications System for macrophytes) scoring taxa. Clasping-leaved pondweed *Potamogeton perfoliatus* was the most dominant species, accounting for an estimated 60% of the Survey Area's total macrophyte cover. No invasive non-native species were recorded in the survey.

5.2.9 Stream water-crowfoot *Ranunculus penicillatus* subsp. *pseudofluitans,* a species characteristic of the River Wensum SAC, was the only species of water-crowfoot observed. A further, six species or groups associated with *Ranunculus* spp. in 'watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' were sampled within the channel; water starwort Callitriche sp., greater water-moss *Fontinalis anntipyretica*, clasping-leaved pondweed, curled pondweed Potamogeton crispus, and spiked water milfoil *Myriophyllum spicatum*.

5.2.10 Other submerged / emergent vegetation observed from the riverbank included unbranched bur-reed *Sparganium emersum*, arrowhead *Sagittaria sagittifolia*, water starwort Callitriche sp. and reed sweet grass *Glyceria maxima*. The river was sparsely lined by mature willows Salix spp. on both sides.

5.2.11 The species identified are similar to those observed by Natural England condition assessment of the River Wensum SSSI in 2010 (Unit 53, Lenwade Mill – Taverham Mill): '*Channel plants are dominated by Sparganium emersum and Potamogeton perfoliatus, with Butomus umbellatus, P. pectinatus and Sagittaria sagittifolia also present. Small discrete patches of Ranunculus circinatus and R. penicillatus ssp. pseudofluitans present. Riparian zone unfavourable* (Natural England, 2010).'

5.2.12 A ditch network is present to the south of the Wensum, running parallel to the main river in many instances (as shown in **Figure 11** of the Aquatic Ecology

Survey Report 2022 (Aquatic Ecology Survey Report 2022; **Document Reference 3.10.12**) This ditch network forms part of the Wensum floodplain, playing a vital role in buffering the river against low flows during drought, and in wetter periods, absorbs much of the river flood waters. Condition assessments of these ditches undertaken in Summer 2022 (Biodiversity Net Gain Technical Report; **Document Reference 3.10.33d**) showed evidence of extensive cattle poaching, dredging activities and agricultural nutrient inputs. Vegetation cover on two ditches was extensive and the channels choked with plants. Watercourse 5 (WC5 also referred to as Ditch C in Aquatic Ecology Survey Report) had a slow but distinct flow, running parallel to the Wensum on the south side of the floodplain. The ditch showed evidence of eutrophication in the form of extensive algae, decomposition of submerged macrophytes and an organic surface scum. Ditch A, west of the viaduct, showed evidence of recent dredging activity, with limited macrophyte cover, bare earth banks and soil spoils along the bank top.

5.2.13 Macrophyte surveys were also conducted on the ditch network. Small patches of frogbit *Hydrocharis morsus-ranae* were recorded in Ditch A. The species is classified as Vulnerable on the Vascular Plant Red List for Great Britain (Cheffings & Farrell, 2005).

5.2.14 The floodplain associated with the River Wensum was characterised by seasonally inundated neutral grassland habitats of varying species compositions dependent on management, intersected occasionally by scrub-dense ditches. An agricultural landscape, these grasslands were predominantly managed, either for crops or grazing cattle. They are heavily influenced by inputs on nutrients from fertilizer and manure from these land uses which in turn influences the background levels of nitrogen and its compounds in soils, groundwater and the River Wensum itself.

5.2.15 The ditches which intersected the floodplain areas were mostly wetted and choked with vegetation and in drier areas dominated by scrub, with constant species including hawthorn *Crataegus monogyna*, willow Salix spp., bramble *Rubus fruticosus* agg., blackthorn *Prunus spinosa*, greater pond sedge *Carex*

riparia, and common reed *Phragmites australis*; commonly associated with a border of reed canary grass *Phalaris arundinacea*.

5.2.16 Areas of intensively managed grassland consisted of dominant floating sweet grass *Glyceria fluitans*, cultivated for hay / sileage, with very few forbs present, other species present were rare including creeping bent *Agrostis stolonifera*, marsh foxtail *Alopecurus geniculatus* and perennial rye-grass *Lolium perenne*, with small amounts of reed canary-grass and hybrid rye-grass *Lolium x boucheanum* (*Lolium perenne x Lolium multiflorum*). This grassland showed a greatest habitat correspondence in UKHab classification to g4 – modified grassland, and in NVC it is best described as transitional community between MG6a *Lolium perenne – Cynosurus cristatus* grassland – typical sub-community: *Alopecurus geniculatus* variant and MG13 *Agrostis stolonifera – Alopecurus geniculatus* grassland community.

5.2.17 Other grassland areas within the floodplain were managed less intensively by cattle grazing, resultantly the structure of the sward was more diverse, with abundant tufted hair-grass *Deschampsoa cespitosa* with accompanying marsh horsetail *Equisetum palustre,* rough meadow grass *Poa trivialis*, marsh foxtail, and floating sweet grass, typical of seasonally inundated pasture This grassland showed a greatest habitat correspondence in UKHab classification to g3c7 – Deschampsia neutral grassland, and in NVC it presented the greatest affinity to MG9a *Holcus lanatus – Deschampsia cespitosa* grassland – *Poa trivialis* sub-community.

5.2.18 Sections were incidentally isolated from semi-regular grazing or cultivation and appeared unmanaged, the sward height here was tall and unvaried in structure, with Yorkshire fog *Holcus lanatus* becoming a constant species with accompanying floating sweet-grass in an overall less diverse grassland. This grassland showed a greatest habitat correspondence in UKHab classification to g3c8 Holcus – Juncus neutral grassland, and in NVC it is best described as having a weak affinity to MG7 *Lolium perenne* leys and related grasslands.

5.3 Norfolk Valley Fens SAC - Potter & Scarning Fens, East Dereham - Habitats

5.3.1 Scarning and Potter Fens in East Dereham covers two sites immediately adjacent to each other, with Scarning Fen to the west of Potter Fen. They cover an area of 6.2 ha and together are a Site of Special Scientific Interest (SSSI), but also make up part of the Norfolk Valley Fens SAC. Potter and Scarning Fens are small calcareous valley fens on shallow peat and considered two of the finest of their type in Britain. The site grades from bryophyte-dominated communities on the open, wet parts of the site, through calcareous fen, to heathland on the drier ground.

5.3.2 Four UKHab habitat types were identified during the survey of the Scarning and Potter Fens undertaken during October 2022: wet woodland W1D, lowland fens f2a (more specifically calcium-rich spring water-fed fen, secondary code 7), lowland heathland h1a and modified grassland g1.

5.3.3 The flora is exceptionally diverse, and several uncommon mosses and liverworts have been recorded. The site has high entomological interest and supports a nationally scarce species of damselfly, the small red damselfly *Ceriagrion tenellum*. Walkover survey recorded a range of plant species, including bogbean *Menyanthes trifoliata*, devil's-bit scabious *Succisa pratensis*, great fen sedge *Cladium mariscus* and many others. Most of the open, wet areas were dominated by common reed, which had been cut to different heights. The wooded areas were dominated by alder *Alnus glutinosa*, a tree commonly found in wet areas, and the drier parts of site, were colonised by gorse *Ulex europaeus* and bramble agg. Survey methods and a full species list is included in **Appendix 2** in this document.

5.4 River Wensum SAC - Desmoulin's Whorl Snail

Introduction and Technical Report Reference

5.4.1 The following detail summarises the findings of survey work undertaken for Desmoulin's whorl snail in relation to the Scheme. It should be read in conjunction with the Proposed Scheme's technical reports which provides a

more extensive description of scope, methods and findings. Survey work was undertaken initially between 2019 and 2020 (Desmoulin's Whorl Snail Survey Report 2019; **Document Reference 3.10.06** and Desmoulin's Whorl Snail Survey Report 2020; **Document Reference 3.10.29,** results mapped each reports respective appendices) and further survey work was undertaken during 2021 (Desmoulin's Whorl Snail Survey Report 2021; **Document Reference 3.10.14**, results mapped in its Appendices).

Background

5.4.2 Desmoulin's whorl snail is a snail typically found in old or semi-natural open calcareous fen and wetlands, usually adjacent or close to rivers, streams, lakes and ponds. In the UK it is chiefly distributed in a broad band of country from central-southern England to East Anglia. Outlying populations also exist in the Midland meres, north Wales, and north Cornwall. Across its range the species has experienced significant reductions in its populations, several of which are no longer viable.

5.4.3 The requirement for survey of this species was established in 2018 following their identification through the Proposed Scheme's ecological desk study, as they comprise a Qualifying Feature of the River Wensum SAC, that is crossed by the Proposed Scheme. It was considered important to understand the distribution of Desmoulin's whorl snail in relation to the Proposed Scheme to understand potential effects on this species.

Methodology

5.4.4 Survey comprised both a desk study and field work to identify habitats occupied by Desmoulin's whorl snail in the River Wensum valley. Desk study comprised a review of ecological records of Desmoulin's whorl snail from within 2 kilometres of the Scheme, as well as identification of sites designated for its protection. Field work comprised spot sampling of the invertebrate community within the Wensum floodplain. Initial surveys in 2019 were extended by further work in 2020 due to changes in the Proposed Scheme design. Further surveys were undertaken in 2021. Sampling involved

collection of molluscs from vegetation directly by surveyors and their subsequent identification to species level. Habitat suitability was also assessed through analysis of vegetation at sampling sites.

Results

5.4.5 Survey work indicated the presence of Desmoulin's whorl snail within the RLB in three floodplain watercourses (WC1, WC3 and WC4), and a population within the Wensum floodplain approximately 1 kilometre to the southeast. of the RLB.

5.4.6 A section of WC1 falls within the Site Boundary. Habitat within the section of WC1 became unsuitable for supporting Desmoulin's whorl snail in 2021 (subsequent to sampling works) and agricultural land use has maintained it in this state since this time. Other watercourses within the Site Boundary either returned a negative result following sampling surveys or were unsuitable to support this species, and so Desmoulin's whorl snail is not considered to be present in the Site Boundary for the purpose of this assessment.

5.4.7 WC3 and WC4 fall within the redline boundary as they will receive ecological enhancements as mitigation for the Proposed Scheme; neither falls within the Site Boundary. WC3 comprises an unmanaged ditch with shallow banks that are heavily poached by cattle, and dense vegetation is found throughout the whole ditch which contained only a few centimetres of water. WC4 comprises a ditch with shallow banks also heavily poached by cattle, and densely vegetated but supporting shallow standing water throughout. Hawthorn *Crategus monogyna* and willow *Salix* sp. trees were present in places along both ditches.

Functionally Linked Land

5.4.8 Desmoulin's whorl snail is a wetland-associated species and is found in vegetation on the edges of watercourses (Natural England, 2022) such as the River Wensum itself, and as shown above ditches with suitable marginal vegetation. This comprises various species of sedge, reed-grass *Glyceria maxima*, and common reed *Phragmites australis*. Other than ditches WC3

and WC4 described above (subject to ecological enhancement), ditches within the Red Line Boundary are not suitable habitat for Desmoulin's whorl snail. The floodplain grassland within the Red Line Boundary is subject to agricultural use and comprises semi-improved grassland, occasional patches of hawthorn and willow, and lacks suitable aquatic plants to support Desmoulin's whorl snail. Floodplain habitat within the Red Line Boundary is therefore not functionally linked land with the wider Desmoulin's whorl snail population within the River Wensum floodplain.

5.5 River Wensum SAC - Brook Lamprey and Bullhead

Introduction and Technical Report Reference

5.5.1 The following detail summarises the findings of survey work undertaken for fish (including bullhead and brook lamprey) in relation to the Proposed Scheme. It should be read in conjunction with the Aquatic Ecology Survey Report 2022 (**Document Reference: 3.10.12**) which provides a more extensive description of scope, methods and findings.

Background

5.5.2 Bullhead are a small bottom dwelling fish species typically found in fast flowing rivers and upland streams. It has a broad range and can be found in most rivers in England and Wales. Bullhead require cool and well oxygenated moderate flowing water, however, do occur in some lakes. Likely due to their vulnerability to predation, bullhead actively hide from light under pebbles, stones, and any other available debris.

5.5.3 Lampreys are not true fish but jawless fish, due to their absence of a lower jaw and a sucker-like mouth. The brook lamprey is the smallest of three lamprey species found in English rivers. Brook lamprey is the most common lamprey and can be found in rivers and streams across the British Isles but is absent from much of northern Scotland.

5.5.4 The requirement for fish surveys on the River Wensum was established in 2018 following the identification of bullhead and brook lamprey through the

Scheme's ecological desk study, as they comprise a Qualifying Feature of the River Wensum SAC, that is crossed by the Scheme. It was considered important to understand the distribution of these two species in relation to the Scheme to understand potential effects on them and the fish community as a whole.

Methodology

5.5.5 Survey comprised both a desk study and field work to identify fish species present within the River Wensum. Desk study comprised a review of the Environment Agency's Ecology and Fish Data Explorer. Field work comprised a 40-minute timed, catch per unit effort (CPUE) electric fishing survey over a 150m stretch of the River Wensum in August 2022 (shown on Figure 3-3 of the Aquatic Ecology Survey Report 2022 (**Document Reference: 3.10.12**)). Sampling involved collection of fish by surveyors and their subsequent measurement and identification to species level. Habitat suitability was also assessed through analysis of aquatic habitats.

Results

5.5.6 A search of the Environment Agency's Ecology and Fish Data Explorer returned data from an Environment Agency catch depletion electric fishing survey carried out in 2019, at a site approximately 8.2 kilometres downstream of the proposed crossing. A total of 456 fish were caught during the survey, with the minnow *Phoxinus phoxinus* dominating the assemblage. Brook lamprey, bullhead and European eel *Anguilla anguilla* were recorded in the Environment Agency survey.

5.5.7 Ecologists conducted a 40-minute timed, catch per unit effort (CPUE) electric fishing survey over a 150m stretch of the River Wensum in August 2022. A total of nine species were caught during the survey. The species captured included dace *Leuciscus leuciscus*, pike *Esox lucius*, chub *Squalius cephalus*, perch *Perca fluviatilis*, roach *Rutilus rutilus*, rudd *Scardinius erythrophthalmus*, stone loach *Barbatula barbatula*, three-spined stickleback *Gasterosteus aculeatus*, and minnow. Neither bullhead nor brook lamprey were caught

during the survey, and neither were any other species of conservation importance.

5.5.8 A qualitative (presence / likely absence) electric fishing survey of the ditch network was also conducted in August 2022. A total of three species were caught during the survey, including brook / river lamprey Lampetra spp., minnow, and three-spined stickleback. River and brook lamprey are indistinguishable in their larval form.

5.5.9 No bullhead or brook lamprey were observed; however, this does not confirm their absence, with records of bullhead in the Wensum downstream and lamprey within the adjacent ditch systems, it is likely both species use this section of the River Wensum temporally.

5.6 River Wensum SAC - White-lawed Crcayfish

Introduction and Technical Report Reference

5.6.1 The following detail summarises the findings of survey work undertaken for white-clawed crayfish in relation to the Scheme. It should be read in conjunction with the Proposed Scheme technical report (River Wensum Crayfish Report 2020; **Document Reference 3.10.07**) which provides a more extensive description of scope, methods and findings.

Background

5.6.2 White-clawed crayfish is a macroinvertebrate found in a diverse variety of clean aquatic habitats, favouring hard-water streams and rivers. A major threat to the native white-clawed crayfish is posed by the introduction of non-native species of crayfish, which have been farmed in Britain since the late 1970s (JNCC, 2023). Signal crayfish *Pacifastacus leniusculus* out-compete the white-clawed crayfish through competition for refuges, reproduction interference and predation, and the introduction of a microsporidial pathogen (known as the crayfish plague) for which the white-clawed crayfish has no immunity (Peay, 2002a; 2002b; 2003).

5.6.3 The requirement for survey of this species was established in 2018 following their identification through the Proposed Scheme's ecological desk study, as they comprise a Qualifying Feature of the River Wensum SAC, that is crossed by the Proposed Scheme. It was considered important to understand the distribution of white-clawed crayfish in relation to the Proposed Scheme in order to understand potential effects on this species.

Methodology

5.6.4 Survey comprised both a desk study and field work to identify habitats and carry out trapping surveys within the River Wensum. Desk study comprised a review of ecological records of white-clawed crayfish from within 2 kilometres of the Proposed Scheme, as well as identification of sites designated for its protection. Field work comprised two trapping surveys in September 2019, using baited traps to sample crayfish populations. Due to the depth of water, manual searching of refuge areas was not possible. All crayfish caught were identified to species level, measured and sexed. The physical characteristics of each survey stretch were recorded, including the length, width and depth of the river; substrate type; extent of siltation; shading; and possible crayfish refuges.

Results

5.6.5 Surveys undertaken in 2019 confirmed likely absence of white-clawed crayfish within the River Wensum due to the presence of the non-native signal crayfish. Recolonisation is now considered very unlikely due to the establishment of a signal crayfish population. Signal crayfish out-compete the white-clawed crayfish through competition for refuges, reproduction interference and predation, and the introduction of a microsporidial pathogen (known as the crayfish plague) for which the white-clawed crayfish has no immunity (Peay, 2002a; 2002b; 2003).

5.6.6 However, the potential for recolonisation, either naturally after removing of factors preventing their return or through a reintroduction programme, has

been considered in relation to operational impacts of the Proposed Scheme. This is discussed in Section 6 below in relation to Proposed Scheme impacts.

6 Stage 1: Screening

6.1 Habitats Site management statement

6.1.1 The Proposed Scheme is not directly connected with or necessary for the management of any of the Habitats Sites identified in Section 4 as within the HRA Study Area. The Proposed Scheme has not been conceived to further the conservation of these sites and nor is it essential to the management of these sites.

6.2 Identification of Impacts

6.2.1 Construction phase impacts of the Proposed Scheme that have been identified (based on detail within Section 2 above) and could lead to effects on Habitats Sites are:

- Temporary and permanent loss of supporting floodplain habitat due to land-take (from the footprint of structures being built, excavations, laydown areas, construction access routes and maintenance track);
- Changes in hydrological conditions – non-flood condition river flows and ground water levels (as a result of construction activity, including piling and excavations, on and around the River Wensum floodplain);
- Changes in hydrological conditions – increased flood risk (resulting from construction activity constraining flows during and following periods of heavy rainfall);
- Shading of in-channel vegetation from the under-construction viaduct, and Temporary Works Platform;
- Fragmentation of the landscape by construction of the Proposed Scheme (where-by movement and dispersal of animals and plants

between areas of suitable habitat are prevented or restricted by under construction structures, equipment or materials);

- Localised changes in air quality due to emissions of construction vehicles;
- Dust, sediment and chemical run-off (released by construction vehicles and equipment);
- Noise and vibrational disturbance (as a result of the movement and operation of construction materials and equipment); and
- Introduction of invasive non-native plants (e.g., Himalayan balsam *Impatiens glandulifera*) and animal (e.g., signal crayfish) species (by construction processes, such as importation of materials and movement / operation of vehicles and equipment).

6.2.2 Operational phase impacts of the Proposed Scheme comprise the use of the bridge by vehicles and periodic maintenance activities, and those that have been identified and could lead to effects on Habitats Sites are:

- Shading of vegetation by the operational viaduct;
- Sediment and chemical run-off (including road salt) from the operational viaduct and link road;
- Localised changes in air quality as a result of emissions from vehicles using the completed viaduct;
- Wide-scale air quality changes within the Affected Road Network (ARN); and
- Noise and vibrational disturbance (from vehicles using the operational viaduct and link road).

6.2.3 Impacts have been identified as related to either the construction phase or operational phase of the development. No detail on decommissioning has been prepared and the operational lifespan of the Proposed Scheme is not yet known. In the absence of detail on decommissioning, impacts of this stage

are assumed to be similar to that of construction and no separate consideration of decommissioning effects has been presented.

6.3 Consideration of Effects - Overview

6.3.1 Relevant threats and pressures identified for each Habitats Site have been considered against impacts of the Proposed Scheme, and information included within Section 2 of this report describing it, to screen for potentially significant effects on Qualifying Features and Conservation Objectives.

6.3.2 Results of this screening process are presented for River Wensum SAC in **Table 6-1** and **Table 6-2**, and for Norfolk Valley Fens SAC in **Table 6-3**.

6.4 Consideration of Effects - River Wensum SAC

6.4.1 The River Wensum SAC would be crossed by the Proposed Scheme and this interaction comprising both potential temporary and permanent effects during construction and operation has been explored by this assessment.

6.4.2 However, there would be no in-channel works within the River Wensum, with no realignment or engineering of the river channel undertaken. Instead, the Wensum would be crossed with a viaduct, with an additional temporary bridge to permit access across the river also installed during construction but removed upon the Proposed Scheme's completion.

6.4.3 Potential construction phase effects are considered in **Table 6-1** and operational effects in **Table 6-2**.

6.5 Consideration of Effects - Norfolk Valley Fens SAC

6.5.1 Norfolk Valley Fens SAC would not receive effects form direct impacts by the Proposed Scheme during construction or operation as the component areas of the SAC are at a distance from RLB (see **Appendix 1**). However, changes in traffic volumes represent an indirect impact as a result of air quality changes, which present a potential effect pathway to one component area which lies adjacent to the Proposed Scheme's ARN; Potter and Scarning Fens, East Dereham which is 11.2 kilometres from the Proposed Scheme.

6.5.2 Other component areas of Norfolk Valley Fens SAC have been excluded from this assessment as there are no effects pathways between them and the Proposed Scheme.

6.5.3 Potential operation phase effects as a result of air quality changes to the ARN are considered in **Table 6-3**.

6.6 Consideration of Effects – Paston Great Barn SAC

6.6.1 Paston Great Barn SAC lies 26 kilometres from the Proposed Scheme and is therefore towards the upper limit of the 30 kilometres Study Area promoted by the DMRB. A review of the barbastelle bats in Norfolk by the Norfolk Barbastelle Study Group included information on the flight lines and foraging areas for Paston Great Barn radio-tagged bats.

6.6.2 Females from the Paston Great Barn colony showed weather-related foraging behaviour. On nights with no wind or light to moderate offshore winds, the coastal cliffs at Mundesley were a favoured location where all six tagged females foraged for prolonged periods. When onshore winds or cold, foggy conditions prevailed at the coast, inland foraging areas were used instead. On some occasions, females flew immediately to the coast after emergence, but returned inland if foraging conditions were poor. Inland core foraging areas were often shared, with the outskirts of North Walsham being the limit of the area used (Natural England, 2019b). The mean-maximum foraging radius of bats at the colony was 3.5 kilometres.

6.6.3 The closest point at which bats from the Paston Great Barn SAC colony approach the Proposed Scheme, North Walsham, is over 21 kilometres away and therefore the Proposed Scheme is not functionally linked to the Paston Great Barn SAC. On this basis there are considered to be no likely construction or operational phase effects from the Proposed Scheme on the SAC.

6.7 Potential In-Combination Effects

6.7.1 When determining the potential implications of a plan or project in light of the conservation objectives for Habitats Sites (i.e., assessing the potential for LSE and ascertaining the potential for effect on site integrity), it is necessary to consider the potential for in-combination effects with other plans and projects on the designated interest features / conservation on the site. This should include:

- Approved but as yet uncompleted plans or projects;
- Permitted on-going activities such as discharge consents of abstraction licences; and
- Plans and projects for which an application has been made and which are currently under consideration but not yet approved by competent authorities.

6.7.2 An in-combination assessment considers the potential for each plan or project to influence the site. In order for an in-combination effect to arise, the nature of two effects does not necessarily have to be the same. The in-combination assessment, therefore, focuses on the overall implications for the site conservation objectives regardless of the type of effect.

6.7.3 A total of 31 developments were identified that meet the above criteria and have been screened in **Table 6-4** below for potential in-combination effects with the Proposed Scheme. Further developments are too distant from the Proposed Scheme to give rise to in-combination effects. The developments identified can be summarised as:

- Thirteen residential developments associated infrastructure, the largest involving creation of 93 new homes. None lie within or adjacent to Habitats Sites, with the closest being ~800m away from the Proposed Scheme.
- Seven commercial developments, comprising new business facilities (e.g., a new hotel), extensions to facilities at existing sites (e.g., a water

storage lagoon and club house at Weston Park Golf Club; a new campsite shower block), hardstanding for machinery and a new agricultural processing facility. None lie within or adjacent to Habitats Sites, with the closest being ~750m away from the Proposed Scheme.

- One new water supply pipeline 4.7 kilometres in length, ~3 kilometres from the Proposed Scheme.
- New facilities including new classrooms and roof alterations at Taverham Hall School, ~1.5 kilometres from the Proposed Scheme.
- New classrooms at Taverham Junior School, ~1.9 kilometres from the Proposed Scheme.
- Two new wind turbines at Weston Longville, ~1.9 kilometres from the Proposed Scheme.
- One proposal for extraction of sand and gravel, followed by restoration of the site, at Attlebridge Quarry, ~700m from the Proposed Scheme.
- One new development within an existing amusement park, the Norfolk Dinosaur Park, ~1.2 kilometres from the Proposed Scheme.
- One road scheme lying directly adjacent to the south of the Proposed Scheme (A47 North Tuddenham to Easton).
- Hornsea Project Three offshore wind farm export cable pipeline, crosses land used for habitat creation as part of the Proposed Scheme using directional drilling techniques.
- Sheringham Shoal (Equinor) Offshore Windfarm / Dudgeon Offshore Wind Farm Extension Project shared export cable pipeline; crosses land used for habitat creation as part of the Proposed Scheme using directional drilling techniques.
- STS Cycle Improvement Scheme.
- Boreas Windfarm On-shore Cable Route.

6.7.4 The majority of these developments are at distance from the Proposed Scheme within existing areas of development, typically beyond ~750m with many within the outskirts of Norwich city or towns / villages in its hinterland. Only the Hornsea Project Three and Sherringham Shoals offshore wind farms, and A47 North Tuddenham to Easton Road development are close to the Proposed Scheme. The latter development lies at the southern end of the ~Proposed Scheme, providing a new link between these upgraded transport corridors.

6.7.5 Traffic modelling undertaken to inform the assessment of the impact of air quality changes as a result of the Proposed Scheme has incorporated, in its projections, allowance for in-combination effects of the Proposed Scheme that would result from these developments. These are expressed through the ARN, and therefore no further in-combination assessment of air quality changes is required; air quality change effects are assessed through operational phase impacts identified in **Table 6-2** and **Table 6-3.**

6.8 Screening – Construction Phase

Table 6-1 River Wensum SAC; Screening for LSEs at the Proposed Scheme Construction Phase

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and C*allitricho-Batrachio*n vegetation	Temporary and permanent loss of supporting floodplain habitat due to land-take	Yes	Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes on which the river and its vegetation community rely. Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Water courses with *Ranunculion fluitantis* and C*allitricho-Batrachion* vegetation	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Yes	Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. Therefore, changes in hydrological conditions – non-flood condition river flows and groundwater levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Changes in hydrological conditions – increased flood risk	Yes	Temporary works structures including the Temporary Works Platform across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of riverbed sediments and associated *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation within the river channel and immediately downstream of the works area, with peak flood flows removing materials and uprooting plants. Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Yes	In-channel vegetation is reliant on light and shading could cause dieback of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation stands and other in-channel and riparian vegetation, and the loss of this qualifying feature. Both the under-construction viaduct and Temporary Works Platform represent sources of shading. Therefore, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Fragmentation of the landscape by construction of the Scheme	Yes	No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. Thus, Fragmentation of in-channel *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and fragmentation within the wider floodplain will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Localised changes in air quality due to emissions of construction vehicles	No	Lowland rivers such as the River Wensum are typically nutrient poor, with the availability of phosphorus (rather than nitrogen) within the ecosystem limiting the growth of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation as well as other macrophyte species and algae (English Nature, 1999; Natural England, 2022). Analysis of nitrogen to phosphorus ratios within the River Wensum confirm phosphorus is the limiting nutrient (Air Quality Ecological Impact Assessment; **Document Reference 3.10.34b**). Emissions from Proposed Scheme construction vehicles would lead to deposition of nitrogen compounds as a result of exhausts during the construction phase including nitrogen dioxide and nitrate (see Environmental Statement **Chapter 6: Air Quality** and ES **Appendix 10.34 Air Quality Ecological Impact Assessment**); phosphorus is not released by vehicle exhausts and would not become elevated in the River Wensum as a result of localised air quality changes. Levels of phosphorus in the River Wensum ecosystem would therefore not change as a result of the Proposed Scheme and would remain as a growth-limited factor for in-stream plants. Thus, the sensitivity of vegetation of the River Wensum to air quality changes during the construction phase is low. Input of nitrogen from agricultural run-off (either consistently over time or through pollution events) would see concentrations of nitrogen enter the river at orders of magnitude greater than from air quality changes due to the Proposed Scheme (Natural England, 2022). In addition, floodplain grassland habitat surrounding the River Wensum in its floodplain show effects of agricultural improvement, and thus is not considered sensitive to the effects of enrichment through nitrogen deposition as it already receives significant nitrogen input from such sources, primarily manure from grazing animals (“Nitrogen deposition :: Improved Grassland”; APIS, 2023). The overall area of the River Wensum exposed to air quality changes would be small due to the small overlap between the River Wensum and the Proposed Scheme construction footprint, and the relatively limited period of time required to construct the Proposed Scheme (i.e., construction phase air quality changes would be temporary). The principal of nutrient neutrality in relation to Habitats Sites was established prior to the UK leaving the European Union by the joined cases C-293/17 and C-294/17 as ruled upon by the Court of Justice of the European Union in 2018 (together, the 'Dutch Nitrogen' case). The ruling concerns agricultural activities in sites protected by the Habitats Directive and where nitrogen deposition levels already exceeded the critical load, and has affected the consent for developments in the UK. The Proposed Scheme does not contradict the precident set by the Dutch Nitrogen cases in relation to River Wensum SAC nor the concurrent principal of nutrient neutrality. Nitrogen received by the River Wensum from aerial deposition during the Proposed Scheme's operational phase exceeds critical load over only a relatively small area (due to the cross section of the viaduct and its overlap with the River Wensum, see above) and the small amount deposited would be diluted quickly by river flows. It would not lead to deterioration of the condition of the River Wensum SAC through a change in nutrient status and would not undermine the objective of restoring the site to a more favourable condition in line with its conservation objectives.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Localised changes in air quality due to emissions of construction vehicles	No	The principal of nutrient neutrality in relation to Habitats Sites was established prior to the UK leaving the European Union by the joined cases C-293/17 and C-294/17 as ruled upon by the Court of Justice of the European Union in 2018 (together, the 'Dutch Nitrogen' case). The ruling concerns agricultural activities in sites protected by the Habitats Directive and where nitrogen deposition levels already exceeded the critical load, and has affected the consent for developments in the UK. The Proposed Scheme does not contradict the precedent set by the Dutch Nitrogen cases in relation to River Wensum SAC nor the concurrent principal of nutrient neutrality. Nitrogen received by the River Wensum from aerial deposition during the Proposed Scheme's operational phase exceeds critical load over only a relatively small area (due to the cross section of the viaduct and its overlap with the River Wensum, see above) and the small amount deposited would be diluted quickly by river flows. It would not lead to deterioration of the condition of the River Wensum SAC through a change in nutrient status and would not undermine the objective of restoring the site to a more favourable condition in line with its conservation objectives. The Wensum is also sensitive to acidification (Natural England, 2022) and deposition of acids (e.g., NH_x, SO_2) from exhaust fumes of construction traffic would affect the water column. However, as with nitrogen deposition the small overlap between the River Wensum and the Proposed Scheme construction footprint would restrict the potential for acidification, and the calcareous chemistry of the river water (Berrie, 1992) would buffer the resulting change in pH to non-perceptible levels. Thus, localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Dust, sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs (including windblown dust) which can smother stands of vegetation and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008), causing significant effects on in-channel vegetation. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream. Therefore, construction phase sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction phase.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Noise and vibrational disturbance	No	*Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation is not sensitive to noise and vibrational disturbance, and consequently it is not a likely effect of the Proposed Scheme during its construction phase.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species	Yes	Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect *Ranunculion fluitanti*s and *Callitricho-Batrachion* vegetation if established. Therefore, Introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase.
White-clawed (or Atlantic stream) crayfish	Temporary and permanent loss of supporting floodplain habitat due to land-take	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (Section 5.6). Thus, white-clawed crayfish would not be affected by temporary and permanent loss of supporting floodplain habitat due to land-take.
White-clawed (or Atlantic stream) crayfish	Changes in hydrological conditions – non-flood condition river flows and ground water levels	No	White-clawed crayfish are absent from the stretch of the River Wensum crossed by the Proposed Scheme and an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (see Section 5.6). Thus, white-clawed crayfish would not be affected by changes in hydrological conditions – non-flood condition river flows and ground water levels.
White-clawed (or Atlantic stream) crayfish	Changes in hydrological conditions – increased flood risk	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (Section 5.6). Thus, white-clawed crayfish would not be affected by changes in hydrological conditions e.g., increased flood risk.
White-clawed (or Atlantic stream) crayfish	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (Section 5.6). Thus, white-clawed crayfish would not be affected by shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform.

Feature	Impact	LSE?	Reasoning
White-clawed (or Atlantic stream) crayfish	Fragmentation of the landscape by construction of the Proposed Scheme	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (Section 5.6). Thus, white-clawed crayfish would not be affected by fragmentation of the landscape by construction of the Proposed Scheme.
White-clawed (or Atlantic stream) crayfish	Localised changes in air quality due to emissions of construction vehicles	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (see Section 5.6). Thus, white-clawed crayfish would not be affected by localised changes in air quality due to emissions of construction vehicles.
White-clawed (or Atlantic stream) crayfish	Dust, sediment and chemical run-off	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (Section 5.6). Thus, white-clawed crayfish would not be affected by sediment and chemical run-off.
White-clawed (or Atlantic stream) crayfish	Noise and vibrational disturbance	No	This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see Section 5.6). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (see Section 5.6). Thus, white-clawed crayfish would not be affected by noise and vibrational disturbance.
White-clawed (or Atlantic stream) crayfish	Introduction of invasive non-native plants (e.g. Himalayan balsam) and animal (e.g. signal crayfish) species	No	This species has been shown to be absent from the River Wensum that is crossed by the Proposed Scheme (see Section 5.6), and a population of signal crayfish has already established itself in its place. Thus, white-clawed crayfish would not be affected by Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species.

Feature	Impact	LSE?	Reasoning
Bullhead	Temporary and permanent loss of supporting floodplain habitat due to land-take	Yes	Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes within the river itself on which bullhead rely. Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Bullhead	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Yes	Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Bullhead	Changes in hydrological conditions – increased flood risk	Yes	Temporary works structures including the Temporary Works Platform across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of in-channel vegetation stands within the river channel and immediately downstream of the works area which bullhead relies upon as a habitat, for foraging areas and for shelter. Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.
Bullhead	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Yes	In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which bullhead relies upon as a habitat, for foraging areas and for shelter. Both the under-construction viaduct and Temporary Works Platform represent sources of shading. Therefore, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Bullhead	Fragmentation of the landscape by construction of the Proposed Scheme	No	No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the main channel as a result of the Proposed Scheme. Although the main River Wensum channel provides suitable habitat for bullhead, due to the recorded absence of bullhead in WC5 and its poor suitability to support them (bullhead require coarse substrates with large stones (Tomlinson and Perrow, 2003)), the proposed temporary diversion and culverting on WC5 is not expected to cause fragmentation for bullhead populations. Thus, no fragmentation of habitat used by bullhead would occur and fragmentation is therefore not considered a likely effect of the Proposed Scheme upon this species.
Bullhead	Localised changes in air quality due to emissions of construction vehicles	No	Localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme on bullhead. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on bullhead through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for Ranunculion fluitantis and Callitricho-Batrachion vegetation, neither nitrogen deposition nor water acidification would significantly alter bullhead habitat within the River Wensum, and thus localised changes in air quality due to emissions of construction vehicles is therefore not considered a likely effect of the Proposed Scheme upon this species.
Bullhead	Dust, sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs (including windblown dust) which can smother stands of vegetation on which bullhead relies, and fill pore-spaces within the riverbed (the ‘hyporheic zone’) (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g. fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme’s River Wensum crossing, as well as downstream, affecting bullhead. Sediment and chemical run-off could also kill bullhead directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Bullhead	Noise and vibrational disturbance	Yes	Construction of the Proposed Scheme would generate noise and vibrational disturbance adjacent to the River Wensum as a result of works to build the proposed viaduct. Fish such as bullhead are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals and consequently effects on the wider population of bullhead in the Wensum. Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Bullhead	Introduction of invasive non-native plants (e.g. Himalayan balsam) and animal (e.g. signal crayfish) species	Yes	Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect bullhead if established. Therefore, Introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Temporary and permanent loss of supporting floodplain habitat due to land-take	Yes	Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes within the river itself on which brook lamprey rely. Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Yes	Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Brook lamprey	Changes in hydrological conditions – increased flood risk	Yes	Temporary works structures including the Temporary Works Platform across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of in-channel vegetation stands within the river channel and immediately downstream of the works area which brook lamprey relies upon as a habitat, as larval feeding areas and for shelter of both larvae and adults. Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.
Brook lamprey	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Yes	In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which brook lamprey relies upon as a habitat, as larval feeding areas and for shelter of both larvae and adults. Both the under-construction viaduct and Temporary Works Platform represent sources of shading. Therefore, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Fragmentation of the landscape by construction of the Proposed Scheme	Yes	No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. Thus, fragmentation of in-channel habitats used by brook lamprey and fragmentation within the wider floodplain will be taken forward for further consideration at Stage 2.
Brook lamprey	Localised changes in air quality due to emissions of construction vehicles	No	Localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme on brook lamprey. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on bullhead through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for Ranunculion fluitantis and Callitricho-Batrachion vegetation, neither nitrogen deposition nor water acidification would significantly alter brook lamprey habitat within the River Wensum, and thus localised changes in air quality due to emissions of construction vehicles is therefore not considered a likely effect of the Proposed Scheme upon this species.

Feature	Impact	LSE?	Reasoning
Brook lamprey	Dust, sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs (including windblown dust) which can smother stands of vegetation on which brook lamprey adults and larvae rely. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting brook lamprey. Sediment and chemical run-off could also kill brook lamprey directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Noise and vibrational disturbance	Yes	Construction of the Proposed Scheme would generate vibrational and percussive noise adjacent to the River Wensum as a result of works to build the proposed viaduct. Fish such as brook lamprey are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals, their ability to breed, and consequently effects on the wider population of brook lamprey in the Wensum. Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species	Yes	Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect brook lamprey if established. Therefore, Introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Temporary and permanent loss of supporting floodplain habitat due to land-take	Yes	Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect wider processes on which this species relies, including habitat fragmentation and links to habitat in the wider landscape. Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Desmoulin's whorl snail	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Yes	Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Changes in hydrological conditions – increased flood risk	Yes	Temporary works structures including the Temporary Works Platform across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and these areas currently support a population of Desmoulin's whorl snail. Increased flood risk could lead to consequent effects on the population's viability, and therefore changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	No	There would be no effect of shading on Desmoulin's whorl snail as it is not found within the Site Boundary and ditches and river margins within this area are not suitable to support Desmoulin's whorl snail (Section 5.4). Thus, no Desmoulin's whorl snail habitat would be lost, and shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform is not considered a likely effect of the Proposed Scheme upon this species.

Feature	Impact	LSE?	Reasoning
Desmoulin's whorl snail	Fragmentation of the landscape by construction of the Proposed Scheme	No	Although the Proposed Scheme crosses the River Wensum floodplain, the use of a viaduct in its design would maintain a link between habitats either site of the Proposed Scheme alignment and avoid effects of fragmentation and the separation of the existing Desmoulin's whorl snail populations in WC3, WC4, and in the Wensum floodplain 1 kilometre to the south-east of the Site Boundary. The principal dispersal mechanism of Desmoulin's Whorl snail is waterborne transportation, and snails typically disperse across floodplains during periods of flooding (Killeen, 2003). The Proposed Scheme design would retain the majority of existing connective floodplain habitat within the Site Boundary, as the design of the viaduct structure minimises the number of piers required and therefore the amount of permanent habitat loss within the floodplain. This would allow for the potential future colonisation of Desmoulin's whorl snail in this area. The Proposed Scheme design also ensures the retention of up- and downstream connectivity of watercourses across the Wensum floodplain for the duration of the operation of the Proposed Scheme, and this would further reduce the risk of fragmentation. The culverting of WC5 to facilitate the construction of a temporary works platform would allow the passage of water and would be reduced to the minimum length required (approximately 22m) to support a permanent maintenance track for the Proposed Scheme operational period. It should be noted that the ditches and the river margins of the Wensum in the crossing area are either not suitable for Desmoulin's whorl snail (Section 5.4) or returned negative results for this species during surveys. Habitat beneath the viaduct would remain passable for the duration of the Proposed Scheme, and the fragmentation of the landscape and therefore the existing populations by construction of the Proposed Scheme is not considered a likely effect of the Proposed Scheme upon this species.

Feature	Impact	LSE?	Reasoning
Desmoulin's whorl snail	Localised changes in air quality due to emissions of construction vehicles	No	Localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme on Desmoulin's whorl snail. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. The temporary nature of the construction works, alongside the distance of the population of this feature from the Site Boundary (~80m), would avoid effects of localised changes in air quality due to emissions of construction vehicles, which is not considered a likely effect of the Proposed Scheme upon this species.
Desmoulin's whorl snail	Dust, sediment and chemical run-off	Yes	Run-off from the Proposed Scheme could enter the ditch system on adjacent land that supports Desmoulin's whorl snail, altering and / or degrading habitat used by this species. Dust from construction may also have a similar effect. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Noise and vibrational disturbance and	No	Desmoulin's whorl snail is not considered to be sensitive to noise and vibrational disturbance, as both these effects are not identified as attributes in site-specific supplementary advice on conserving and restoring site features for River Wensum SAC (Natural England, 2022), and thus this is not considered to be a likely effect upon this species.
Desmoulin's whorl snail	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species	Yes	Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect Desmoulin's whorl snail if established. Therefore, the introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.

6.9 Screening – Operation Phase (River Wensum SAC)

Table 6-2 River Wensum SAC; Screening for LSEs at the Proposed Scheme Operational Phase

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Shading of vegetation by the operational viaduct	Yes	In-channel vegetation is reliant on light and shading could cause dieback of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation stands, as well as other in-channel and riparian vegetation. The permanent viaduct represents a source of shading. That comprises a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008), causing significant effects on in-channel vegetation. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream. Therefore, operational phase sediment and chemical run-off represents a potential LSE of the Proposed Scheme and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	No	Lowland rivers such as the River Wensum are typically nutrient poor, with the availability of phosphorus (rather than nitrogen) within the ecosystem limiting the growth of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation as well as other macrophyte species and algae (English Nature, 1999; Natural England, 2022). Analysis of nitrogen to phosphorus ratios within the River Wensum confirm phosphorus is the limiting nutrient (Air Quality Ecological Impact Assessment; **Document Reference 3.10.34b**)). Emissions from vehicles using the Proposed Scheme during operation would lead to deposition of nitrogen compounds as a result of exhausts including nitrogen dioxide and nitrate (Environmental Statement **Chapter 6: Air Quality**); phosphorus is not released by vehicle exhausts and would not become elevated in the River Wensum as a result of localised air quality changes. Levels of phosphorus in the River Wensum ecosystem would therefore not change as a result of the Proposed Scheme and would remain as a growth-limiting factor for in-stream plants. Thus, the sensitivity of vegetation of the River Wensum to air quality changes during the operational phase is low. Input of nitrogen from agricultural run-off (either consistently over time or through pollution events) would see concentrations of nitrogen enter the river at orders of magnitude greater than from air quality changes due to the Proposed Scheme (Natural England, 2022). In addition, floodplain grassland habitat surrounding the River Wensum in its floodplain show effects of agricultural improvement, and thus is not considered sensitive to the effects of enrichment through nitrogen deposition as it already receives significant nitrogen input from such sources, primarily manure from grazing animals (“Nitrogen deposition :: Improved Grassland”; APIS, 2023). Nitrogen deposition would not significantly raise the nutrient status of the river due to the small overlap between the River Wensum and the operational cross section of the viaduct, the Wensum only being 10-12m wide beneath it. The height of the viaduct would also reduce nitrogen compound deposition, with exhaust fumes dispersing before descending to the level of the River Wensum. In addition, given the surrounding land uses, nitrogen from existing background agricultural run-off into the Wensum is relatively high and that received by the water column from vehicles using the completed viaduct would not be perceptible above existing inputs to the river.

Feature	Impact	LSE?	Reasoning
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	No	The principal of nutrient neutrality in relation to Habitats Sites was established prior to the UK leaving the European Union by the joined cases C-293/17 and C-294/17 as ruled upon by the Court of Justice of the European Union in 2018 (together, the 'Dutch Nitrogen' case). The ruling concerns agricultural activities in sites protected by the Habitats Directive and where nitrogen deposition levels already exceeded the critical load and has affected the consent for developments in the UK. The Proposed Scheme does not contradict the precedent set by the Dutch Nitrogen cases in relation to River Wensum SAC nor the concurrent principal of nutrient neutrality. Nitrogen received by the River Wensum from aerial deposition during the Proposed Scheme's operational phase exceeds critical load over only a relatively small area (due to the cross section of the viaduct and its overlap with the River Wensum, see above) and the small amount deposited would be diluted quickly by river flows. It would not lead to deterioration of the condition of the River Wensum SAC through a change in nutrient status and would not undermine the objective of restoring the site to a more favourable condition in line with its conservation objectives. The Wensum is also sensitive to acidification (Natural England, 2022) and deposition of acids (e.g. NHx, SO_2) from exhaust fumes traffic would affect the water column. However, as with nitrogen deposition the small overlap between the River Wensum and the Proposed Scheme construction footprint would restrict the potential for acidification, and the calcareous chemistry of the river water (Berrie, 1992) would buffer the resulting change in pH to non-perceptible levels. Thus, localised changes in air quality as a result of emissions from vehicles using the completed viaduct is not a likely effect of the Proposed Scheme during its operational phase.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Noise and vibrational disturbance	No	*Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation is not sensitive to noise and vibrational disturbance, and consequently it is not a likely effect of the Proposed Scheme during its operational phase.

Feature	Impact	LSE?	Reasoning
White-clawed (or Atlantic stream) crayfish	Shading of vegetation by the operational viaduct	Yes	In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which white-clawed crayfish would rely upon as a habitat upon recolonisation, for foraging areas and for shelter. The operational viaduct would represent a permanent source of shading. Therefore, shading of in-channel vegetation by the completed viaduct represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
White-clawed (or Atlantic stream) crayfish	Sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation on which recolonising white-clawed crayfish relies, and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting recolonising white-clawed crayfish. Sediment and chemical run-off could also kill recolonising white-clawed crayfish directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
White-clawed (or Atlantic stream) crayfish	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	No	Localised changes in air quality due to emissions of vehicles using the operational viaduct is not a likely effect of the Proposed Scheme on recolonising white-clawed crayfish. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on white-clawed crayfish through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen deposition nor water acidification would significantly alter habitat within the River Wensum, and thus localised changes in air quality due to emissions of vehicles using the operational viaduct is therefore not considered a likely effect of the Proposed Scheme upon this species.

Feature	Impact	LSE?	Reasoning
White-clawed (or Atlantic stream) crayfish	Noise and vibrational disturbance	Yes	Operation of the Proposed Scheme would generate noise and vibrational adjacent to the River Wensum. Noise would not only be transmitted directly through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. White-clawed crayfish are sensitive to such sources of disturbance which could prevent them from recolonising viable habitat in the vicinity of works, which may have effects on recolonising of white-clawed crayfish in the Wensum. Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Bullhead	Shading of vegetation by the operational viaduct	Yes	In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which bullhead relies upon as a habitat, for foraging areas and for shelter. The operational viaduct represents a permanent source of shading. Therefore, shading of in-channel vegetation by the completed viaduct represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Bullhead	Sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation on which bullhead relies, and fill pore-spaces within the riverbed (the ‘hyporheic zone’) (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme’s River Wensum crossing, as well as downstream, affecting bullhead. Sediment and chemical run-off could also kill bullhead directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Bullhead	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	No	Localised changes in air quality due to emissions of vehicles using the operational viaduct is not a likely effect of the Proposed Scheme on bullhead. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on bullhead through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen deposition nor water acidification would significantly alter bullhead habitat within the River Wensum, and thus localised changes in air quality due to emissions of vehicles using the operational viaduct is therefore not considered a likely effect of the Proposed Scheme upon this species.
Bullhead	Noise and vibrational disturbance	Yes	Operation of the Proposed Scheme would generate noise and vibrational adjacent to the River Wensum. Noise would not only be transmitted directly through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. Fish such as bullhead are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals and consequently effects on the wider population of bullhead in the Wensum. Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Shading of vegetation by the operational viaduct	Yes	In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which brook lamprey relies upon as a habitat, for foraging areas and for shelter. The operational viaduct represents a permanent source of shading. Therefore, shading of in-channel vegetation by the completed viaduct represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Brook lamprey	Sediment and chemical run-off	Yes	Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation on which brook lamprey relies, and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting brook lamprey. Sediment and chemical run-off could also kill brook lamprey directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Brook lamprey	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	No	Localised changes in air quality due to emissions of vehicles using the operational viaduct is not a likely effect of the Proposed Scheme on brook lamprey. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on brook lamprey through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen deposition nor water acidification would significantly alter brook lamprey habitat within the River Wensum, and thus localised changes in air quality due to emissions of vehicles using the operational viaduct is therefore not considered a likely effect of the Proposed Scheme upon this species.
Brook lamprey	Noise and vibrational disturbance	Yes	Operation of the Proposed Scheme would generate noise and vibrational adjacent to the River Wensum. Noise would not only be transmitted directly through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. Fish such as brook lamprey are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals and consequently effects on the wider population of brook lamprey in the Wensum. Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.

Feature	Impact	LSE?	Reasoning
Desmoulin's whorl snail	Shading of vegetation by the operational viaduct	No	There would be no effect of shading on Desmoulin's whorl snail as this species is not considered to be present within the Site Boundary that contains the viaduct, and habitat in this area was considered to be unsuitable for supporting this species. No Desmoulin's whorl snail habitat would therefore be impacted by shading and shading of vegetation by the operational viaduct (which crosses suitable habitat for this species in the River Wensum floodplain) is not considered a likely effect of the Proposed Scheme upon this species.
Desmoulin's whorl snail	Sediment and chemical run-off	Yes	Run-off from the Proposed Scheme could enter the ditch system on adjacent land that supports Desmoulin's whorl snail, altering and / or degrading habitat used by this species. Therefore, operational phase sediment and chemical run-off represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	Yes	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct would occur and could affect land adjacent to the Proposed Scheme. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. Changes in vegetation in the River Wensum floodplain due to air quality changes therefore represent a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Desmoulin's whorl snail	Noise and vibrational disturbance	No	Desmoulin's whorl snail is not considered to be sensitive to noise and vibrational disturbance, as both these effects are not identified as attributes in site-specific supplementary advice on conserving and restoring site features for River Wensum SAC (Natural England, 2022), and thus this is not considered to be a likely effect upon this species.

6.10 Screening – Operation Phase (Norfolk Valley Fens SAC)

Table 6-3 Norfolk Valley Fens, SAC, Potter and Scarning Fens; Screening for LSEs at the Proposed Scheme Operational Phase

Feature	Impact	LSE?	Reasoning
Alkaline Fens	Wide-scale air quality changes within the ARN	Yes	Perceptible effects of air quality changes are typically limited to within 200m of their source (Highways England, 2019), in this case adjacent roads included within the Proposed Scheme's ARN. This 200m zone overlaps with the boundary of Potter and Scarning Fens. As Alkaline Fen habitat is present at all three SAC areas, this and could lead to effects on this habitat through chemical changes to soil (e.g., nutrient status, soil pH) or direct contact between aerial pollutants and plants (e.g. soot). Therefore, operational phase wide-scale air quality changes within the ARN represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.
Northern Atlantic Wet Heaths with *Erica tetralix*	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that northern Atlantic wet heath with *Erica tetralix* habitat is not present at Potter and Scarning Fens within 200m of the ARN. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
European dry heaths	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that European dry heaths habitat is not present at Potter and Scarning Fens within 200m of the ARN. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
Semi-natural dry grasslands and scrublands facies on calcarerous substrates (*Festuco-Brometalia*) (important orchid sites)	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that semi-natural dry grasslands and scrublands facies on calcareous substrate habitat is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Feature	Impact	LSE?	Reasoning
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that Molinia meadows on calcareous, peaty or clayey-silt-laden soils habitat is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
Alluvial forests with *Alnus glutinosa* and *Fraxinus exceslsior* (*Alno-Padion, Anion incanae, Salicion albae*)	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* habitat is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
Narrow-mouthed whorl snail	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that narrow-mouthed whorl snail is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.
Desmoulin's whorl snail	Wide-scale air quality changes within the ARN	No	Site-specific supplementary advice on conservation objectives indicates that Desmoulin's whorl snail is not present at Potter and Scarning Fens. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Table 6-4 Screening of Developments for Construction and / or In-Combination (I-C) Effects

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20211535	S6	Consented dual carriageway A47 North Tuddenham to Easton	Yes	The A47 meets the southern boundary of the Proposed Scheme where it is intended to provide a new route north between the A47 and A1067. Dualling of the A47 could therefore interact with the Proposed Scheme directly and in-directly. In-combination effects on River Wensum SAC are therefore possible and will be assessed through Stage 2 Appropriate Assessment. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20201769	S1	TMA Bark Supplies Ltd; extension to existing commercial development	No	Relatively small-scale development at an existing site a long distance (~1.7 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20190458	N/A	Weston Park Golf Club; new clubhouse and other facilities	No	Relatively small-scale development at an existing site a long distance (~1.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20181090	N/A	Colton Road, Honingham; new agricultural / food processing facility	No	Relatively small-scale development at a long distance (~1.9 kilometres) from the Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20180674	N/A	Old Hall Farm; construction of lined reservoir for water storage	No	Relatively small-scale development creating a waterbody that, although it would be lined and would not support marginal vegetation, offers new open water habitat within an existing golf course. Located ~800m to the east of the Proposed Scheme. The type, scale and distance of the development mean it would not act in-combination with the Proposed Scheme to effect Habitats Sites. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20170547	N/A	2No. wind turbine construction at Weston Longville	No	Development at a considerable distance from the Proposed Scheme (1.9 kilometres), with a relatively small footprint. It would therefore not act in-combination with the Proposed Scheme to effect Habitats Sites. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20171676	N/A	Wensum Valley Golf Course; construction of a new hotel and leisure complex, and installation of a new golf course reservoir	No	Relatively small-scale development at an existing site a long distance (~0.8 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20171001	N/A	Land at Fir Covert Road, Taverham; construction of new supermarket	No	Relatively small-scale development at an existing site a long distance (~0.7 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to effect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20211831	S2	Roundwood, Taverham; change of use of land to campsite with associated buildings	No	Relatively small-scale development at an existing site a long distance (~1.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20211698	S13	Land off Beech Avenue, Taverham; construction of 25 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20172148	S13	Land off Beech Avenue, Taverham; construction of 93 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.4 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20171782	S5	Taverham Garden Centre; new retail units	No	Relatively small-scale re-development within an existing garden centre site at distance (~800m) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20171097	N/A	Taverham Junior School; new classroom buildings	No	Relatively small-scale development at an existing school site a long distance (~1.9 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20161425	N/A	Taverham Hall School; new classrooms and roof alterations	No	Relatively small-scale development at an existing school site a long distance (~1.5 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20200518	S13	Land off Beech Avenue, Taverham; construction of 93 new dwellings	No	As above for Reference 20172148.
20191659	S13	Land off Beech Avenue, Taverham; construction of 93 new dwellings	No	As above for Reference 20172148.
20200033	N/A	Taverham Park, Taverham; construction of 6 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.5 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
20201332	S4	Earth Bund directly north of the A1270 Fakenham Road, land that lies between the Fakenham Road and Fir Covert Road junctions.	No	This small-scale development involves landscaping only and lies ~850m from the Proposed Scheme. The scale and distance of the development from the Proposed Scheme would prevent in-combination effects on Habitats Sites. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20181302	N/A	Attlebridge Quarry; proposed extraction of sand and gravel	No	Lies ~1 kilometre from the River Wensum and ~0.7 kilometres from the Proposed Scheme to its north. Although this quarry development may require loss of woodland habitat whilst extraction takes place, this would not interact with the Proposed Scheme to lead to significant effects on the aquatic habitats in the River Wensum SAC or other Habitats Sites. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20191399	N/A	1-4 Station Road, Swannington; construction of 10 new dwellings	No	Relatively small-scale development a long distance (~2.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
3PL/2016/0620/VAR	N/A	Land East of Heath Road, Hockering; construction of 10 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.9 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
3PL/2021/1269/D	N/A	Land adjacent to No. 20 Heath Road, Hockering; construction of 10 new dwellings	No	As above for Reference 3PL/2016/0620/VAR.
3PL/2021/1009/O	N/A	Rectory Farm Heath Road Hockering; construction of 18 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.9 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
3PL/2021/0533/VAR	N/A	Hill House, Albatross Road, Hockering; construction of 14 new dwellings	No	Relatively small-scale development within a residential area a long distance (~1.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to effect National Network sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
3SR/2018/0001/SCR	N/A	East of Tuddenham to Mattishall Water Treatment Works; new water pipeline	No	Although the scale of this pipeline development is relatively large, it lies over 3 kilometres from the Proposed Scheme and when completed would be buried, meaning construction only requires temporary land-take with habitats restored once its construction ends. Thus, it would not act in-combination with the Proposed Scheme to effect Habitats Sites. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
3PL/2017/0367/O	N/A	Land adjacent to Common Road; construction of 10 new dwellings	No	Relatively small-scale development within a residential area a long distance (~2.1 kilometres) from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
20220034	N/A	Norfolk Dinosaur Park	No	Development within an existing golf course / leisure complex a long distance (~1.2 kilometres) from the Proposed Scheme, and over 3 kilometres from the Scheme crossing of the River Wensum. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
EN010080	S7	Hornsea Project Three Offshore Export Cable	No	Installation of an electricity cable which would cross the River Wensum. Hornsea Project Three is ~2 kilometres from the Proposed Scheme on the west-side of Attlebridge. Although the project crosses the River Wensum SAC, it would achieve this by the use of directional drilling underneath it and so avoid adverse effects. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
EN010109	S11	Sheringham Shoal Offshore Wind Farm Extension Project and Dudgeon Offshore Wind Farm Extension Project	No	Two offshore windfarm projects with a joint export cable system, offshore and onshore, connecting to the national grid transmission network at Norwich Main substation. The cable which would cross the River Wensum ~1.5 kilometres to the north-west of the Proposed Scheme. It would achieve this by the use of directional drilling underneath it and so avoid adverse effects. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

Ref	ES Appendix 10.36 ID	Development Name	I-C Effect?	Reasoning
Not subject to planning application	S15	STS Scheme - Cycle friendly improvements within the highway boundary.	No	Improvement of an existing highways with cycle friendly improvements. Although adjacent to the Proposed Scheme, is small scale and within the existing highways boundary so would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.
EN010087	S10	Norfolk Boreas Offshore Wind Farm - onshore cable route.	No	The geographic location of above ground elements of the development is over 10 kilometres from the Proposed Scheme. Would not act in-combination with the Proposed Scheme to affect Habitats Sites for these reasons. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within this report inherently consider an in-combination assessment of movements associated with this development.

6.11 Results of Screening

6.11.1 No LSEs were identified for Paston Great Barn SAC as described in Section 6.6 above. LSEs were identified potentially affecting River Wensum SAC and Norfolk Valley Fens SAC. These comprised:

- River Wensum SAC – Construction Phase:
  Temporary and permanent loss of supporting floodplain habitat due to land-take – Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; and Desmoulin's whorl snail.

  Changes in hydrological conditions – non-flood condition river flows and ground water levels – Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; Desmoulin's whorl snail.

  Changes in hydrological conditions-increased flood risk – Water course with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; and Desmoulin's whorl snail.

  Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform – water course with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; and brook lamprey.

  Sediment and chemical run-off – water course with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; and Desmoulin's whorl snail.

  Noise and vibrational disturbance – bullhead; and brook lamprey.

  Introduction of invasive non-native plant (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species – water course with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; and Desmoulin's whorl snail.

- River Wensum SAC – Operational Phase:
  Shading of vegetation by the operational viaduct – *water course with Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; and brook lamprey.

  Sediment and chemical run-off – *water course with Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; bullhead; brook lamprey; and Desmoulin's whorl snail.

  Noise and vibrational disturbance – bullhead; and brook lamprey.

- Norfolk Valley Fens SAC – Operational Phase
  Wide-scale air quality changes within the ARN - Alkaline Fens (Potter and Scarning Fens).

6.11.2 **Table 6-5** audits the LSEs against each Habitats Site, Proposed Scheme phases and qualifying features in detail. The results of screening are also summarised through a matric approach as presented in Appendix 3.

6.11.3 In addition, a proposed road scheme, A47 North Tuddenham to Easton, was identified that could potentially act in-combination with the Proposed Scheme to lead to effects.

6.11.4 LSEs have been identified in the absence of mitigation, in line with case law. However, suitable measures to avoid and mitigate LSEs can be applied at Appropriate Assessment stage and LSEs that have been identified could be managed through the application of good working practices that would mitigate for potential adverse effects during the construction and / or operational stages, as described in section 8 below.

6.11.5 Stage 2 Appropriate Assessment has been undertaken in section 8 below to provide the required information for the competent authority to make an informed decision on the Proposed Scheme. The Appropriate Assessment process examines in more detail the LSEs identified above, as well as potential in-combination effects with other schemes, and whether they would

lead to adverse effects on Habitats Sites as a result of the Proposed Development.

Table 6-5 Habitats Sites and associated LSEs following screening

Habitats Site	Proposed Scheme Phase	LSE	Qualifying Feature
River Wensum SAC	Construction	Temporary and permanent loss of supporting floodplain habitat due to land-take	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Temporary and permanent loss of supporting floodplain habitat due to land-take	Bullhead
River Wensum SAC	Construction	Temporary and permanent loss of supporting floodplain habitat due to land-take	Brook lamprey
River Wensum SAC	Construction	Temporary and permanent loss of supporting floodplain habitat due to land-take	Desmoulin's whorl snail
River Wensum SAC	Construction	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Bullhead
River Wensum SAC	Construction	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Brook lamprey

Habitats Site	Proposed Scheme Phase	LSE	Qualifying Feature
River Wensum SAC	Construction	Changes in hydrological conditions – non-flood condition river flows and ground water levels	Desmoulin's whorl snail
River Wensum SAC	Construction	Changes in hydrological conditions – increased flood risk	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Changes in hydrological conditions – increased flood risk	Bullhead
River Wensum SAC	Construction	Changes in hydrological conditions – increased flood risk	Brook lamprey
River Wensum SAC	Construction	Changes in hydrological conditions – increased flood risk	Desmoulin's whorl snail
River Wensum SAC	Construction	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Bullhead
River Wensum SAC	Construction	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	Brook lamprey

Habitats Site	Proposed Scheme Phase	LSE	Qualifying Feature
River Wensum SAC	Construction	Fragmentation of the landscape by construction of the Proposed Scheme	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Fragmentation of the landscape by construction of the Proposed Scheme	Brook lamprey
River Wensum SAC	Construction	Sediment and chemical run-off	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Sediment and chemical run-off	Bullhead
River Wensum SAC	Construction	Sediment and chemical run-off	Brook lamprey
River Wensum SAC	Construction	Sediment and chemical run-off	Desmoulin's whorl snail
River Wensum SAC	Construction	Noise and vibrational disturbance	Bullhead
River Wensum SAC	Construction	Noise and vibrational disturbance	Brook lamprey

Habitats Site	Proposed Scheme Phase	LSE	Qualifying Feature
River Wensum SAC	Construction	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish*)* species	Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
River Wensum SAC	Construction	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species	Bullhead
River Wensum SAC	Construction	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species	Brook lamprey
River Wensum SAC	Construction	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g. signal crayfish) species	Desmoulin's whorl snail
River Wensum SAC	Operation	Shading of vegetation by the operational viaduct	Water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation
River Wensum SAC	Operation	Shading of vegetation by the operational viaduct	White-clawed (or Atlantic stream) crayfish
River Wensum SAC	Operation	Shading of vegetation by the operational viaduct	Bullhead
River Wensum SAC	Operation	Shading of vegetation by the operational viaduct	Brook lamprey

Habitats Site	Proposed Scheme Phase	LSE	Qualifying Feature
River Wensum SAC	Operation	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	Desmoulin's whorl snail
River Wensum SAC	Operation	Sediment and chemical run-off	Water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation
River Wensum SAC	Operation	Sediment and chemical run-off	White-clawed crayfish
River Wensum SAC	Operation	Sediment and chemical run-off	Bullhead
River Wensum SAC	Operation	Sediment and chemical run-off	Brook lamprey
River Wensum SAC	Operation	Sediment and chemical run-off	Desmoulin's whorl snail
River Wensum SAC	Operation	Noise and vibrational disturbance	White-clawed crayfish
River Wensum SAC	Operation	Noise and vibrational disturbance	Bullhead
River Wensum SAC	Operation	Noise and vibrational disturbance	Brook lamprey
Norfolk Valley Fens SAC (Potter and Scarning Fens)	Operation	Wide-scale air quality changes within the ARN	Alkaline Fens

7 Mitigation

7.1 Outline Construction Environmental Management Plan

7.1.1 Construction phase environmental mitigation and avoidance measures, including those relevant to ecological features, have been compiled in an Outline Construction Environmental Management Plan (OCEMP) for the Proposed Scheme (**Document Reference 3.03.01**). The OCEMP has been designed to accompany the submission for planning approval for the Proposed Scheme and is a live document with the responsibility of its implementation falling to the Principal Contractor.

7.1.2 It would be their responsibility to develop the document into a full Construction Environmental Management Plan (CEMP) and ensure proposed measures are implemented, reviewed and updated on a regular basis throughout the construction phase, with new environmental construction measures are identified and implemented as needed. Compliance with this would be secured by planning condition.

7.1.3 The OCEMP sets out the overarching principles for construction management of the Proposed Scheme and aims to:

- Provide an overview of the methodology to be adopted during construction of the Proposed Scheme;
- Outline the environmental constraints on and around the RLB and the potential impacts of these;
- Ensure that mitigation measures set out in the environmental statement submitted as part of the application for planning approval are implemented during construction;
- Ensure that industry best practice standards are adopted throughout the construction of the Proposed Scheme; and

- Be a point of reference for the project team, interested parties, site workers etc.

7.1.4 **Table 7-1** summarises environmental mitigation measures included within the OCEMP relevant to LSEs associated with River Wensum SAC and Norfolk Valley Fens SAC.

Table 7-1 Summary of relevant OCEMP mitigation measures

Category	Description of Mitigation Measures

Dust Control	• Measures to be used wherever practicable include (but are not necessarily limited to) the following. The Principal Contractor would be required to routinely monitor the effectiveness of dust mitigation. Regular inspections would be undertaken to monitor dust. The frequency of monitoring would be increased when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions. The choice on mitigation would be tailored to the activity and impacts expected throughout the construction phase:
	  • Dust generating activities (e.g., cutting, grinding, and sawing) would be minimised and weather conditions considered prior to conducting potentially dust emitting activities.
	  • Open-air storage mounds or stockpiles of potentially dusty materials including sand, aggregates, soil, spoil, and waste shall be minimised order to prevent exposure to wind and / or dust nuisance. Such storage within 200m of any sensitive receptor is to be avoided as far as is practicable.
	  • Surfaces of storage mounds or stockpiles are to be maintained in a damp condition where practicable to minimise the risk of dust.
	  • Storage mounds and stockpiles are to be carefully profiled to avoid collapse.
	  • Remove materials that have the potential to produce dust from Site as soon as possible, unless being re-used on Site.
	  • All waste must be stored in appropriate containers to prevent any fugitive emissions of dust or odour.
	  • Roads and accesses would be kept clean.
	  • Surfaces of unpaved haul roads and Site areas routinely crossed by vehicles and plant are to be regularly compacted and maintained in a damp condition to minimise the risk of dust mobilisation by the wind or passage of vehicles / plant.
	• Where possible, plant would be located away from construction site boundaries that are close to residential areas.
	• Vehicles / Skips transporting waste or construction materials would be securely covered.
	• Material or waste would not be burnt on-site.
	• Earthworks operations shall be organised to avoid double handling of potentially dusty materials where practicable.
	• Re-vegetate earthworks and other exposed areas to stabilise surfaces as soon as is practicable.
	• All loads of potentially dusty materials are to be covered / contained before transport on the public highway to prevent the escape of materials.
	• Water-assisted dust sweeper(s) are to be employed to remove, as soon as practicable, any accumulations of mud and debris from hard standing areas within the Site and public highway due to trackout.
	• Wheel wash facilities would be installed at major construction site exits. Prior to leaving the Site all vehicles are to be inspected and, if necessary, cleaned to prevent the track-out of mud and debris onto the public highway.
	• Vehicle cleaning facilities are to be provided before the Site egress (where required to avoid mud on the public roads) with appropriate drainage arrangements to prevent pollution of surface and ground waters.
	• A daily record of weather and ground conditions at the Site is to be maintained. On dry working days, this is to include an account of visual inspections of all Site areas and safely accessible off-Site areas including the public highway and verges along construction traffic routes within 100m of the Site egress. Any clearly visible deposits of mud or debris on paved surfaces, off-site dust soiling, or plumes of dust crossing the Site boundary shall be noted along with any investigative and remedial actions taken.
	• All dust and air quality complaints are to be logged and investigated to identify cause(s) and ensure remedial measures are put in place and that these are effective. The complaints log and record of investigation and remedial action is to be made available to the Local Authority on request.
	• Regular monitoring (e.g., site walkovers) should be carried out by the Environmental Manager, a site supervisor or clerk of works when dust generating activities are occurring.
	• All dust and air quality complaints are to be logged and investigated to identify cause(s) and ensure remedial measures are put in place and that these are effective. The complaints log and record of investigation and remedial action is to be made available to the Local Authority on request.

Category	Description of Mitigation Measures
Run-off Control	The following general mitigation measures for the water and sediment environment should be in place during the construction phase to reduce or eliminate potential adverse impacts: • The preliminary earthwork drain (PED) network, the infrastructure for the management of surface water runoff, should be installed at the start of the construction phase. These should include suitable measures to deal with sediment settlement generated as part of the construction phase. • Vehicles and construction plants would be refuelled in the construction compound on an impermeable surface away from any drains or watercourses. • Spill kits would be made available in the refuelling area. • Bunds and interceptors would be used to prevent run-off carrying sedimentation or construction material into the PED network, ditches or local watercourses. • Bunded trays for standing pumps and chemical storage containers would be used as anti-pollution measures for site compounds located at / near potential sources of contamination. • Construction vehicles would be maintained, and construction materials managed to minimise the risk posed to the aquatic environment. • The Environment Agency and other appropriate bodies must be consulted prior to the commencement of site activity. • Nothing is permitted to enter the surface water drains which could cause pollution. • No foul drainage or contaminated surface water run-off would be discharged into any borehole, well, spring, soak away, lake or watercourse (including dry ditches having a connection with a watercourse). • Any water that has encountered contaminated materials must be disposed of in accordance with the Water Resources Act 1991 and the Water Industry Act 1991 to the satisfaction of the Environment Agency, sewerage provider and local authority as applicable. • No bentonite or any other piling support fluid must be allowed to reach the ground or surface waters of the River Wensum. In stakeholder discussions it has been agreed that a pipe can be used to transport bentonite piling support fluid across the River Wensum with appropriate mitigation. The mitigation measures shall be included within the Risk Assessment Method Statement (RAMS) produced by the Principal Contractor which would form part of the Flood Risk Activity Permit (FRAP). • Cut-off ditches would be used for entrance and exit from site to avoid sediment dispersion. Wheel washing facilities would be incorporated. These would require suitable containment of wash water, and sediment settlement provided if the wash water is to be discharged to a grass swale or similar. • The Principal Contractor would be required to produce a Flood Risk Management Action Plan / Method Statement which would provide details of the response to an impending flood and include. • A Piling Risk Assessment (PRA) would be required due to groundwater and surface water sensitivity within the River Wensum floodplain. This shall be produced by the Principal Contractor based on the detailed piling design. This would need to consider and ensure that no contamination becomes entrained into the shallow or deeper chalk aquifer, because of pile installation. This would need to be submitted as part of the Environmental Permits associated with the works. • Flood risk activity permits would be required for the construction of elements of the Proposed Scheme within 8m of the River Wensum or those elements within the floodplain which are not covered by the planning application. Appropriate methods statements would be required as part of the permit applications. These would need to set out site access requirements including the temporary works proposals within the River Wensum floodplain. The temporary works platform is situated above the River Wensum floodplain and would be used to store materials and plant during the construction phase. Restrictions on working areas and types of activities to be undertaken on this working platform should be put in place to minimise the risk of pollution events. For example, areas for washing down vehicles and storage of fuels should be avoided where possible). • Supervision by an ecological clerk of works for high-risk works within proximity of the River Wensum, including vegetation clearance and installation of temporary structures. • If required within the floodplain, any bentonite processing plants and associated pumping stations must be bunded, to contain any leaks or spills, with an impermeable membrane or surface to avoid any impacts to ground or water. • Any wheel washing facilities would need suitable containment of wash water, and sediment settlement would need to be provided if the wash water is to be discharged, via a grassed swale if feasible. • Fuel tanks or COSHH storage areas to be bunded to 110% of contents volume. • All project plants are to be maintained according to the manufacturer's standards.

Category	Description of Mitigation Measures
Run-off Control	• Spill kits to be stored at selected locations. • There should be no uncontrolled run-off of water or mud from the Site. • All machinery would be regularly checked for oil leaks or similar, which, if found, must be prevented from entering the drainage ditches or watercourses either through immediate repair of the machinery or by a drip tray / spill kit or similar. • Pollution control measures in place on-site, including silt barriers, allocated re-fuelling areas, and spill response measures in place (e.g., spill kits, emergency contractor). This would also need to consider runoff from any temporary bridges required for construction. • In the event of a spillage on site, the material to be contained (using an absorbent material such as sand or soil or commercially available booms). Sorbents would be used to soak up a spill and stop it from spreading on hard surfaces. Using sorbents generates waste and this method would only be used on small spills, or where a spill has been contained to stop further spread. All used sorbents would be disposed of at an accredited site for disposal. • If it is not possible to stop the spill at the source, significant attempts would be made to stop it as close to the source as possible. If possible, the spilling material would be safely moved into another container to limit the size of the spill. The use of a suitable container and pump may be required. • Fuel, oil, and chemicals would be stored in secondary containment and located a minimum of 10m from any watercourse. The secondary containment system must provide storage of at least 110% of the tank's maximum capacity and ensure that any valves, filters, sight gauges, vent pipes or other ancillary equipment are also situated within the secondary containment system and arranged so that any discharges are contained. • Temporary works de-watering (groundwater abstraction) is likely to be required locally. A dewatering management plan (dewatering strategy) would need to be developed and agreed with the Environment Agency to obtain suitable abstraction licenses and discharge permits. In particular in proximity to the River Wensum significant groundwater inflows into excavations should be avoided as much as practical to reduce the need for comprehensive water management. • De-watering and contaminated land control measures should be in place: particularly with reference to the management of excavated material from excavations which may be contaminated. • Sign up for flood warnings and check online warnings regularly. • Appropriate thresholds and flood warning systems should be identified beyond which working on the temporary works platform should be avoided because there is unacceptable risk associated with high flow events. • Site compounds should not be placed within an area at high risk of surface water flooding as identified on Environment Agency mapping, most notably the surface water flow paths that run between: • Weston Road and Ringland Lane, in close proximity to the Ringland Road site compound; • Along the alignment of the Foxburrow Stream between Honingham and Weston Green, where the Broadway Green Bridge is proposed. • Attenuation features that control additional surface water runoff resulting from the PED network and associated changes to the natural topographic catchment should be put in place at the start of the construction phase. If a flood warning is issued, move all machinery and equipment out of the floodplain. If this cannot be completed in a safe time, secure equipment to prevent it from being washed away
Storage and Management of Chemicals and Materials	All workers on-site would be made aware of potential contamination issues on the Site and would use best practice techniques during the construction phase. The operation of construction vehicles and the handling, use and storage of hazardous materials would be undertaken as follows: • Construction vehicles and plant would be regularly maintained and supplied with spill kits and drip trays to reduce the risk of hydrocarbon contamination. • Refuelling would be undertaken in specified areas where there is non-permeable hardstanding where practicable, and drainage passes through an oil interceptor prior to discharge. Where this is not possible suitable pollution prevention measures would be required. Drip trays would be installed to collect leaks from diesel pumps. • The Principal Contractor would provide provisions for the protection of surface water drains and catchments of surface run-off to reduce the risk of contaminated run-off and high-suspended solids moving off-site. • Adequate bunded and secure areas with impervious walls and floors, with a capacity of 110% of substance volume, are to be provided for the temporary storage of fuel, oil and chemicals on Site during construction. • Oil interceptor(s) would be installed on discharge points from any temporary oil storage / refuelling areas. • Development of Site pollution control procedures in line with "Pollution Prevention Guidance 6 – Working at Construction and Demolition Sites" all relevant licences obtained, and appropriate training for all construction staff. Provision of spill containment equipment such as absorbent material on Site. • The Principal Contractor would ensure the management of stockpiles of recycled (crushed) construction aggregates and contaminated soils awaiting off-site disposal and / or on-site treatment to minimise the potential for generation of contaminated run-off and dust. • As part of construction monitoring, audits must be carried out by the Environmental Manager to ensure compliance and correction action is implemented. • Hazardous materials already present on-site or proposed to be used during the construction works would be identified and an appropriate Control of Substances Hazardous to Health (COSHH) Assessment carried out.

Category	Description of Mitigation Measures
Noise and Vibration	• A three-metre construction exclusion zone from the SAC boundary of the River Wensum would be enforced, avoiding construction activity and therefore noise and vibration effects in proximity to the SAC. The Temporary Works Platform would be an exception as this would be used to allow access across the river for construction, and for this small area vehicles would approach and cross the river; • Sensitivity (to noise and vibration) of fish species present would be considered to ensure that appropriate construction methods can be implemented to minimise and avoid disturbance; • Soft-start piling method would be implemented for sheet piling in close proximity to watercourses, including the temporary bridge over the River Wensum. This procedure is implemented before the start of each shift when sheet piling is about to take place before the sheet piling works commence at full power. The vibratory hammer is positioned on the sheet piles and powered up with the hammer energy very low, increasing gradually to full power over a period of approximately 20 minutes. • Timing of piling works near watercourses would allow for fish dispersion and be of a short duration to allow migratory fish a window to move upstream; • All construction plant used on the site would be in good working order and copies of certificates of inspection and maintenance would be held with the plant register; all plant items should be properly maintained and operated according to manufacturers' recommendations and in such a manner as to avoid causing excessive noise and vibration; • all plant items operating intermittently on the Site should be shut down in the intervening periods; • all pneumatic tools should be fitted with silencers or mufflers where practicable; • no loud music or loud radios would be played on the site; • works (including deliveries) would be programmed such that the requirement for working outside normal working hours is minimised; • further noise mitigation (such as temporary environmental noise barriers) would be considered by the contractor to minimise the impacts at sensitive receptors; and • the importance of noise and vibration and its potential to cause disturbance would be included in the general induction training for the Site and specific training would be given to staff who would have particular responsibility for managing noise and vibration during construction. • The Principal Contractor shall review the need for and scope of any noise and vibration monitoring and reporting that is necessary (agreed by the Contractor through discussion with the Local Authority through its s61 consent(s)) to ensure and demonstrate compliance with all noise and vibration commitments and any s61 consent(s).
Biosecurity	To address the risk of spreading invasive non-native plant and animal species an invasive species strategy would be produced by the Principal Contractor. This strategy should include the following measures: • A pre-construction ecological survey would be completed in the active growing season (approximately April to August inclusive) prior to vegetation and site clearance commencing in any part of the Site. • Measures to present the spread of any invasive species across and beyond the Site. Exclusions zones around identified areas of invasive species where no works are to take place would be implemented to ensure these species are not disturbed by works. This would include surveys for American mink. The invasive species removal would be carried out by a specialist contractor. • Briefing and training of workers on good biosecurity practices appropriate to their role. • Equipping workers with the necessary equipment, Personal Protective Equipment (PPE) and substances to implement biosecurity control measures, including effective hygiene and sanitation practices. This would most frequently comprise disinfectant tablets, sprayers and brushes to clean and disinfect equipment and PPE prior to leaving site. • Ensure that Defra's "Check, Clean, Dry" principles are followed and ensure that all PPE and survey equipment is clean and dry (and if necessary, disinfected) prior to going to and from site.

7.2 Operational Drainage Design

7.2.1 As part of the Proposed Scheme the following drainage structures relating to road run-off are proposed (as fully outlined in the Surface Water Drainage Strategy **Document Reference 2.08.00**):

- Outfall discharging to the Foxburrow Stream from an attenuation basin;
- Outfall discharging into the A47 surface water drainage system; and
- Scheme-wide infiltration basins conveying surface water discharge from the Proposed Scheme to ground.

7.2.2 **Table 7-2** below provides an overview of the proposed attenuation, infiltration and treatment measures for each proposed outfall and infiltration basin. Further detail on Foxburrow Stream can be found in the Drainage Network Water Quality Assessment (**Document Reference 3.12.01**)

Table 7-2 Overview of proposed surface water drainage system

Ref	Proposed attenuation and treatment	Discharge location
Basin 1 (attenuation)	50% of runoff passes through grassed swales (lined) upstream of basin and all runoff passes through catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Pollution control value for spillage control.	Outlet discharges into the existing Northern Distributor Road (NDR) Basin 1A which then discharges to ground.
Basin 2	Grassed swales (lined) and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. The drainage along the viaduct includes catchpits instead of grassed swales due to spatial constraints.	Infiltration to ground.

Ref	Proposed attenuation and treatment	Discharge location
Basin A1067	Catchpits and deep-pot gullies to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control valve (isolation penstock) for spillage control.	Infiltration to ground.
Basin 3	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.
Basin 4	Grassed swales (lined), catchpits and roadside drainage ditches with attenuation to intercept silt and sediment at the edge of the carriageway. Additional c.300mm depth of permeable topsoil included in basin. Separate sediment forebay with wetted area for planting. Pollution control value (isolation penstock) for spillage control.	Infiltration to ground.

Ref	Proposed attenuation and treatment	Discharge location
Basin 5 (attenuation)	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	Outfall to Foxburrow Stream.
Basin 6 (attenuation)	Grassed swales (lined) and catchpits to intercept silt and sediment at the edge of the carriageway. Sediment forebay with wetted area for planting. Penstock pollution control value for spillage control.	Outfall to National Highways A47 DCO surface water drainage system.

7.3 Environmental Barrier

7.3.1 As part of embedded mitigation, an environmental barrier, designed for acoustic performance would be approximately 1.2m height and run the length of the viaduct on the outermost edge of the parapets.

7.4 Ecological Clerk of Works

7.4.1 Compliance with environmental mitigation, biosecurity protocols and the implementation of the operation drainage design would be monitored by an ECoW.

7.4.2 The ECoW would be responsible for monitoring the works and ensuring that construction is undertaken without contravening wildlife regulations / law and that the ecological items included in the Principal Contractor's methodology are adhered to. The ECoW would also help to resolve any ecological issues identified on site and help to provide a solution. Where mitigation measures of design details are not implemented correctly or fully, the ECoW would have the power to apply corrective actions, including stopping works.

7.4.3 Any high-risk works within proximity of the River Wensum, including vegetation clearance and installation of temporary structures would be completed under supervision by an ECoW.

7.4.4 In addition, should any part of a watercourse need to be impounded during the works, then a fish translocation should be carried out to remove fish from the impoundment. Fish translocation operations would require a permit from the EA in order to use electric fishing and ancillary equipment (such as hand nets).

7.5 Ecological Enhancements

7.5.1 The Proposed Scheme includes commitments to enhancement of habitats within the RLB within the Ecological Mitigation Strategy (**Document Reference 3.10.32**), comprising:

- Restoration of bank profiles within the Site Boundary following removal of temporary routes / crossings.
- Habitat creation – Habitat creation would be undertaken to replace areas lost to the Proposed Scheme, including the creation of new areas of wetland and grassland within the Wensum floodplain. Newly created habitats would be either planted, sown or left to re-colonise naturally. It is considered that on reaching maturity, newly created habitats would be effective in the long-term at mitigating impacts of the Scheme identified by its Environmental Statement for the habitats lost and the species they support. However, habitat creation does not constitute compensation for effects on Habitats Sites identified by this HRA.
- Habitat enhancement – Areas of habitat within and adjacent to the Proposed Scheme would be managed to improve their condition. This would include improvement to watercourses WC3 and WC4, and other ditch network improvements.

Additional enhancements to the River Wensum / Wensum floodplain are proposed (such as in-channel features, vegetation planting and bank reprofiling), that would result in a net improvement to aquatic habitats for the benefit of all Qualifying Features of the River Wensum SAC.

8 Stage 2: Appropriate Assessment; Determination of Potential Adverse Effects on Integrity

8.1 River Wensum SAC

8.1.1 The Wensum is a naturally enriched, calcareous lowland river. The upper reaches are fed by springs that rise from the chalk and by run-off from calcareous soils rich in plant nutrients. This gives rise to beds of submerged and emergent vegetation characteristic of a chalk stream. Ranunculus vegetation occurs throughout much of the river's length. The river supports an abundant and rich invertebrate fauna formerly including the native freshwater white-clawed crayfish as well as a diverse fish community, including bullhead and brook lamprey. The site has an abundant and diverse mollusc fauna which includes Desmoulin's whorl-snail Vertigo moulinsiana, which is associated with aquatic vegetation at the river edge and adjacent fens.

8.1.2 **Table 8-1** provides the assessment of potential adverse effects during the construction phase and **Table 8-2** the operational Phase. Both take into account baseline data for Qualifying Features as described in Section 4, and Proposed Scheme mitigation as described in Section 7.

8.1.3 Conservation objectives of the River Wensum SAC are to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;

- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species: and;
- The distribution of qualifying species within the site.

Site-specific supplementary advice on conservation objectives is available for River Wensum SAC (Natural England, 2022) and attributes and targets applicable to LSEs have been used in the assessment of potential adverse effects on integrity.

Table 8-1 Assessment to identify adverse effects on site integrity for the River Wensum SAC during the Proposed Scheme Construction Phase alone or in combination with other plans or projects

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Temporary and permanent loss of supporting floodplain habitat due to land-take	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	The assessment demonstrates that functional interactions between the River Wensum and surrounding floodplain would not be affected by the Proposed Scheme. Compared to the wider floodplain, a relatively small area currently used for livestock grazing would fall under the RLB and be subject to construction phase effects, with piling forming the supports of the viaduct left following the completion of this phase, but which would not be located within the River itself. There would be no reduction in the extent of floodplain habitat that functionally supports the River Wensum, no effect of the dynamic environment of the river, and the riparian zone would be maintained by an 3m construction exclusion zone which would separate works from the river itself, and an 8m buffer for permanent structures. In addition, latitudinal connectivity of the floodplain with the river, via throughflow of ground water and surface water flow, and flow through floodplain drains and ditches would not be affected by the Proposed Scheme. Chalk rivers are reliant on organic matter inputs from outside the river channel (“allochthonous” organic matter) through autumn and winter, receiving this material from overhanging or adjacent trees and woodland in the floodplain via delivery of dead leaves in autumn (Berrie, 1992; Joyce and Wotton, 2008). Dead wood, important for river function as an organic matter resource and habitat for fish, also enters this way. The River Wensum, where it is crossed by the Proposed Scheme, is surrounded by flood plain grasslands grazed by cattle, with only limited sources of dead leaves or dead wood (some mature willow trees are present but there are few overhanging trees that would be lost) which enter the river from other parts of the floodplain, higher in the catchment. The limited floodplain adjacent to the River Wensum within the RLB is therefore not an important area of supporting habitat to the watercourse or it’s associated in-channel *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. The loss of this habitat to temporary works areas, as well as permanent infrastructure associated with the Proposed Scheme viaduct would therefore not lead to adverse effects on this the water course or its associated vegetation communities. Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Temporary and permanent loss of supporting floodplain habitat due to land-take	**Supporting habitat: structure / function, integrity of off-site habitats** – Restore Integrity of off-site habitats.	Bullhead use marginal and mid-channel stands of vegetation as places to forage and as places of shelter from predators. However, as demonstrated in the table row above in relation to water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation, floodplain habitat within the Proposed Scheme provides very limited support to habitat within the River Wensum. Additionally, the habitats within WC5 are unlikely to support bullhead. Fish surveys recorded an absence of bullhead in WC5 and poor suitability to support bullhead. Bullhead require coarse substrates with large stones for breeding, and prefer natural, sinuous channel forms with associated riffle and pool and substrates (Tomlinson and Perrow, 2003). Therefore, temporary and permanent loss of floodplain habitat as a result of the Proposed Scheme would not lead to adverse effects on bullhead. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum or species living within it (including bullhead) and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Brook lamprey	Temporary and permanent loss of supporting floodplain habitat due to land-take	**Supporting habitat: structure / function, integrity of off-site habitats** – Restore Integrity of off-site habitats.	Culverting of WC5 would require temporary dewatering and diversion of a section of the existing watercourse. Aquatic ecology surveys of the ditch in 2022 found the presence of lamprey ammocetes using the silt deposits within the channel as shelter. Brook lamprey larvae feed and grow in organic sediments in marginal and mid-channel stands of vegetation. The temporary realignment of WC5 would result in access to silt deposits being temporarily limited during the construction period. Authorisation from the Environment Agency would be sought to allow fish translocation of lamprey larvae and other fish present within WC5 to a safe location, with appropriate habitat to support them. This would be carried out by a trained ecologist and would avoid fish and lamprey entrapment within the ditch during construction. Temporary and permanent culverts would be placed so that the invert level is below the existing bed level, to prevent impedance of fish movement. Once construction is complete, WC5 would be returned to its original alignment, with an expectation that habitat would naturally reinstate itself with flow regimes and recovery of macrophyte cover over time. Permanent culverts on WC5 that remain to allow maintenance access to the viaduct would be designed so that fish and lamprey movement is not inhibited by the structure, with an oversized design and natural substrate. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, including brook lamprey. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Temporary and permanent loss of supporting floodplain habitat due to land-take	**Supporting habitat: extent and distribution, distribution of supporting habitat** –Restore the distribution and continuity of the feature and its supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site. **Supporting habitat: extent and distribution, extent of supporting habitat** – Maintain the total extent of the habitat(s) which support the feature: Fen, marsh and swamp habitats S3, S4, S5, S7, S25 f 45.9 hectares. Wetter stands of MG8 type communities may also support Desmoulin's whorl snail.	Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle but is not found within the Wensum channel. This species is present within the RLB in watercourses WC3 and WC4 (WC1 not suitable habitat). It is also present outside of the RLB in the Wensum floodplain 1 kilometre to the south-east. The Desmoulin's whorl snail population present within WC3 and WC4 would not be affected by temporary or permanent loss of supporting floodplain habitat due to land-take as they would not be subject to activities associated with Scheme construction. Habitat enhancement work is proposed for these watercourses, undertaken to benefit Desmoulin's whorl snail and other aquatic species and is not required to compensate for effects of the Scheme on Desmoulin's whorl snail as a feature of the River Wensum SAC. The enhancement work would be undertaken using sensitive working methods and under ecological supervision to ensure enhancement work would only lead to benefits for the Desmoulin's whorl snail population found in WC3 and WC4. Thus there would be no temporary or permanent loss of habitat supporting this species, either from permanent loss of habitat (such as piers or the maintenance track) or from temporary construction areas (such as laydown areas or access tracks). Watercourses and floodplain habitat outside of WC3 and WC4 are not currently occupied by Desmoulin's whorl snail, and so temporary and permanent works in the floodplain would not affect this species. The permanent habitat loss would be restricted to viaduct piers and a maintenance track, allowing for reinstatement and retention of the majority of floodplain habitat beneath the viaduct; this would allow for the potential future colonisation of Desmoulin's whorl snail as part of a shift away from agricultural management practices. However, it should be noted there are currently no plans or proposals for such a change available, and it has been assumed areas currently managed for agriculture would continue to be managed in such a manner. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum or species living within it (including Desmoulin's whorl snail) and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, temporary and permanent loss of supporting floodplain habitat due to land-take would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation	Changes in hydrological conditions – non-flood condition river flows and ground water levels	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short-term (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions within the River Wensum and the vegetation communities present within it, as well as its floodplain. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction, but areas of engineered fill associated with the platform would remain permanently in place but would not have a significant impact on groundwater levels and flow in the flood plain. Excavations related to road cuttings, Temporary Works Platform or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions within the River Wensum and the vegetation communities present within it, as well as its floodplain. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Changes in hydrological conditions – non-flood condition river flows and ground water levels	**Supporting habitat: structure / function, flow regime** - Ensure more than 90% of the naturalised daily mean flow remains in the river all year round.	Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short-term (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by bullhead or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction, but areas of engineered fill associated with the platform would remain permanently in place but would not have a significant impact on groundwater levels and flow in the flood plain. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by bullhead or its habitat. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Changes in hydrological conditions – non-flood condition river flows and ground water levels	**Supporting habitat: structure / function, flow regime** - Ensure more than 90% of the naturalised daily mean flow remains in the river all year round.	Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by brook lamprey or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction, but areas of engineered fill associated with the platform would remain permanently in place but would not have a significant impact on groundwater levels and flow in the flood plain. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by brook lamprey or its habitat. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Changes in hydrological conditions – non-flood condition river flows and ground water levels	**Supporting habitat: structure / function, flow regime** - Ensure more than 90% of the naturalised daily mean flow remains in the river all year round.	Analysis of potential effects on river flows and ground water undertaken as part of the Proposed Scheme's Environmental Impact Assessment have concluded no such changes are anticipated (as reported in Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**), and water resources within the River Wensum and its floodplain would not be affected by the Proposed Scheme. Non-flood condition river flows are described in the River Wensum Geomorphology Assessment (**Document Reference 3.12.04**) and ground water modelling has been described in the Groundwater Modelling Report (**Document Reference 3.12.05**). Although piling would require dewatering around the pile locations, the areas affected would be small compared to the chalk aquifer feeding the River Wensum, would be short-term during construction and to be highly localised. The most notable construction-phase impacts in the River Wensum and adjacent ditches on the floodplain would occur during high-magnitude events (e.g., 1 in 20-years or 5% annual exceedance probability or greater), which have a low likelihood of occurrence within the timeframe of the construction phase. In addition, any potential alterations to the bed and bank forms that may occur would be highly localised and are likely to be off set in the short-term (< 5-10 years) by sedimentation during successive flood events. The overall effect on river flows would be negligible, and consequently not lead to changes in hydrological conditions experienced by Desmoulin's whorl snail or its habitat. Piles are not expected to create additional groundwater flow pathways near the River Wensum (i.e. within its floodplain) as vertical connectivity between the various strata is already in place under natural conditions. Sheet piling proposed to support the Temporary Works Platform is expected to penetrate the Chalk and temporarily create a groundwater flow barrier in the superficial and Chalk aquifers; temporary drainage is included in the design to mitigate the risk of groundwater flooding associated with this. The sheet piles associated with the Temporary Works Platform would be removed after construction, but areas of engineered fill associated with the platform would remain permanently in place but would not have a significant impact on groundwater levels and flow in the flood plain. Excavations related to road cuttings, temporary works platforms or construction of drainage features along the scheme may require temporary groundwater dewatering. None of the excavations are expected to extend into the Chalk. The overall effect on ground water would be negligible, and consequently not lead to changes in hydrological conditions experienced by Desmoulin's whorl snail or its habitat. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, Changes in hydrological conditions – non-flood condition river flows and ground water levels would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation	Changes in hydrological conditions-increased flood risk	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Temporary works structures including the Temporary Works Platform across the River Wensum would result in a change to the flooding regime across the floodplain. There would be an increase in flood risk as the temporary works would be acting to confine river discharge past the Proposed Scheme. Changes in velocities would vary across the floodplain, there would be a reduction in velocities in the southern half of the floodplain and an increase in the norther half towards the Temporary Works Platform. Increases are limited and constrained to approximately 0.1m/s in the region closest to the Temporary Works Platform. The funnelling effects taper out upstream with increases in velocities 0.05m/s or less from 200m upstream of the temporary work. Thus, flood conditions could lead to increased tendency of upstream areas to flood, and increased water velocity through the confined works area. However, modelling of river flows undertaken to support the Proposed Scheme's design and to inform the Environmental Statement (**Chapter 12: Road Drainage and Water Environment**) has shown that under a 1 in 2-year return period, which is the most likely scenario during construction, no change to geomorphological processes or receptors are anticipated during the construction phase, and that the channel is predicted to remain as a transport-dominated system with no morphological adjustments due to erosion. Modelling suggests that during the temporary works phase, there could be a localised change in habitat biotopes, with a change from glide habitat to riffle-run habitat within the zone of the temporary works. However, habitat biotopes would return to baseline during operation. Structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and to which vegetation is naturally adapted. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, the River Wensum and its vegetation would not be affected by hydrological changes through increased flood risk during the construction phase. Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Bullhead	Changes in hydrological conditions-increased flood risk	**Supporting habitat: structure / function, flow regime** - Ensure more than 90% of the naturalised daily mean flow remains in the river all year round.	Bullhead use marginal and mid-channel stands of vegetation as places to forage and as places of shelter from predators. As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and are part of bullhead's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, bullhead would not be affected by hydrological changes through increased flood risk during the construction phase. Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Changes in hydrological conditions-increased flood risk	**Supporting habitat: structure / function, flow regime** - Ensure more than 90% of the naturalised daily mean flow remains in the river all year round.	Brook lamprey larvae feed and grow in organic sediments in marginal and mid-channel stands of vegetation, and adults use them as places shelter from predators. As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and are part of brook lamprey's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, brook lamprey would not be affected by hydrological changes through increased flood risk during the construction phase. Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Desmoulin's whorl snail	Changes in hydrological conditions-increased flood risk	**Supporting processes (on which the feature and / or its supporting habitat relies): Water flow (rivers)** - Restore the natural flow regime of the river, with daily flows as close to what would be expected in the absence of abstractions and discharges (the 'naturalised' flow).	As demonstrated above in relation to water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, structures present during the construction phase would not lead to river discharge changes, including peak flows, under flood conditions over and above that would normally occur when the River Wensum is in flood, and which are part of Desmoulin's whorl snail's natural habitat. No significant departures to the naturalised flow of the river are expected despite structures being present. Therefore, Desmoulin's whorl snail would not be affected by hydrological changes through increased flood risk during the construction phase. Thus, changes in hydrological conditions-increased flood risk during construction would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Garbey et al. (2006) demonstrated that a 50% reduction in light intensity leads to a reduction in biomass of pond water-crowfoot *Ranunculus peltatus*. Therefore, it is considered that the viaduct would result in levels of shading that could reduce water-crowfoot abundance directly underneath the structure, albeit at present their density is low. However, it should be noted that *Ranunculus* spp. are still able to regenerate under such conditions and other species, also characteristic of the qualifying feature, are able to grow under such levels of shading. Stream water-crowfoot, and clasping-leaved pondweed were the most abundant species found within the River Wensum at the viaduct location from macrophyte surveys carried out 2022 (Aquatic Ecology Survey Report 2022; **Document Reference 3.10.12**). Like pond water-crowfoot, both species have Ellenberg light indicator values of 7 (Ellenberg, 1991). As such, it is likely that these species would respond similarly to pond water-crowfoot and would still be able to regenerate and adapt to a reduction in light intensity. Clasping-leaved pondweed, and other submerged macrophyte species, are known to alter their physiology and morphology as an adaptation in response to low light conditions (Twilley and Barko, 1990; Asaeda et al., 2004; Sultana et al., 2009). For the above reasons, it is concluded there would be a potential change in the composition of the plant community in areas affected by shading from the under-construction viaduct. However, some of the plants within the vegetation community which are more shade tolerant could still grow, while others which are less tolerant of shade may be eventually replaced. Additionally, the plasticity observed in the morphology of many macrophyte species in response to lower light conditions would enable plants to adapt (Garbey et al. 2006). The presence of the Temporary Works Platform would likely result in localised shading and temporary loss of the macrophyte community within the immediate vicinity of the crossing. As the temporary crossing is transient in nature, no long-term vegetation loss, including those designated under the qualifying feature, is foreseen. Following removal of the Temporary Works Platform it is expected that the vegetation community would recolonise areas affected by shading. Overall, there would be no adverse effect on the qualifying feature (i.e. the river as a whole) due to their temporary and localised nature, with potential effects in an area <0.1ha, when compared to the total area of the River Wensum SAC (306.79ha). Thus, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	**Supporting habitat, structure / function: Riparian zone** - Restore areas of riparian habitat. **Supporting habitat, structure / function: Vegetation structure, cover of submerged macrophytes** - Restore suitable cover of submerged macrophytes.	Bullhead uses stands of vegetation including (but not limited to) the vegetation described above within the river channel during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items for bullhead within the immediate vicinity of the under-construction viaduct and Temporary Works Platform. However, the bridges themselves would provide some shelter, as would other forms of shelter, such as submerged branches, tree roots, pebbles and cobble. The direct effects of the temporary crossing and the under-construction viaduct on bullhead would be negligible due to their tolerance of shade (Tomlinson and Perrow, 2003) and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Following recolonisation by macrophytes after the removal of the Temporary Works Platform, shelter, food items and breeding habitat would be restored to their original or similar state. Similarly, effects from the change in vegetation structure localised below the under-construction viaduct, such as changes to shelter, food items and breeding habitat would be negligible. Thus, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Brook lamprey	Shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform	**Supporting habitat, structure / function: Riparian zone** - Restore areas of riparian habitat.	Brook lamprey benefit from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. Temporary loss of macrophytes as described above may result in a temporary loss of shelter and food items for brook lamprey within the immediate vicinity of the under-construction viaduct and Temporary Works Platform. The direct effects of this temporary crossing and the under-construction viaduct on brook lamprey would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Following recolonisation by macrophytes after the removal of the Temporary Works Platform, shelter and food availability would be restored to their original or similar state. Similarly, effects from the change in vegetation structure localised below the under-construction viaduct, such as changes to shelter and food availability would be negligible. Thus, shading of in-channel vegetation from the under-construction viaduct and Temporary Works Platform would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Fragmentation of the landscape by construction of the Proposed Scheme	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the main channel as a result of the Proposed Scheme. The temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. WC5 does not share the same characteristics of the River Wensum and does not support *Ranunuclus* within the Site Boundary (Aquatic Ecology Survey Report 2022; **Document Reference: 3.10.12**). Thus, it is not characteristic of a watercourse with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. However, WC5 has a supporting function for the River Wensum SAC, where temporary fragmentation may have a minor effect on the feature. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, and contributes to the targets of the qualifying feature, by restoring natural river habitat function and processes, and the extent of in-channel riparian habitats. This would balance temporary or permanent losses in the floodplain aquatic habitats and contribute to the targets for the feature. Thus, fragmentation of the landscape by construction of the Proposed Scheme would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Brook lamprey	Fragmentation of the landscape by construction of the Proposed Scheme	**Supporting habitat, structure / function: Riparian zone** - Restore areas of riparian habitat.	No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5, resulting in potential fragmentation of habitat for brook lamprey. Areas within the Wensum and Wensum floodplain would be enhanced to improve aquatic habitat that supports a variety of aquatic fauna and flora, including brook lamprey. This would mitigate any loss of available habitat to temporary or permanent structures in the floodplain aquatic habitats and contribute to the targets for this species. Thus, fragmentation of the landscape by construction of the Proposed Scheme would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Sediment and chemical run-off	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Stands of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off that could smother and kill vegetation in the area surrounding the Proposed Scheme, as well as downstream. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the extent of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and maintain supporting habitat structure / function (through achieving favourable chemical status of water quality and a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Sediment and chemical run-off	**Population: Juvenile densities -** Restore juvenile densities at those expected under unimpacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations. **Population: Abundance -** Restore the abundance of the population to a density which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status is for adult density of >0.5 individuals m^{-2} and >40% of individuals in the 0+ age class indicating a suitable age structure and recruitment. **Supporting habitat structure / function: Sediment regime -** Restore sediment regime.	Bullhead use stands of vegetation including (but not limited to) the Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel during their life cycle. These vegetation stands provide shelter and foraging areas for both adults and juveniles. Sediment and chemical run-off threatens individual bullhead as well as the vegetation they rely on, as accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and bullhead themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile bullhead and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Sediment and chemical run-off	**Population: Juvenile densities -** Restore juvenile densities at those expected under unimpacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations. **Population: Abundance** - Restore the abundance of the population to a level which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status ammocoete abundance in chalk stream optimal habitat is >10m^{-2} and >2m^{-2} on a catchment basis. **Supporting habitat structure / function: Sediment regime -** Restore the natural supply of coarse and fine sediment to the river.	Brook lamprey benefit from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. Sediment and chemical run-off threatens individual brook lamprey as well as the vegetation they rely on, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and brook lamprey themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile brook lamprey and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Sediment and chemical run-off	**Population: Abundance** - Restore a healthy adult: juvenile structure and population density (typically>250 individuals per m^2 in late summer), whilst avoiding deterioration from current levels as indicated by the latest peak count or equivalent. **Supporting processes (on which the feature and / or its supporting habitat relies): Water quantity / quality** - Where the feature or its supporting habitat is dependent on surface water and / or groundwater, restore water quality and quantity to a standard which provides the necessary conditions to support the feature / Phosphate standards for the River Wensum: Main river below Sculthorpe Mill 30 μgl^{-1}. River Tat and River Wensum above Sculthorpe Mill 20 μgl^{-1}.	Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle and is not found within the Wensum itself nor within the Site Boundary where it crosses the Wensum floodplain as habitat here is not suitable; however, it is found in the wider floodplain surrounding the Proposed Scheme with the closest population identified by survey being ~80m to the west of the Site Boundary (Section 5.4), and within the Red Line Boundary. The Proposed Scheme threatens Desmoulin's whorl snail through sediment and chemical run-off into the surrounding floodplain habitat, such as the drainage ditch network. There are no conservation objective attributes and targets specifically aligned with indirect effects of development, however attributes / targets aiming to restore the abundance of both adult and juvenile Desmoulin's whorl snail and maintain supporting processes on which they rely (specifically water quality) would be threatened by accidental sediment and chemical run-off. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Noise and vibrational disturbance	**Population (of the feature): Population abundance** - Restore the abundance of the population to a density which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status is for adult density of >0.5 individuals m^{-2} and >40% of individuals in the 0+ age class indicating a suitable age structure and recruitment.	Fish, including bullhead, are sensitive to noise and vibration disturbances from construction activities such as pile driving and movement of heavy machinery. The extent to which intense underwater sound might adversely impact on fish is dependent upon the level of noise, its frequency, duration and / or the repetition rate of the sound (Hastings and Popper, 2005). The range of potential impacts from intense sound sources, such as pile driving, includes immediate death, permanent or temporary tissue damage and hearing loss, behavioural changes and masking effects. Lethal effects may occur to fish species where source levels of noise exceed between 207 and 213 dB re 1 µPa for fish with high and low hearing sensitivity respectively (Popper et al., 2014). Physical injury may occur when source levels of noise exceed 186 dB re 1 µPa (Popper et al. 2014). Fish may exhibit a behavioural response to noise which is above 135 dB re 1 µPa (Hawkins et al. 2014). Mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would reduce noise and vibration from construction to negligible levels. Additionally, effects on bullhead would be negligible due to their ability to move away from any disturbances temporarily. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, noise and vibrational disturbance would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Noise and vibrational disturbance	**Population (of the feature): Population abundance** - Restore the abundance of the population [to] a level which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status ammocoete abundance in chalk stream optimal habitat is >10m^{-2} and >2m^{-2} on a catchment basis	As stated above, fish are sensitive to noise and vibration disturbances from construction activities such as pile driving and movement of heavy machinery. Brook lamprey have no swim bladder, and therefore have a lower sensitivity to sound pressure (Turnpenny and Nedwell, 1994). Excessive and repetitive noise and vibration levels may still have an effect in disturbing brook lamprey behaviours. Mitigation measures that would avoid noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would reduce noise and vibration from construction to negligible levels. Additionally, effects on brook lamprey would be negligible due to their ability to move away from any disturbances temporarily. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, noise and vibrational disturbance would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Introduction of invasive non-native plants (e.g. Himalayan balsam) and animal (e.g. signal crayfish) species	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic** - Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Stands of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by the introduction of invasive non-native plant and animal species that could kill vegetation up and downstream of the Proposed Scheme and change conditions within the river degrading habitats. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g. signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Introduction of invasive non-native plants (e.g. Himalayan balsam) and animal (e.g. signal crayfish) species	**Supporting habitat, structure / function: Vegetation composition, invasive non-native species** - Control and prevent where possible all invasive non-native species.	Bullhead are threatened by the introduction of invasive non-native plant and animal species which could negatively interact with this species directly to reduce populations and their viability and change conditions within the river degrading the habitat. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Brook lamprey	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g. signal crayfish) species	**Supporting habitat, structure/function: Vegetation composition, invasive non-native species** - Control and prevent where possible all invasive non-native species.	Brook lamprey are threatened by the introduction of invasive non-native plant and animal species which could negatively interact with this species directly to reduce populations and their viability, and change conditions within the river degrading the habitat. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, due to the implementation of mitigation measures, the risk of introduction of invasive non-native plant (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g. signal crayfish) species	**Supporting habitat, structure / function: Vegetation composition, invasive non-native species** – Ensure invasive non-native plants are either rare or absent within the site.	The Proposed Scheme threatens Desmoulin's whorl snail through introduction of invasive non-native plant and animal species during construction into the surrounding floodplain habitat, such as the drainage ditch network, and their spread into habitat occupied by this species. Mitigation measures that would avoid introduction of invasive non-native plant and animal species during construction into the floodplain of the River Wensum have been included as part of the design of the Proposed Scheme and are set out in the OCEMP. These mitigation measures are described in Section 7. These measures would avoid the risk of introducing invasive non-native plant species. The A47 North Tuddenham to Easton Proposed scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar measures to prevent introduction of invasive non-native species, as would be put in place by the Proposed Scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, due to the implementation of mitigation measures, the risk of Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Table 8-2 Assessment of potential adverse effects on site integrity for the River Wensum SAC during the Proposed Scheme's Operational Phase alone or in combination with other plans or projects

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Shading of in-channel vegetation by the operational viaduct	**Extent and distribution of the feature: Extent of the feature associated with the site** - Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic -** Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Garbey *et al.* (2006) demonstrated that a 50% reduction in light intensity leads to a reduction in biomass of pond water-crowfoot *Ranunculus peltatus*. Therefore, it is considered that the viaduct would result in levels of shading that could reduce water-crowfoot abundance directly underneath the structure, albeit at present their density is low. However, it should be noted that *Ranunculus* spp. are still able to regenerate under such conditions and other species, also characteristic of the qualifying feature, are able to grow under such levels of shading. Stream water-crowfoot, and clasping-leaved pondweed were the most abundant species found within the Wensum at the viaduct location from macrophyte surveys carried in 2022 (Aquatic Ecology Survey Report 2022; **Document Reference 3.10.12**). Like pond water-crowfoot, both species have Ellenberg light indicator values of 7 (Ellenberg, 1991). As such, it is likely that these species would respond similarly to pond water-crowfoot and would still be able to regenerate and adapt to a reduction in light intensity. Clasping-leaved pondweed, and other submerged macrophyte species, are known to alter their physiology and morphology as an adaptation in response to low light conditions (Twilley and Barko, 1990; Asaeda *et al*., 2004; Sultana *et al*., 2009). For the above reasons, it is concluded there would be a potential change in the composition of the plant community in areas affected by shading from the operational viaduct. However, some of the plants within the vegetation community which are more shade tolerant could still grow, while others which are less tolerant of shade may be eventually replaced. Additionally, the plasticity observed in the morphology of many macrophyte species in response to lower light conditions would enable plants to adapt (Garbey et al. 2006). Indirect effects on vegetation through poaching of soil as a result of livestock sheltering under the viaduct are not expected, as this would occur only infrequently in response to rain, with the length of the viaduct offering shelter would avoid congregation at high densities. Thus, shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
White-clawed Crayfish	Shading of in-channel vegetation by the operational viaduct	**Population (of the feature): Population abundance -** Restore the abundance of the population to a level which is above that surveyed by Rogers and Holdich 1997, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Recolonising white-clawed crayfish would use stands of vegetation including (but not limited to) the Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* described above within the river channel to during its life cycle. Vegetation stands typically provide shelter and foraging areas for juveniles, but they also use the physical structure of the river banks for this purpose. Adults use larger structures in river margins such as rocks, woody debris and tree roots, but can also find shelter amongst marginal vegetation. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items (as the vegetation community adjusts to the localised change in light conditions) that could potentially be used by recolonising white-clawed crayfish within the immediate vicinity of the operational viaduct. However, as the species is not reliant on vegetation for shelter, and the fact the shading area is relatively small, direct effects of the operational viaduct on recolonising white-clawed crayfish would be negligible. Thus, shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Shading of in-channel vegetation by the operational viaduct	**Supporting habitat, structure / function: Riparian zone -** Restore areas of riparian habitat. **Supporting habitat, structure / function: Vegetation structure, cover of submerged macrophytes -** Restore suitable cover of submerged macrophytes.	Bullhead use stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* described above within the river channel to during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. The temporary loss of macrophyte biomass as described above would result in a temporary loss of shelter and food items (as the vegetation community adjusts to the localised change in light conditions) for bullhead within the immediate vicinity of the operational viaduct. The direct effects of the operational viaduct on bullhead would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Effects from the change in vegetation structure localised below the operational viaduct, such as changes to shelter and food availability would be negligible. Indirect effects on vegetation through poaching of soil as a result of livestock sheltering under the viaduct are not expected, as this would occur only infrequently in response to rain, with the length of the viaduct offering shelter would avoid congregation at high densities. Thus, shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Brook lamprey	Shading of in-channel vegetation by the operational viaduct	**Supporting habitat, structure / function: Riparian zone -** Restore areas of riparian habitat.	Brook lamprey benefits from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* described above within the river channel. These vegetation stands can provide shelter for adults and juveniles and trap sediments in which ammocoete larvae shelter and feed. The temporary loss of macrophyte biomass as described above may result in a temporary loss of shelter and food items (as the vegetation community adjusts to the localised change in light conditions) for brook lamprey within the immediate vicinity of the operational viaduct. The direct effects of shading from the operational viaduct on brook lamprey would be negligible due to their tolerance of shade and their ability to change their individual spatial distribution (i.e., move in and out of shade freely). Effects from the change in vegetation structure localised below the operational viaduct, such as changes to shelter and food availability would be negligible. Indirect effects on vegetation through poaching of soil as a result of livestock sheltering under the viaduct are not expected, as this would occur only infrequently in response to rain, with the length of the viaduct offering shelter would avoid congregation at high densities. Thus, shading of in-channel vegetation from operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Localised changes in air quality as a result of emissions from vehicles using the completed viaduct	**Supporting processes (on which the feature and / or its supporting habitat relies): Air quality -** Restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).	Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. The website www.apis.ac.uk does not specify critical loads of levels or provide detail on effects of aerial pollutants on Desmoulin's whorl snail. The closest population to the Proposed Scheme viaduct occurs in a ditch system on the south-western bank of the River Wensum approximately 80m away (ditches and river margins within the Site Boundary are not suitable to support Desmoulin's whorl snail, Section 5.4 above). Other elements of the Desmoulin's whorl snail metapopulation in the River Wensum floodplain occur at a distance (Section 5.4 above) and their habitat would not be subject to air quality changes. In the area where air quality changes would occur (up to 200m from the operational Proposed Scheme) Desmoulin's whorl snail exists in habitat comprising mostly intensively managed grassland cultivated for hay / sileage and that are grazed, intersected with smaller areas of less intensive management and grazing; ditches are mostly dry and associated with scrub (Section 5.2 above). No fen, marsh and swamp habitats are present where this metapopulation is found. The habitats supporting the Desmoulin's whorl snail metapopulation within the zone of air quality change are subject to agricultural improvement, involving nutrient enrichment (e.g., from nitrogen inputs from grazing animals) and not sensitive to the limited increase in nutrients as would result from air quality changes from road emissions (Air Pollution Information System (APIS), 2023). The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail, and their specific zones of air quality change do not therefore overlap where this species exists. Interactions in traffic volume have been taken into account through consideration of the ARN, which incorporates the Proposed Scheme's crossing of the River Wensum. Thus, Localised changes in air quality as a result of emissions from vehicles using the completed viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Sediment and chemical run-off	**Extent and distribution of the feature: Extent of the feature associated with the site -** Restore the extent of the H3260 feature as determined by natural river habitat function and processes. **Structure and function (including its typical species): Biotope (habitat) mosaic -** Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Stands of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* grow within the river channel supported by the water column and rely on the conditions created by the chalk river environment of the Wensum. These conditions are threatened by accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off that could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the extent of Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* and maintain supporting habitat structure / function (through achieving favourable chemical status of water quality and a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (Section 7.3) would attenuate nitrogen inputs to the River Wensum in such cases negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised long-term increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in Section 7.3. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
White-clawed Crayfish	Sediment and chemical run-off	**Population (of the feature): Population abundance -** Restore the abundance of the population to a level which is above that surveyed by Rogers and Holdich 1997, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Recolonising white-clawed crayfish would primarily use physical structures within the River Wensum as habitat, but juveniles may also use stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel for shelter and foraging. Sediment and chemical run-off threatens individual recolonising white-clawed crayfish directly as well as through vegetation used for foraging or shelter, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and recolonising white-clawed crayfish directly. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (Section 7.3) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised long-term increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in Section 7.3. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Bullhead	Sediment and chemical run-off	**Population: Juvenile densities –** Restore juvenile densities at those expected under unimpacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations. **Population: Abundance –** Restore the abundance of the population to a density which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status is for adult density of >0.5 individuals m^{-2} and >40% of individuals in the 0+ age class indicating a suitable age structure and recruitment. Supporting habitat structure / function: Sediment regime – Restore sediment regime.	Bullhead uses stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* described above within the river channel during its life cycle. These vegetation stands provide shelter and foraging areas for adults and juveniles. Sediment and chemical run-off threatens individual bullhead as well as the vegetation they use, as accidental release of chemicals (e.g., fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and bullhead themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the abundance of both adult and juvenile bullhead and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (Section 7.3) would attenuate nitrogen inputs to the River Wensum in such cases negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised long-term increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum (such as drainage basins) would be included within the Proposed Scheme's operational drainage design. These drainage design features are described in Section 7.3. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Sediment and chemical run-off	**Population: Juvenile densities -** Restore juvenile densities at those expected under unimpacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations. **Population: Abundance -** Restore the abundance of the population to a level which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status ammocoete abundance in chalk stream optimal habitat is >10m^{-2} and >2m^{-2} on a catchment basis. Supporting habitat structure / function: Sediment regime - Restore the natural supply of course and fine sediment to the river.	Brook lamprey benefits from stands of vegetation including (but not limited to) the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation described above within the river channel. These vegetation stands provide shelter for adults and juveniles and traps sediments in which ammocoete larvae feed. Sediment and chemical run-off threatens individual brook lamprey as well as the vegetation they rely on, as accidental release of chemicals (e.g. fuels, lubricants) and sediments into the river channel through run-off could kill vegetation in the area surrounding the Proposed Scheme, as well as downstream, and brook lamprey themselves directly. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes / targets aiming to restore the abundance of both adult and juvenile brook lamprey and maintain supporting habitat structure / function (through achieving a natural sediment regime) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (Section 7.3) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised long-term increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Desmoulin's whorl snail	Sediment and chemical run-off	**Population: Abundance -** Restore a healthy adult: juvenile structure and population density (typically>250 individuals per m² in late summer), whilst avoiding deterioration from current levels as indicated by the latest peak count or equivalent. **Supporting processes (on which the feature and / or its supporting habitat relies) -** Where the feature or its supporting habitat is dependent on surface water and / or groundwater, restore water quality and quantity to a standard which provides the necessary conditions to support the feature / Phosphate standards for the River Wensum: Main river below Sculthorpe Mill 30 μgl^{-1}. River Tat and River Wensum above Sculthorpe Mill 20 μgl^{-1}.	Desmoulin's whorl snail uses floodplain habitat surrounding the River Wensum to complete its lifecycle and is not found within the Wensum itself nor within the Red Line Boundary where it crosses the Wensum floodplain as habitat here is not suitable; however, it is found in the wider floodplain surrounding the Proposed Scheme with the closest population identified by survey being ~80m to the west of the Site Boundary (Section 5.4). The Proposed Scheme threatens Desmoulin's whorl snail through sediment and chemical run-off into the surrounding floodplain habitat, such as the drainage ditch network. There are no conservation objective attributes and targets specifically aligned with indirect effects of operation of the Proposed Scheme. However, attributes/targets aiming to restore the abundance of both adult and juvenile Desmoulin's whorl snail and maintain supporting processes on which they rely (specifically water quality) would be threatened by sediment and chemical run-off during Proposed Scheme operation. Routine run-off, comprising contaminants from the wear of car brakes, tyres, antifreeze etc. washed off the surface in rainfall events but excluding accidental spillages, is not a major source of soluble nitrogen entering watercourses, nitrogen is excluded from tools used to assess effects of surface water run-off on water quality (Highways England, 2020). Increases in nitrogen availability in water courses could lead to eutrophication, the process of nutrient enrichment, which often leads to significant changes to vegetation communities forming a habitat as those that readily absorb nitrogen outcompete those normally present. Although spillages could represent acute sources of nitrogen these can be expected to be rare and mitigation included in the Proposed Scheme's operational drainage design, which comprises a groundwater infiltration system (Section 7.3) would attenuate nitrogen inputs to the River Wensum in such cases to negligible levels. Impacts from salt spraying (de-icing during winters) associated with the operational viaduct on groundwater quality have been assessed as part of the Proposed Scheme's Environmental Impact Assessment (Chapter 12 Road Drainage and Water Environment; **Document Reference 3.12.00**) and its associated Groundwater Modelling Report (**Document Reference: 3.12.05**). Modelling predicts localised long-term increases in chloride (salinity) concentrations in groundwater underneath and adjacent to the road drainage infiltration basins, but these would not extend more widely into the floodplain or the River Wensum itself. Mitigation measures that would avoid sediment and chemical run-off into the River Wensum would be mandated by their inclusion in the Proposed Scheme's OCEMP. These mitigation measures are described in Section 7. These measures would reduce the risk of sediment and chemical run-off to negligible levels. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and its floodplain habitat used by Desmoulin's whorl snail and is subject to similar sediment and chemical run-off prevention measures as outlined above, as secured by the DCO for that scheme. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, sediment and chemical run-off would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
White-clawed Crayfish	Noise and vibrational disturbance	**Population (of the feature): Population abundance** - Restore the abundance of the population to a level which is above that surveyed by Rogers and Holdich 1997, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Embedded mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, noise and vibrational disturbance from the operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.
Bullhead	Noise and vibrational disturbance	**Population (of the feature): Population abundance** - Restore the abundance of the population to a density which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status is for adult density of >0.5 individuals m^{-2} and >40% of individuals in the 0+ age class indicating a suitable age structure and recruitment.	Fish, including bullhead, are sensitive to noise and vibration from anthropogenic sources. The extent to which intense underwater sound might adversely impact on fish is dependent upon the level of noise, its frequency, duration and / or the repetition rate of the sound (Hastings and Popper, 2005). Most damaging effects of sound pressures come from a range of intense sound sources such as pile driving, and behaviours can be affected by intense signals from boats and sonar systems. Lethal effects may occur to fish species where source levels of noise exceed between 207 and 213 dB re 1 µPa for fish with high and low hearing sensitivity respectively (Popper et al., 2014). Physical injury may occur when source levels of noise exceed 186 dB re 1 µPa (Popper et al. 2014). Fish may exhibit a behavioural response to noise which is above 135 dB re 1 µPa (Hawkins et al. 2014). The noise levels from road traffic predicted in the immediate vicinity of the operational viaduct (as shown in Figure 7.5 of the **Chapter 7: Noise and Vibration**) are 55-60 dB LA10,18h (re 20 µPa). Even adopting worst-case assumptions for the transfer of noise from the air into the water, the operational road traffic noise levels are much lower than the level than what would be expected to have lethal impact, cause damage or influence behaviours in bullhead. Embedded mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, noise and vibrational disturbance from the operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attributes / Targets	Assessment
Brook lamprey	Noise and vibrational disturbance	**Population (of the feature): Population abundance -** Restore the abundance of the population [to] a level which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. Favourable status ammocoete abundance in chalk stream optimal habitat is >10m^{-2} and >2m^{-2} on a catchment basis	As stated above, fish are sensitive to noise and vibration disturbances from anthropogenic sources. Brook lamprey have no swim bladder, and therefore have a lower sensitivity to sound pressure (Turnpenny and Nedwell, 1994). Embedded mitigation measures that would limit noise and vibration disturbances in close proximity to watercourses (including the River Wensum) have been included as part of the design of the Proposed Scheme, such as the environmental barrier, which would be in place along the length of both sides of the viaduct. Additionally, effects on bullhead would be negligible due to their ability to move away from any disturbances temporarily. The A47 North Tuddenham to Easton scheme lies over 5 kilometres from the Proposed Scheme's crossing of the River Wensum and due to this distance is not expected to interact with the Proposed Scheme to produce in-combination effects. No effect pathways between A47 North Tuddenham to Easton and the Proposed Scheme, either direct or indirect, including through hydrological connections, would exist at this distance. Thus, noise and vibrational disturbance from the operational viaduct would not lead to adverse effects on this Qualifying Feature or the integrity of River Wensum SAC, either alone or in-combination with the other plans or projects.

8.2 Norfolk Valley Fens SAC

8.2.1 This site comprises a series of valley-head spring-fed fens. Such spring-fed flush fens are very rare in the lowlands. The individual fens vary in their structure according to intensity of management and provide a wide range of variation. There is a rich flora associated with these fens, including species such as grass-of-Parnassus Parnassia palustris, common butterwort *Pinguicula vulgaris,* marsh helleborine *Epipactis palustris* and narrow-leaved marsh-orchid *Dactylorhiza traunsteineri* (since the publication of the Norfolk Valley Fens SPA citation this species is now referred to as Pugsley's March Orchid *Dactylorhiza traunsteinerioides).* In places the calcareous fens grade into acidic flush communities on the valley sides. Within the Norfolk Valley Fens there are a number of marginal fens associated with pingos – pools that formed in hollows left when large blocks of ice melted at the end of the last Ice Age. These are very ancient wetlands and several support strong populations of Desmoulin's whorl snail as part of a rich assemblage of rare and scarce species in standing water habitat. At Flordon Common a strong population of narrow-mouthed whorl snail occurs.

8.2.2 **Table 8-3** provides the assessment of potential adverse effects during the Proposed Scheme's operational phase (no LSEs were identified for the construction phase) on one unit within Norfolk Valley Fens SAC; Potter and Scarning Fens, East Dereham. Other SAC units would not be affected, and LSEs were not identified for them at screening stage. The assessment takes into account baseline data for Qualifying Features as described in Section 4, and Proposed Scheme mitigation as described in Section 7.

8.2.3 Conservation objectives of the Norfolk Valley Fens SAC are to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;

- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

Site-specific supplementary advice on conservation objectives is available for Norfolk Valley Fens SAC (Natural England, 2019a) and attributes and targets applicable to LSEs have been used in the assessment of potential adverse effects. In particular, reference has been made to “Table A” within that document which indicates which qualifying habitats and species are present at each SAC unit, as only a subset of features is present at each

Table 8-3 Assessment to identify adverse effects on site integrity for the Norfolk Valley Fens SAC during the Proposed Scheme's Operational Phase alone or in combination with other plans or projects

Qualifying Feature	Likely Significant Effect Identified at Stage 1 (Screening)	Attribute / Target	Assessment
Alkaline Fens	Wide-scale air quality changes within the ARN	**Supporting processes (on which the feature relies):** Restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).	**Assessment: Potter and Scarning Fens, East Dereham** Fen habitat lies within the 200m zone adjacent to the A47 where effects of air quality changes would occur as a result of the ARN, with modelling predicting an increase in the deposition of aerial pollutants above 1% of the critical load for this habitat type up to ~60m away from the A47 roadside (as shown by transect modelling of air quality changes, see Environmental Statement Chapter 6: Air Quality; **Document Reference 3.06.00** as well as its supporting appendices, 3.06.05, and 3.06.07. The 1% of critical load measurement is used as a threshold to differentiate between significant and non-significant effects (Natural England, 2018). Modelled effects would occur through the deposition of nitrogen compounds including ammonia (NH_3) and nitrogen oxides (NO_x) that could affect habitats through nutrient enrichment and consequent plant community change, and through direct toxicity. The model predicts changes for the Proposed Scheme opening year (2027) and for them to persist (the effect is still present as a result of the model in 2041, representing the future effect of the ARN). Fen habitat within this 60m area (and therefore exceeding 1% of critical load) represents 5% of that present at Potter and Scarning Fens. Despite the changes predicted by the model, in reality air quality changes would not lead to effects on fen habitat. Several factors not incorporated in the model would attenuate air quality changes as a result of the ARN, so nitrogen compound deposition would not exceed 1% of the critical load for fen habitat: • Woodland approximately 30m deep from the road edge is present along the A47 between it and fen habitat within Potter and Scarning Fens. This would attenuate changes in air quality by acting as a barrier to and aid dispersion of emissions, and although won't exclude deposition of nitrogen compounds from the ARN completely, would significantly reduce their concentration. These barrier effects are not accounted for in the ARN model (Environmental Statement **Chapter 6: Air Quality**). • Alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Potter and Scarning Fens is not limited in terms of plant growth by nitrogen. Rather, it is phosphorus-limited. Therefore, an increase in nitrogen availability would not result in a deleterious effect on vegetation as a result of nutrient enrichment, as the growth-limiting nutrient would not be elevated by the predicted air quality change (McBride et al., 2011). Taking these factors into account, despite the predictions of the ARN model, fen habitat would not receive a significant increase in deposition of nitrogen compounds as a result of air quality changes due to the Proposed Scheme's ARN. Emissions as a result of the A47 North Tuddenham to Easton were modelled as part of the ARN, and thus in combination effects have been considered as part of this assessment. In conclusion, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the A47 North Tuddenham to Easton scheme.

9 Conclusions

9.1.1 This assessment identified LSEs potentially affecting two Habitats Sites; River Wensum SAC and Norfolk Valley Fens SAC. No LSEs were identified potentially affecting Paston Great Barn SAC. The assessment concludes that there would be no adverse effects on the integrity of either of these Habitats Sites as a result of the Proposed Scheme.

9.1.2 For River Wensum SAC, mitigation measures would avoid adverse effects on the integrity of the Habitats Site. Mitigation would comprise control of construction through imposition of a CEMP, biosecurity measures during construction and a drainage design to remove the effects of sediment and chemical run-off during operation.

9.1.3 No mitigation measures are proposed for Norfolk Valley Fens SAC where assessment of effects of the ARN on fen habitats concluded there would be no adverse effects on the integrity of the Habitats Site as a result of the Proposed Scheme.

9.1.4 No further HRA stages are required to determine the effects of the Proposed Scheme on Habitats Sites, whose integrity would be maintained during and following the Proposed Scheme works.

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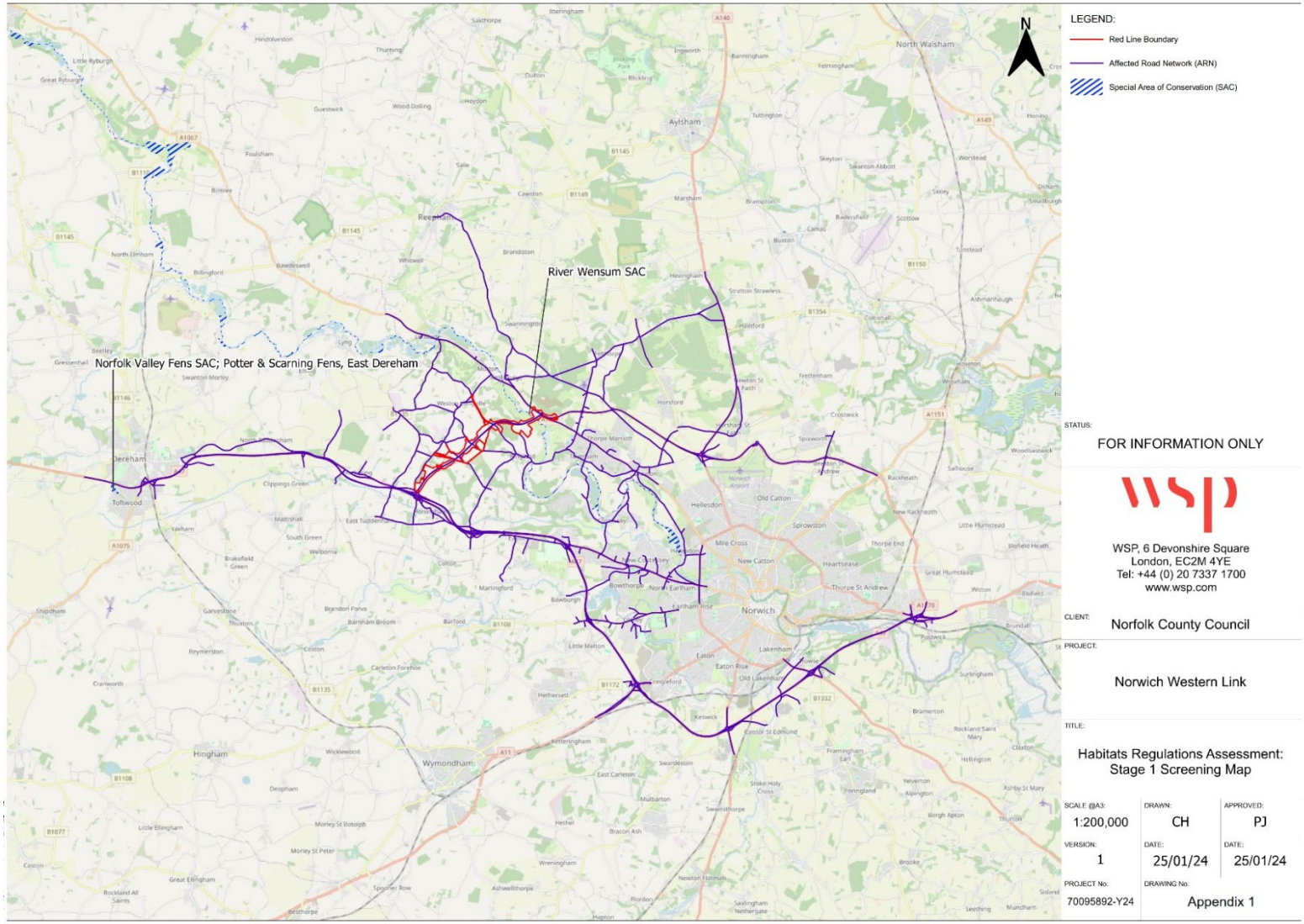
Appendix 1 - Map of Habitats Sites Screened into Assessment and the Proposed Scheme ARN


River Wensum SAC
Norfolk Valley Fens SAC; Potter & Scarning Fens, East Dereham
N
LEGEND:
Red Line Boundary
Affected Road Network (ARN)
Special Area of Conservation (SAC)
STATUS:
FOR INFORMATION ONLY
WSP, 6 Devonshire Square
London, EC2M 4YE
Tel: +44 (0) 20 7337 1700
www.wsp.com
CLIENT:
Norfolk County Council
PROJECT:
Norwich Western Link
TITLE:
Habitats Regulations Assessment:
Stage 1 Screening Map
SCALE @A3:
1:200,000
DRAWN:
CH
APPROVED:
PJ
VERSION:
1
DATE:
25/01/24
DATE:
25/01/24
PROJECT No:
70095892-Y24
DRAWING No:
Appendix 1

Appendix 2 – UKHAB Survey Method, Habitat Maps and Species Lists

UKHab Survey Method

UKHab survey of Potter & Scarning Fens, East Dereham was undertaken on the 5th of October 2022 under wet and windy conditions. Habitats were described and mapped following the Professional Version 1.1 of UKHab using the following documents:

- UK Habitat Classification User Manual (Butcher *et al*., 2020a) (hereafter the 'UKHab User Manual');
- UK Habitat Classification Field Key (UK Habitat Classification Working Group, 2020a);
- The UK Habitat Classification Habitat Definitions Version 1.1 (Butcher et al., 2020b); and
- UK Habitat Classification Basic Edition: Suggested Symbology for Maps (UK Habitat Classification Working Group, 2020b).

The UK Habitat Classification Working Group describes UKHab as "…*a unified and comprehensive approach to classifying habitats, designed to provide a robust technique for classifying and mapping British habitats*". The dominant plant species are recorded, and habitats are classified according to their vegetation types.

The UKHab system comprises a principal hierarchy (the Primary Habitats) and non-hierarchical Secondary Codes. Primary Habitats include ecosystems (level 1), broad habitat types (level 2 and level 3), more defined habitats including HPI (level 4) and further defined habitats including Annex I habitats (level 5).

Secondary Codes are then used to provide more information on a habitat from the following categories:

- mosaic habitats;
- habitat complexities;

- origin of habitat;
- management;
- land use;
- environmental qualifiers;
- hydrological regime; and
- green infrastructure.

A single Primary Habitat is assigned to each polygon, line or point feature with generally a maximum of six Secondary Codes used. Habitats are described by the Primary Habitat first (e.g. w1h5 other woodland; mixed predominantly broadleaved) with Secondary Codes following where necessary (e.g. w1h5 36 57 other woodland; mixed predominantly broadleaved that is plantation with young trees - self set). For habitats of interest that were too small to map, point features were used with Primary Habitats and Secondary Codes where applicable. Where possible level 5 Primary Habitat codes were used for habitats.

A list of plant species was compiled, with relative plant species abundance estimated using the DAFOR scale as follows: Dominant (D) - >75% cover, Abundant (A) – 51-75% cover, Frequent (F) – 26-50% cover, Occasional (O) – 11-25% cover, Rare (R) – 1-10% cover. The term ‘Locally’ (L) is also used where the frequency and distribution of a species are patchy, and ‘Edge’ (E) is also used where a species only occurs on the edge of a habitat type. The scientific names for plant species follow those in the New Flora of the British Isles (Stace, 2019).

Habitats were marked using a mobile mapping application and were subsequently digitised using a Geographical Information System (GIS).

Any invasive plant species listed on Schedule 9 of the WCA 1981 (as amended) which were evident during the UKHab survey were target noted. However, detailed mapping of such species; or a full survey for all invasive plant species beyond the scope of the survey.

Species List - Potter and Scarning Fens, East Dereham SSSI

1. Marsh thistle *Cirsium palustre* (F)
2. Alder *Alnus glutinosa* (LD)
3. Common pennywort *Umbilicus intermedius* (A)
4. Water mint *Mentha aquatica* (A)
5. Bogbean *Menyanthes trifoliata* (F)
6. Sharp-flowered rush *Juncus acutiflorus* (F)
7. Silver birch *Betula pendula* (O)
8. Compact rush *Juncus conglomeratus* (A)
9. Marsh cinquefoil *Potentilla palustris* (F)
10. Devil's-bit scabious *Succisa pratensis* (F)
11. Goat willow *Salix caprea* (R)
12. Common reed *Phragmites australis* (D)
13. Great fen-sedge *Cladium mariscus* (A)
14. Lesser tussock sedge *Carex diandra* (R)
15. Gorse *Ulex europaeus* (LA)
16. Common ragwort *Senecio jacobaea* (R)
17. Bramble *Rubus fruticosus* agg. (LA)
18. Hard rush *Juncus inflexus* (O)
19. Creeping cinquefoil *Potentilla reptans* (R)
20. Tormentil *Potentilla erecta* (R)
21. Creeping thistle *Cirsium arvense* (R)
22. Soft rush *Juncus effusus* (A)
23. Red fescue *Festuca rubra* (D)
24. Black bog-rush *Schoenus nigricans* (A)
25. Hemp agrimony *Eupatorium cannabinum* (A)
26. Meadowsweet *Filipendula ulmaria* (R)
27. Tall fescue *Festuca arundinacea* (A)
28. Marsh valerian *Valeriana dioica* (R)
29. Wild angelica *Angelica sylvestris* (O)
30. Dwarf thistle *Cirsium acaule* (O)
31. Columbine *Aquilegia vulgaris* (O)
32. Tormentil *Potentilla erecta* (R)
33. Goat willow *Salix caprea* (A)
34. Beech *Fagus sylvatica* (O)
35. Pedunculate oak *Quercus robur* (R)
36. Tufted hair grass *Deschampsia cespitosa* (LD)
37. Salad burnet *Sanguisorba minor* (R)
38. Male-fern *Dryopteris filix-mas* (LA)
39. Greater bittercress *Cardamine flexuosa* (R)
40. Rowan *Sorbus aucuparia* (R)