



Norwich Western Link

Environmental Statement

Chapter 10: Biodiversity

Appendix 10.34: Air Quality Ecological Impact Assessment

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Glossary of Abbreviations and Defined Terms

Term	Definition
ARN	Affected Road Network
APIS	Air Quality Pollution Information System
Critical loads	a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.
Critical levels	concentrations of pollutants in the atmosphere above which direct adverse effects on features, such as human beings, plants, ecosystems or materials, may occur according to present knowledge.
CWS	County Wildlife Site
LNR	Local Nature Reserve
NH ₃	Ammonia
N deposition	Nitrogen deposition
NO _x	Nitrous Oxides
SPA	Special Protection Area
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
RNR	Roadside Nature Reserve



1 Introduction

1.1 Overview of the Proposed Scheme

1.1.1 The Proposed Scheme is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

1.1.2 The Proposed Scheme, would comprise the following listed below:

- A dualling upgrade of the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 400m to the northwest;
- Construction of a new roundabout;
- Construction of a dual carriageway link from the new roundabout to a new junction with the A47 near Honingham.

1.1.3 As part of a separate planned scheme, National Highways are promoting a scheme to upgrade the A47 from the existing roundabout at Easton to join the existing dual carriageway section at North Tuddenham ('A47 DCO'). The A47 DCO received planning approval to proceed in August 2022, and it is expected that National Highways would construct the Honingham junction and the Proposed Scheme would connect to the north-eastern side of that junction.

1.1.4 The Proposed Scheme would cross the River Wensum and its floodplain by a viaduct bridge and would also cross four minor roads by overpass or underpass bridges. The Proposed Scheme would also include works for cyclists and walkers, including necessary changes of the local road network and allowing for environmental improvement measures.



1.2 Report objectives

- 1.2.1 This report presents the results of an assessment of potential effects of air quality changes at sites and features of ecological importance resulting from the operation of the Proposed Scheme. This report presents an ecological assessment based upon the results of air quality modelling presented in the Environmental Statement (ES) **Chapter 6 Air Quality** (Document Reference: 3.06.00) and therefore should be read in conjunction with that chapter.
- 1.2.2 While scoped in as part of the assessment undertaken in **Chapter 6 Air Quality** (Document Reference: 3.06.00), impacts from construction traffic are considered negligible and are therefore not considered further in this report.
- 1.2.3 In accordance with Design Manual for Roads and Bridges (DMRB) LA 105 Air Quality (hereafter LA 105), air quality assessments should include an assessment of the impacts on “designated habitats” of international, national, and local ecological conservation interest for protected / notable species and habitats within 200m of the Affected Road Network (ARN), as determined by the air quality modelling (**Chapter 6 Air Quality** (Document Reference 3.06.00)). In accordance with LA 105, designated habitats include Ramsar sites, Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSIs), Local Nature Reserves (LNRs), County Wildlife Sites (CWSs), Roadside Nature Reserves (RNRs), ancient woodland and ancient / veteran trees.
- 1.2.4 This assessment follows a modified approach from that outlined within Figure 2.98 of LA 105 and LA 108 Biodiversity (hereafter LA 108) (Highways Agency, 2020) and considers designated habitats within 200m of the ARN for the Proposed Scheme where it is predicted that ammonia (NH₃), nitrogen (N) deposition and nitrous oxides (NO_x) would increase above threshold levels set out from Air Pollution Information System (APIS).
- 1.2.5 This report provides an assessment on the significance of the effects on each site or feature, in the absence of mitigation or compensation measures. This assessment will inform ES **Chapter 10: Biodiversity** (Document Reference



3.10.00) and also cross reference with the **Habitats Regulations Assessment Report** (Document Reference: 4.03.00) for the Proposed Scheme. Mitigation and compensation are not covered in this report and will be covered within a separate **Outline Air Quality Compensation Strategy** (Document Reference: 06.01.00).

2 Methodology

2.1 Ecological Feature Identification

Desk Study

- 2.1.1 An assessment of designated habitats within 200m of the ARN was undertaken. The ARN is defined in ES **Chapter 6 Air Quality** (Document Reference: 3.06.00) following the application of the scoping criteria in LA105.
- 2.1.2 The ARN was identified using traffic modelling for 2029 (opening year scenario) and 2044 (design year scenario).
- 2.1.3 Designated habitats within 200m of the combined ARN were identified, with the following included in the air quality screening assessment modelling (ES **Chapter 6 Air Quality** (Document Reference: 3.06.00)):
- International importance – Ramsar sites, SPA and SAC;
 - National importance – SSSI, ancient woodland and veteran and ancient trees; and
 - County importance – CWS, and RNR.
- 2.1.4 A total of 59 transects covering 44 sites were scoped into the assessment. Hereafter, the features included in the assessment are referred to as ‘Sites’. The locations of all Sites considered in the screening assessment are shown in Figure A-1, Sub appendix A of this Appendix 10.34.
- 2.1.5 The Sites were identified as part of the desk study for the Proposed Scheme, as described in the **Chapter 10: Biodiversity** (Document Reference: 3.10.00). Information about habitats within International Sites and SSSIs was



taken from site citations. For CWS and other sites of county importance information about habitats was taken from site descriptions obtained as part of the desk study, provided by Norfolk Biodiversity Information Service (NBIS). The Priority Habitats Inventory (Natural England, 2023a) and aerial imagery were also consulted where citations referred to Habitats of Principal Importance (HPI, JNCC, 2012) in order to quantify the area of habitats within the Site. Where Site descriptions were not available, aerial imagery and HPI inventory were used to determine sensitive habitats within the Site. Ancient Woodland information was identified through the Ancient Woodland Inventory (Natural England, 2023b).

- 2.1.6 The Arboricultural Impact Assessment (Document Reference: 3.10.35) includes a desk study of data regarding ancient, veteran and notable trees using information held on the Ancient Tree Inventory (ATI), a database maintained by the Woodland Trust. The Arboricultural Impact Assessment (Document Reference: 3.10.35) further reports on a baseline survey of ancient and veteran trees; the location of trees identified combined with a veteran tree layer provided by NBIS is shown on Figure A-2, Sub appendix A. Tree numbering is not consistent with that reported in ES Appendix 10.35, however tree numbers are referred to later in the report.
- 2.1.7 HPI were not considered as a separate feature for this report as it is considered that CWS would constitute a representative amount of the HPI within the ARN. Furthermore, it was considered that a suitable assessment could not be made of HPI considering that little publicly accessible information is available with regards to HPI condition. Within 200m of the ARN, 2,103ha of HPI was identified, comprising 63.69% deciduous woodland. The Sites considered within the ARN cover 39.82% of all the HPI.

2.2 Assessment of Air Quality Effects

- 2.2.1 This assessment will follow a modified approach outlined within Figure 2.98 of LA 105 and LA 108 to consider the effects of NH₃ and nitrogen oxides (NO_x)



(both in terms of their concentration in air and as a contributing factor to overall nitrogen (N) deposition).

- 2.2.2 **Chapter 6 Air Quality** (Document Reference: 3.06.00) of the ES provides full details on the approach to modelling and assessment of changes in annual mean NO_x concentrations, annual mean NH₃ concentrations, and N deposition rates that would occur as a result of the operation of the Proposed Scheme.
- 2.2.3 For the identified Sites, the air quality assessment has modelled predicted changes in concentrations of NO_x, NH₃, and N deposition rates between the “Do Minimum” (future baseline without the Proposed Scheme) and “Do Something” (with the Proposed Scheme) scenarios. Data was acquired at 10m intervals along a (up to) 200m length linear transect from the centreline of the Proposed Scheme and the ARN, starting from the nearest point of the feature. For those Sites which are due to be directly impacted through habitat removal as a result of the Proposed Scheme, the nearest retained or reinstated point of the feature has been used. For ancient and veteran trees, modelling was conducted for the point location of the individual tree.
- 2.2.4 Critical loads and levels were obtained from the APIS database and were correct at December 2023. APIS only provides site specific critical levels and loads for SAC, SPA and SSSI and therefore the remaining sites required assessment against the APIS habitat pollutant pages. Where a range in the critical load was provided for a particular habitat, the lowest value in the range was used to make the assessment precautionary. Site descriptions and citations indicated that most of the designated sites had broadleaved deciduous woodland as their main constituent. As critical loads and levels are not published for ancient and veteran trees, the published information for broadleaved deciduous woodland was also used for that habitat type.
- 2.2.5 **Table 1** below displays the critical loads and levels for habitats present within each of the Sites. NH₃ critical levels are 3µg/m³ for higher plants and 1µg/m³ where bryophytes or lichens (lower plants) are present and considered to be



an important part of the ecosystem. A full list of Sites and the relevant critical loads and levels for the habitats present within 200m of the ARN are described in **Table A1**, sub-appendix A of this Appendix 10.34.

Table 1 Critical Loads and Levels for Site Habitats Obtained from APIS Database

Habitat	NH ₃ critical level (µg/ m ³)	N deposition critical load (N/ha/yr)	NO _x critical level (µg/ m ³)
Broadleaved deciduous woodland	1 - 3	10 -15	30
Fen, marsh, and swamp: Rich fens	1 - 3	15 - 25	30
Coastal, floodplain and grazing marsh	1 - 3	10 -20	30

2.2.6 The significance of effects was considered where the change in modelled total N deposition, NO_x or NH₃ with the Proposed Scheme (“Do Something” scenario) in comparison to the future baseline (“Do Minimum” without the Proposed Scheme scenario) was greater than 1% (as an absolute number), and the critical load / level for the habitat was exceeded. Where the 1% threshold was not exceeded, the effects were considered not to be significant.

2.2.7 Where the 1% threshold was exceeded, the potential ecological implications were assessed as described between paragraphs 2.2.12 and 2.2.23. Further to this, the professional judgement of the ecologists completing the assessment was applied. A qualified statement regarding the potential ecological significance of effects was then produced.

2.2.8 Air quality impacts that may be significant following application of the thresholds have then been characterised against the impact and effect descriptors used in paragraph 3.10 and Table 3.11 of (Highways Agency, 2020) and applicable CIEEM guidance (CIEEM, 2021). The approach to describing each impact characteristic, which informs the overall Level of Impact under LA 108, is set out below.



Resource Importance

2.2.9 The importance of the ecological features has been identified as follows, in line with DMRB guidance, LA 108, and in line with the geographical framework set out in CIEEM (2018) **Chapter 10: Biodiversity** (Document Reference: 3.10.00) focuses on four levels of geographical scale for ecological importance as follows:

- Local;
- County;
- National; and
- International.

2.2.10 Common and widespread features that do not have appreciable value are considered to be of 'negligible' importance in CIEEM (2019) Chapter 10.

Duration and Reversibility

2.2.11 Duration and reversibility is categorised as either 'permanent and irreversible' or 'temporary and reversible'.

2.2.12 There have been considerable declines in total NO_x emissions from road transport over the last two decades, with the National Atmospheric Emission Inventory (NAEI) identifying that total NO_x emissions from road transport in 2018 were approximately a third of the level experienced in 1999 and have approximately halved since 2005 (National Atmospheric Emissions Inventory, 2018). The reversibility of the impacts is largely dependent on the predicted increase in N deposition, NH₃ or NO_x (magnitude, see paragraph 2.2.17 below) and the proximity of the designated habitat to the Proposed Scheme.

2.2.13 The duration and reversibility of the impacts of the pollutants have therefore been determined on a case-by-case basis based upon the position of the affected feature in relation to the Proposed Scheme and the outcomes of the air quality modelling.



2.2.14 Impacts that are considered as ‘retarding the improvement’ will generally be categorised as temporary and reversible, subject to application of professional judgement. This is in cases where the level of pollutant is predicted to decrease from the baseline regardless of the scenario, but the “Do Something” scenario pollutant level is still greater than that in the “Do Minimum” scenario. Impacts are generally described as ‘permanent and irreversible’ where the level or rate of deposition of the pollutant in the ‘Do Something’ scenario is predicted to increase from the baseline. This is subject to the application of professional judgement, i.e. it is not an absolutely rigid part of the assessment process.

Extent

2.2.15 In the case of the Sites, the extent is categorised as the area of the habitat(s) that form part of their site designation that experience a potentially significant air quality effect after applying the methodology detailed above (paragraph 2.2.6). In the case of ancient or veteran trees, where a potentially significant air quality effect may occur at the location of a tree’s central grid reference, this is considered to occur across the whole tree.

2.2.16 Additional investigation was undertaken for each Site where exceedance of the 1% change criterion was indicated beyond 200m from the nearest affected road. This involved re-running the air quality models to predict the impacts over a 10m x 10 m receptor grid extending to the designation boundary of each site in question. The extents of these impacts are illustrated in Figures A3-A10, Sub appendix A.

Magnitude

2.2.17 Magnitude is categorised as the maximum predicted dose of nitrogen or NO_x/NH₃ onto a designated habitat that would result from operation of the Proposed Scheme. This is expressed in kg N/ha/yr for N deposition. The dose for NH₃ and NO_x is expressed in µg/m³. The predicted maximum dose from the Proposed Scheme which occurs in both the opening year and design year



is reported. These results are taken from the air quality modelling presented in **Chapter 6 Air Quality** (Document Reference: 3.06.00).

Frequency

2.2.18 Frequency is described as ‘the number of times an activity occurs’ in the CIEEM Guidelines (CIEEM, 2018). The impact arises from increased traffic flows during operation of the Proposed Scheme, which would occur on an ongoing basis from the opening year. As the impacts for N deposition is assessed against an annual metric (kg N/Ha/yr) and the impacts for NH₃ and NO_x is expressed as an annual mean concentration (µg/m³), the frequency is categorised as ‘annual’ for all habitat sites.

Timing

2.2.19 As described in paragraph 2.2.10, the impact would occur continuously from the opening year. Timing is therefore categorised as ongoing during the operational period.

Integrity and Key Characteristics of the Resource

2.2.20 Potential effects on the integrity and key characteristics of each designated habitat are assessed with consideration of:

- The type and condition of the habitats for which the designated habitats have been designated;
- The characterisation of the impact as described above (paragraph 2.2.9 to 2.2.18); and
- The likely biophysical responses of the designated habitats subject to a potentially significant effect, and whether these responses could undermine the ecological coherence, functioning, and conservation status of the features for which the designated habitat is designated (and hence its integrity).

2.2.21 Additional nutrient analysis was undertaken for the River Wensum SAC and SSSI to support the assessment of adverse deposition impacts on the



integrity and key characteristics of the Sites. Sub appendix B provides details on the methodology and results of this additional nutrient analysis.

Level of Impact

2.2.22 Level of impact is categorised against the criteria set out in Table 3.11 of LA 108, as shown in **Table 2** which includes determining whether an impact will be beneficial or adverse, and whether the integrity or key characteristics of the designated habitat would be affected. A consideration of background levels of N deposition and NH₃/NO_x concentration has been used to inform this assessment. Judgments are made based on the predicted impact magnitude in addition to the predicted extent of change plus, where known, the frequency and or timing of an impact.

Table 2 Level of Impact And Typical Descriptions (Table Adapted from Table 3.11 LA108 (Highways Agency, 2020))

Level of Impact	Adverse / Beneficial (change)	Typical Description
Major	Adverse	1) Permanent / irreversible damage to a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact negatively affects the integrity or key characteristics of the resource.
Major	Beneficial	1) Permanent addition of, improvement to, or restoration of a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact positively affects the integrity or key characteristics of the resource.
Moderate	Adverse	1) Temporary / reversible damage to a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact negatively affects the integrity or key characteristics of the resource.
Moderate	Beneficial	1) Temporary addition of, improvement to, or restoration of a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact positively affects the integrity or key characteristics of the resource.
Minor	Adverse	1) Permanent / irreversible damage to a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact does not affect the integrity or key characteristics of the resource.
Minor	Beneficial	1) Permanent addition of, improvement to, or restoration of a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact does not affect the integrity or key characteristics of the resource.
Negligible	Adverse	1) Temporary / reversible damage to a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact does not affect the integrity or key characteristics of the resource.
Negligible	Beneficial	1) Temporary addition of, improvement to, or restoration of a biodiversity resource; and 2) the extent, magnitude, frequency, and / or timing of an impact does not affect the integrity or key characteristics of the resource.
No change	No change	No observable impact, either beneficial or adverse.



Effect Significance

2.2.23 Table 3.13 of LA 108, as shown in **Table 3**, was used to determine the significance of effect. **Table 3** includes two possible significance categories (for example 'Slight or Moderate') for some combinations of Resource Importance and Levels of Impact. LA 108 states at paragraph 3.13.1 that *'where Table 3.13 includes two significance categories, evidence should be provided to support the reporting of a single significance category'*. The evidence that has been considered when choosing the significance categories includes the permanence and / or reversibility of the impact, the extent and magnitude of the effect and information on the nature and condition of the resource affected.

Table 3 Level of impact and the effect significance in relation to the resource importance (table adapted from Table 3.13 LA108 (Highways Agency, 2020))

Resource Importance / Level of Impact	No Change	Negligible impact	Minor Impact	Moderate Impact	Major Impact
International or European Importance	Neutral significance	Slight significance	Moderate or large significance	Large or very large significance	Very large significance
UK or National Importance	Neutral significance	Slight significance	Slight or moderate significance	Moderate or large significance	Large or very large significance
Regional Importance	Neutral significance	Neutral or slight significance	Slight significance	Moderate significance	Moderate or large significance
County or Equivalent authority importance	Neutral significance	Neutral or slight significance	Neutral or slight significance	Slight significance	Slight or moderate significance
Local Importance	Neutral significance	Neutral significance	Neutral or slight significance	Neutral or slight significance	Slight significance



2.3 Notes and Limitations

- 2.3.1 The assessment assumptions in relation to the air quality modelling are provided within **Chapter 6 Air Quality** (Document Reference 3.06.00).
- 2.3.2 Some transects may refer to more than one Site due to proximity to neighbouring Sites or overlapping designations. A full list of Sites and their associated transects is available in Table A1, Sub appendix A of this Appendix 10.34.
- 2.3.3 Where possible, the most recent data has been used for the assessment, however many of the citations provided by NBIS for the CWS sites are over 10-years old. As such, the assessment utilises multiple data sources including HPI data and aerial imagery of habitats within the designated sites along the modelled transects, to confirm the extent of designated habitats within the site. This information has been used to support the assignment of critical loads for the relevant sites.
- 2.3.4 Where no citations have been provided by NBIS, then the Site has been assessed against HPI within the Site with cross-referencing to aerial imagery. The assessment has therefore been based on the conservative assumption that AQ modelling was based on most sensitive habitat likely present on the Site.



3 Importance of Ecological Features

3.1 Ecological Features

3.1.1 A total of 44 designated habitats and / or areas of ecological importance were identified within 200m of the ARN and scoped in for assessment. These are listed in **Table 4** below alongside their importance and the specific Sites.

Table 4 Designated Habitats and / or Areas of Ecological Importance Scoped into Assessment

Designated habitat and area of ecological importance	Importance	Sites scoped into assessment
Special Areas of Conservation	International	Norfolk Valley Fens SAC River Wensum SAC
Sites of Special Scientific Interest	National	Alderford Common SSSI Potter & Scarning Fens, East Dereham SSSI Sweetbriar Road Meadows, Norwich SSSI River Wensum SSSI
Ancient Woodland	National	Church Wood Ancient Woodland Primrose Grove Ancient Woodland Snake Wood Ancient Woodland Sprowston Wood Ancient Woodland

Designated habitat and area of ecological importance	Importance	Sites scoped into assessment
County Wildlife Sites (CWSs)	County	<p>Attlebridge Hills CWS</p> <p>Bawburgh / Colney Gravel Pits CWS</p> <p>Botany Bay Farm CWS</p> <p>Brook House Marshes CWS</p> <p>Broom & Spring Hills CWS</p> <p>Church Hill Common CWS</p> <p>Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation CWS</p> <p>Costessey Pits (East) CWS</p> <p>Earlham and Colney Marshes CWS</p> <p>East Hills CWS</p> <p>Fen Plantation CWS</p> <p>Fen West of East Tuddenham CWS</p> <p>Great Witchingham Common CWS</p> <p>Hellesdon Pastures CWS</p> <p>Horsham Meadows CWS</p> <p>Intwood Carr CWS</p> <p>Jennis' Wood & Dryhill Plantation CWS</p> <p>Land Adjoining Foxburrow Plantation CWS</p> <p>Lenwade Pits (East) CWS</p> <p>Lenwade Pits (West) CWS</p> <p>Long Dell and Westlodge Hills CWS</p> <p>Marriott's Way CWS</p> <p>Meadow Farm Meadow CWS</p> <p>Mouse Wood CWS</p>

Designated habitat and area of ecological importance	Importance	Sites scoped into assessment
County Wildlife Sites (CWSs)	County	Old Covert, Wood Lane CWS Primrose Grove CWS River Tud at Easton and Honingham CWS River Wensum Pastures CWS River Yare (west and east), Bowthorpe CWS Taverham Mill CWS Walsingham Plantation CWS Wensum Pastures at Morton Hall CWS Weston Meadow CWS
Roadside Nature Reserve	County	Fakenham Road RNR



3.1.2 In addition to the areas identified in **Table 2**, 73 ancient and / or veteran trees were identified within the Study Area. As ancient and veteran trees are considered irreplaceable habitat, they are deemed to be of comparable importance to ancient woodland. As such, ancient and veteran trees are considered of National importance.

4 Potential Impacts

4.1 Background

4.1.1 In summary, N deposition can lead to a range of negative effects upon biodiversity, primarily concerning loss of sensitive species and changes to habitat structure and composition. Individual trees may be impacted by factors such as increased growth, which can be associated with reduced investment in root growth; therefore, increasing vulnerability, for example, to windthrow. However, negative effects are difficult to detect even with comparatively large doses of nitrogen. Some species / groups of plants may also benefit rather than being adversely affected by increased deposition rates, including when habitat-specific critical loads are already exceeded. Atmospheric NO_x can be directly toxic to vegetation at high concentrations.

4.1.2 With regard to NH_3 , a summary of the information provided by APIS (APIS, 2023) on the effects upon vegetation is as follows. NH_3 is a highly reactive and soluble alkaline gas that can be taken up by leaves via stomata. As well as increasing the potential for nutrient nitrogen uptake, the alkalinity of NH_3 is thought to lead to deleterious effects upon plants and lichens. Atmospheric NH_3 can also increase soil acidity when it dissolves to ammonium. The effects of NH_3 include direct toxicity, leading to increased likelihood of detrimental interactions with other abiotic (e.g., increased risk of frost damage or desiccation) and biotic stressors (e.g., pest and pathogen attack), as well as contribution to increased N deposition with associated impacts upon community composition. Mosses and lichens are most at risk from NH_3



pollution as they have limited detoxification capacity relative to their uptake potential and a large surface area relative to mass.

- 4.1.3 It is considered that effects of N deposition and NH₃ on individual trees are particularly difficult to predict. Trees would be less vulnerable to changes in habitat structure as, for example, they have no ground flora that could be altered. However, they can support epiphytes such as bryophytes and lichens that can be particularly vulnerable to the effects of N deposition and atmospheric NH₃.
- 4.1.4 It is considered that the strongest effect of emissions of NO_x across the UK is through their contribution to total N deposition. However, the direct effects of gaseous nitrogen oxides, may also be important, especially in areas close to sources (e.g., roadside verges). The critical level for all vegetation types from the effects of NO_x has been set to 30 µg/m³. Experimental evidence suggests that moderate concentrations of NO_x may produce both positive and negative growth responses, with the potential for synergistic interactions with sulphur dioxide (SO₂) being very important. There is evidence to suggest that the effects of NO₂ are much more likely to be negative in the presence of equivalent concentrations of SO₂. At the same time, the ratio of SO₂ to NO₂ has decreased greatly in urban areas of the UK over the past 30 years.

4.2 Site Specific Factors

- 4.2.1 Considering site specific factors, background levels of NH₃ and N deposition exceed critical levels and loads to a considerable degree across the Study Area. Table 21 in the Natural England Commissioned Report (NECR) 201 (Caporn, 2016) provides evidence that when background levels of N deposition are high, greater increases of N deposition are needed to result in perceptible effects upon habitats, than when background levels of N deposition are low. This may be interpreted as evidence that habitats experiencing high levels of N deposition at baseline (as per the Study Area) are likely to respond less to increased N deposition than habitats experiencing low levels of N deposition at baseline.



4.2.2 High NH_3 and N deposition levels may be attributed to the extensive areas of land in use by agriculture across the Study Area, for example approximately 56.79% of the Red Line Boundary is made up of arable cropland. Of particular note, there is currently a pig farm adjacent to the Primrose Grove Ancient Woodland and CWS within the Red Line boundary. This land parcel would be used as a temporary works compound during the construction period of the Proposed Scheme and would likely revert to agricultural use after the Proposed Scheme has been built. Agricultural sources of nitrogen have not been modelled within this assessment and therefore the benefits of potential removal of these (where they would necessarily be removed to facilitate construction) as a source of nitrogen are not considered within this assessment.

4.2.3 It is noted above that mosses and lichens can be particularly sensitive to the effects of N deposition and elevated concentrations of NH_3 . APIS does not list critical levels for NH_3 for CWS sites. In addition, the majority have not been recently surveyed and lack up-to-date citation information. As such, a precautionary assumption has been made that important lower plant communities may be present at those sites and therefore the lower critical load has been used for NH_3 . Where a critical level has been supplied by APIS, as per SSSIs, the given critical level has been applied. Important lichen communities can be found on ancient and veteran trees and hence the lower critical level for NH_3 has been used for these.

4.3 Future baseline / cumulative Impact

4.3.1 Both Do Something and Do Minimum scenarios consider traffic growth associated with national / regional / local developments and the assumption of decarbonisation of the UK vehicle fleet. These therefore represent future baseline and cumulative impact in growth, but this is indistinguishable from future baseline in this discussion.

4.3.2 The Proposed Scheme is not a trip generating scheme, rather it provides new highway capacity and is not associated with any new developments, for



example housing or employment sites. It is not considered to be development dependent infrastructure and it is also not required to unlock any identified specific sites, although it does support general housing and employment growth across Greater Norwich. The Proposed Scheme offers new highway capacity and new route options for existing journeys, which may re-route in response to the new infrastructure. The traffic impact associated with the Proposed Scheme is largely based on re-assignment of traffic. However, within the data used for ES **Chapter 6: Air Quality** (Document Reference: 3.06.00) and ES **Chapter 15: Climate and Greenhouse Gases** (Document Reference: 3.15.00), the modelling carried out considers effects potentially caused by induced traffic across the network throughout the 24-hour day. This is so that a robust assessment is provided. The Do Minimum network includes all planned committed developments that are near certain, or more than likely, and committed local transport schemes and improvement measures that are expected to be in place in the modelled timeframes for the 2029 opening year and 2044 design year. The baseline forecast network used within the strategic modelling also includes the National Highways proposals for A47 North Tuddenham to Easton Improvement Scheme, Thickthorn Junction improvements and Burlingham to Blofield Improvements (Transport Assessment, Document Reference: 4.01.00). The additional route provided by the Proposed Scheme is considered within the Do-Something scenario only. The differences between Do Something and Do Minimum are therefore the effects of the Proposed Scheme.

- 4.3.3 As described above, both Do Something and Do Minimum include all planned committed development and committed transport schemes. Therefore, the impacts assessed as arising from the predicted changes in traffic also incorporate consideration of cumulative effects arising as a result of these committed developments and transport scheme.



5 Assessment of Effects

5.1 Designated Sites

5.1.1 A total of 44 Sites were scoped into the assessment. All Sites modelled are currently exceeding the critical level and load for NH₃ and N deposition and are predicted to continue exceeding the critical level and load for NH₃ and N deposition regardless of the Proposed Scheme. Seventeen of the 44 sites are currently exceeding the critical level for NO_x regardless of the Proposed Scheme.

Insignificant effects

5.1.2 Of the 44 sites assessed, seven sites are predicted to experience no change in N deposition, NH₃, or NO_x greater than 1% of the critical load or level for the pollutants in either of the modelling years, 2029 and 2044 as a result of the Proposed Scheme. As such, the changes in N deposition, NH₃, or NO_x would result in Neutral (not significant) effects and these features are not considered further within this assessment. The Sites are as follows:

- Bawburgh / Colney Gravel Pits CWS;
- Great Witchingham Common CWS;
- Fen Plantation CWS;
- Lenwade Pits (East) CWS;
- Lenwade Pits (West) CWS;
- Sprowston Wood Ancient Woodland; and
- River Yare (west and east), Bowthorpe CWS.

Operational Adverse Effects – Opening Year 2029

5.1.3 **Table 5** assesses the potentially significant effects in regard to N deposition for 2029, the opening year of the Proposed Scheme. Of the 44 Sites assessed, 18 Sites were predicted to have an increase in N deposition that exceeded the 1% threshold as a result of the Proposed Scheme. Of these, it



is considered that these changes would result in neutral (not significant) effects for eight Sites, slight adverse effects for seven Sites, and moderate adverse effects for three Sites. The modelling data is shown in Table C-1, Sub appendix C.

5.1.4 **Table 6** assesses the potentially significant effects in regard to NH₃ for 2029, the opening year of the Proposed Scheme. Of the 44 Sites assessed, 19 Sites were predicted to have increases in NH₃ that exceed the 1% threshold as a result of the Proposed Scheme. Of these, it is considered that these changes would result in neutral (not significant) effects for six Sites, slight adverse effects for six Sites, moderate adverse effects for six Sites and large adverse effects for one Site. The modelling data is shown in Table C-2, Sub appendix C.

5.1.5 No sites were predicted to have increases in NO_x exceeding the 1% threshold as a result of the Proposed Scheme.

Table 5 Assessment of Potentially Adverse Significant Effects from Nitrogen Deposition upon Sites in Opening Year (2029)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Alderford Common SSSI	ECO54	No change	Impacts greater than 1% of critical load only present up to 10m into the Site, where only woodland (not a citation feature of the SSSI) is present. As such, it is anticipated that no change would occur to the Site as the key characteristics and integrity of the qualifying habitats (calcareous grassland) are unlikely to be affected (due to the absence of calcareous grassland within the extent of the impacts).	Neutral
Attlebridge Hills CWS	ECO35	Temporary, Reversible	<p>Baseline N deposition levels at Attlebridge Hills CWS already significantly exceed the critical load in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects due its location close to an existing road and arable land.</p> <p>Woodland planting is proposed along the southern edge of the Site which, once mature, would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the air quality model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>As impacts with the Proposed Scheme would not exceed the current baseline N deposition levels, it is considered that the Proposed Scheme would contribute to the retarding of improvement with regards to N deposition. As such, the magnitude, extent of N deposition is unlikely to affect the integrity or the key characteristics of the Site and therefore a negligible adverse level of impact is concluded the most likely outcome.</p>	Slight adverse
Broom & Spring Hills CWS	ECO53	Temporary, Reversible	<p>Baseline N deposition levels at Broom & Spring Hills CWS already significantly exceed the critical load in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects due its location close to arable land.</p> <p>The impacts are predicted to occur over 100% of the Site. The Proposed Scheme would not lead to an exceedance of baseline N deposition levels but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Church Wood Ancient Woodland	ECO72	Temporary, Reversible	<p>Baseline N deposition levels are almost three times higher than the assigned critical load in the absence of the Proposed Scheme, likely due to the Site's close proximity to the Broadland Northway.</p> <p>The Proposed Scheme is not predicted to exceed current baseline N deposition levels and only results in a change greater than 1% for 1.4% of the Site.</p> <p>The magnitude of the predicted N deposition impact is unlikely to affect the integrity or key characteristics of the Site and would likely contribute to a small retarding of improvement. Due to the extent of the impacts, a negligible adverse level of impact is concluded to be the most likely outcome.</p>	Slight adverse , due to the Site being of National importance
Fakenham Road RNR	ECO85, ECO86	Permanent, Irreversible	<p>Baseline N deposition levels are almost three times higher than the assigned critical load in the absence of the Proposed Scheme, likely due to the Site's immediate proximity to Fakenham Road.</p> <p>The Site is designated for Hoary Mullein. Hoary Mullein is commonly found on disturbed ground, and within roadside ruderal habitats and therefore can tolerate elevated levels of nitrogen deposition.</p> <p>This RNR is to be partially removed and subsequently reinstated to enable the construction of the Proposed Scheme, and therefore would be directly adjacent to the Proposed Scheme and Fakenham Road. As such, 100% of the Site would be impacted by changes in air quality due to the Proposed Scheme.</p> <p>Due to the RNR's proximity and associated magnitude of impact to the Proposed Scheme a major adverse level of impact is concluded.</p>	Moderate adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Land Adjoining Foxburrow Plantation CWS	ECO16, ECO37	Permanent, Irreversible	<p>NVC surveys classified Land Adjoining Foxburrow Plantation CWS as fen-meadow, which aligns with purple moor-grass and rush pastures BAP habitat. Further surveys recorded the Site as occasionally cattle grazed but not intensively and had been subject to agricultural improvement with some bramble and bracken encroachment.</p> <p>The Proposed Scheme is predicted to increase N-dep across 80.6% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>Therefore, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
Marriott's Way CWS	ECO13	No change	<p>The CWS is designated for an old railway line which has now been repurposed as a footpath. Woodland associated with the footpath may be sensitive to nitrogen, however baseline N deposition levels at Marriott's Way CWS already significantly exceed the critical load in the absence of the Proposed Scheme. Furthermore, the Proposed Scheme is predicted to not exceed baseline N deposition levels.</p> <p>As the extent of N deposition is unlikely to affect the key characteristics and integrity of the Site as a whole (being a public footpath), it is concluded that no material changes to the Site would occur due to the Proposed Scheme.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Norfolk Valley Fens SAC	ECO55	No change	<p>Approximately 30m of woodland is present along the A47 between it and fen habitat within Norfolk Valley Fens. This would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration and therefore also their contribution to deposition. These barrier effects are not accounted for in the modelling (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>Plant growth on alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Norfolk Valley Fens SAC is not limited 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). In addition, impacts exceeding 1% of critical load occur over less than 0.1% of the SAC.</p> <p>Taking these factors into account, no adverse change is anticipated due to the Proposed Scheme.</p>	Neutral
Potter & Scarning Fens, East Dereham SSSI	ECO55	No change	<p>Approximately 30m of woodland is present along the A47 between it and fen habitat within Norfolk Valley Fens. This would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration and therefore also their contribution to deposition. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>Plant growth on alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Potter and Scarning Fen is not limited 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).</p> <p>Taking these factors into account, no adverse change is anticipated due to the Proposed Scheme.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Old Covert, Wood Lane, CWS	ECO18	Temporary, Reversible	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme. As such, it is likely that the woodland throughout the Site may already be facing negative effects due to its location close to an existing road.</p> <p>Baseline N deposition is currently highest nearest Wood Lane and is predicted within the DM scenario to remain high, although lower than the current Baseline. The DS scenario predicts the inverse for N deposition, with the highest changes relative to Critical load predicted to occur nearest the Proposed Scheme, whilst N deposition rates nearest Wood Lane are predicted to be significantly lower under the DS scenario than in the DM scenario. The Proposed Scheme is not predicted to contribute to N deposition levels higher than the current Baseline N deposition levels, and therefore would be contributing to a retarding of improvement.</p> <p>The predicted N deposition levels nearest the Proposed Scheme are unlikely to affect the integrity or key characteristics of the Site and would likely contribute to a small retarding of improvement. This is predicted to affect 43.9% of the Site. As a portion of the Site nearest the existing road is predicted to experience improvements in N deposition, it is anticipated that a negligible adverse impact would be most likely.</p>	Neutral
Primrose Grove Ancient Woodland	ECO38, ECO62	Temporary, Reversible	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme. It was noted during the Site survey that large volumes of leaf litter and detritus were present, which can be caused by a loss of species diversity with respect to ectomycorrhiza and reductions in decomposition and increase litter fall or loss of species with respect to high levels of N deposition.</p> <p>As such, it is possible that the Site is already experiencing some negative effects due its location adjacent to arable fields and a pig farm.</p> <p>The Proposed Scheme would not lead to an exceedance of baseline N deposition levels but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. The impacts are predicted to occur over 100% of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome</p>	Moderate adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Primrose Grove CWS	ECO38, ECO62, ECO63	Temporary, Reversible	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme. It was noted during the Site survey that large volumes of leaf litter and detritus were present, which can be caused by a loss of species diversity with respect to ectomycorrhiza and reductions in decomposition and increase litter fall or loss of species with respect to high levels of N deposition.</p> <p>As such, it is possible that the Site is already experiencing some negative effects due its location adjacent to arable fields and a pig farm.</p> <p>The Proposed Scheme would not lead to an exceedance of baseline N deposition levels but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. The impacts are predicted to occur over 100% of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome.</p>	Slight adverse
River Tud at Easton and Honingham CWS	ECO82, ECO81, ECO84, ECO83	Temporary, Reversible	<p>Baseline N deposition levels at River Tud at Easton and Honingham CWS already exceed the critical load in absence of the Proposed Scheme. N deposition levels are predicted to increase significantly regardless of the Proposed Scheme due to the realignment of the A47. The Proposed Scheme would result in a change greater than 1% for 1.0% of the Site.</p> <p>The magnitude of the predicted N deposition impact is unlikely to affect the integrity or key characteristics of the Site. Due to the extent of the impacts, a negligible adverse level of impact is concluded to be the most likely outcome.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum SAC	ECO28, ECO39	No change	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme.</p> <p>The Proposed Scheme is predicted to significantly increase N deposition levels by more than 1% of critical load across up to 0.9% of the Site. However, given the site importance, this is still a significant area to be impacted.</p> <p>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 <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation as well as other macrophyte species and algae (English Nature, 1999) (Natural England, 2022). Phosphorus is not released by vehicle exhausts and therefore would not contribute to current phosphorus levels within the River Wensum.</p> <p>As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SAC.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum SSSI	ECO28, ECO39	No change	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme.</p> <p>The Proposed Scheme is predicted to significantly increase N deposition levels by more than 1% of critical load across up to 0.9% of the Site. The River Wensum SSSI is designated for aquatic and associated terrestrial features, such as acid and unimproved grasslands. No associated terrestrial habitat is present within 200m of the ARN and therefore is not predicted to be impacted due to the Proposed Scheme</p> <p>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 <i>Ranunculion fluitantis</i> and <i>Callitricho-Batrachion</i> vegetation as well as other macrophyte species and algae (English Nature, 1999) (Natural England, 2022). Phosphorus is not released by vehicle exhausts and therefore would not contribute to current phosphorus levels within the River Wensum.</p> <p>As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SSSI.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum Pastures CWS	ECO28, ECO39	Permanent, Irreversible	<p>River Wensum Pastures comprises inter-flooded, predominantly semi-improved, cattle-grazed pasture which is dissected by spring-fed ditches and includes several pockets of wet woodland. NVC surveys noted that grazing may accentuate the mosaic structure as many animals avoid the tough leaves and graze on the more palatable species between the tussocks.</p> <p>The Proposed Scheme is predicted to significantly increase N deposition levels across 59.9% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>Therefore, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
Walsingham Plantation CWS	ECO7, ECO21	Temporary, Reversible	<p>Baseline N deposition levels across the Site already significantly exceed the critical load in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects due its location adjacent to two existing roads, Fakenham Road and Broadland Northway.</p> <p>The predicted N deposition levels are not anticipated to affect the integrity, or the key characteristics of the Site as the Proposed Scheme would not lead to N deposition rates that exceed the current baseline N deposition rates. The Proposed Scheme would result in a retardation of improvement which would affect 100% of the Site. Therefore, a minor adverse level of impact is concluded the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Wensum Pastures at Morton Hall CWS	N/A	Temporary, Reversible	<p>Wensum Pastures at Morton Hall was not subject to the original modelling assessment as it is situated over 200m from the centreline of the ARN. It was however included in the additional modelling exercise. It is predicted that the Proposed Scheme would result in a retardation of improvement that would affect 37.5% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>As such, a moderate adverse level of impact is concluded.</p>	Slight adverse

Table 6 Assessment of Potentially Adverse Significant Effects from Ammonia upon Sites In Opening Year (2029)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Alderford Common SSSI	ECO54	No change	Impacts greater than 1% of critical level only present up to 3m into the Site, where only woodland is present ((not a citation feature of the SSSI)). As such, it is anticipated that no change would occur to the Site as the key characteristics and integrity of the qualifying habitats are unlikely to be affected (due to the absence of calcareous grassland in the impacted location).	Neutral
Attlebridge Hills CWS	ECO35	Permanent, Irreversible	<p>The baseline levels for NH₃ currently significantly exceed the critical level in the absence of the Proposed Scheme. This is likely due to the CWS's location close to an existing road, Fakenham Road, and arable land. Woodland planting is proposed along the southern edge of the Site which, once mature, would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the air quality model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>The magnitude and extent of impacts from NH₃ is unlikely to affect the integrity or the key characteristics of the Site. Therefore, a minor adverse level of impact is concluded the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Broom & Spring Hills CWS	ECO53	Permanent, Irreversible	<p>The baseline levels for NH₃ are more than three times higher than the assigned critical level in the absence of the Proposed Scheme. It is likely that agricultural sources of NH₃, including pheasant rearing at the site, would be contributing to these levels. Lichen surveys have identified a tree with sparse lichen flora with <i>occasional Pachnolepia pruinata</i> and <i>Diploica canescens</i> and a small patch of <i>Pertusaria hymenea</i> on the southern edge of the Site, nearest the Proposed Scheme. <i>Pertusaria hymene</i> is a N-sensitive species and has a restricted distribution in Norfolk and is likely a recent colonisation at this Site. Another tree surveyed within the woodland noted <i>Lepraria</i> species only, which can be N-tolerant. The presence of N-sensitive species in extremely low numbers, given the current high baseline levels, suggest that NH₃ levels are already contributing to a potential decline in lower plant species.</p> <p>The Proposed Scheme may contribute to a further increase in NH₃, which is predicted to affect 100% of the Site. This may contribute to further loss of species diversity and further compromise the integrity of the Site. Therefore, a major adverse level of impact is concluded the most likely outcome.</p>	Moderate adverse
Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation CWS	ECO2	Permanent, Irreversible	<p>The baseline levels for NH₃ are almost three times higher than the assigned critical level in the absence of the Proposed Scheme. NH₃ levels are predicted to increase a maximum of 0.01µg/m³ between DS and DM scenarios and the impact would only exceed 1% of critical level over approximately 2.6% of the Site, nearest the road. Given the already high NH₃ levels, the minor increase in NH₃ is unlikely to affect the integrity or key characteristics of the Site. It is therefore concluded that a minor adverse impact would be the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Church Wood Ancient Woodland	ECO72	Permanent, Irreversible	Baseline NH ₃ levels are almost three times higher than the assigned critical level in the absence of the Proposed Scheme, likely due to the Site's close proximity to the Broadland Northway. NH ₃ levels are predicted to increase a maximum of 0.02µg/m ³ between DS and DM scenarios and the impact would only exceed 1% of critical level over approximately 6.2% of the Site, nearest the road. Given the already high NH ₃ levels, the minor increase in NH ₃ is unlikely to affect the integrity or key characteristics of the Site. It is therefore concluded that a minor adverse impact would be the most likely outcome.	Slight adverse, due to the Site being of National importance
Fakenham Road RNR	ECO85, ECO86	Permanent, Irreversible	The Site is situated directly adjacent to Fakenham Road and is designated for Hoary Mullein. Hoary Mullein is commonly found on disturbed ground, and within roadside ruderal habitats and therefore can tolerate elevated levels of NH ₃ . Regardless, the Proposed Scheme is predicted to elevate NH ₃ levels within the Site by 1.66 µg/m ³ (166.0%) and impact 100% of the Site. Due to this, a major adverse level of impact is concluded.	Moderate adverse
Land Adjoining Foxburrow Plantation CWS	ECO16, ECO37	Permanent, Irreversible	NVC surveys classified Land Adjoining Foxburrow Plantation CWS as fen-meadow, which aligns with purple moor-grass and rush pastures BAP habitat. Further surveys recorded the Site as occasionally cattle grazed but not intensively and had been subject to agricultural improvement with some bramble and bracken encroachment. The Proposed Scheme is predicted to increase NH ₃ levels for 97.5% of the Site. As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. Therefore it is concluded that a major adverse impact would be the most likely outcome.	Moderate adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Marriott's Way CWS	ECO13	No change	The CWS is designated for an old railway line which has now been repurposed as a footpath. Woodland associated with the footpath may be sensitive nitrogen, however baseline NH ₃ levels at Marriott's Way CWS already significantly exceed the critical level in the absence of the Proposed Scheme. As such, it is possible that the Site is already experiencing some negative effects due its location close to an existing road. The Site spans several miles and therefore the extent of impact is relatively small in the context of the entire Site. As the key characteristics of the Site are unlikely to be affected by NH ₃ levels from the Proposed Scheme, it is therefore concluded that a neutral level of impact is the most likely outcome.	Neutral
Norfolk Valley Fens SAC	ECO55	No change	Impacts greater than 1% of critical level are present 30m into the Site where only woodland is present, which is not a feature of the site. The woodland would also attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)). As the key characteristics and integrity of the qualifying habitats of the Site are unlikely to be materially affected by increased NH ₃ levels from the Proposed Scheme, it is concluded that no changes to the Site would occur as a result of the Proposed Scheme.	Neutral
Potter & Scarning Fens, East Dereham SSSI	ECO55	No change	Impacts greater than 1% of critical level present up to 30m into the Site where only woodland is present, which is not a feature of the site. The woodland would also attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)). As the key characteristics and integrity of the qualifying habitats of the Site are unlikely to be materially affected by increased NH ₃ levels from the Proposed Scheme, it is concluded that no changes to the Site would occur as a result of the Proposed Scheme.	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Old Covert, Wood Lane, CWS	ECO18	Permanent, Irreversible	<p>It is worth noting that the for the first 90m of the transect, NH₃ levels are predicted to decrease by a maximum of -45.71% (-0.46ug/m³) at 5m from the centreline of the road. Traffic is predicted in the DS scenario to be diverted onto the Proposed Scheme and away from the existing road, resulting in an increase in NH₃ nearest the Proposed Scheme (80 – 180m).</p> <p>As the Proposed Scheme is predicted to reduce NH₃ at the Site nearest the existing road network, but increase in areas nearest the Proposed Scheme, a minor adverse effect is predicted.</p>	Slight adverse
Primrose Grove Ancient Woodland	ECO38, ECO62	Permanent, Irreversible	<p>Baseline NH₃ levels are more than three times higher than the assigned critical level in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects from NH₃ from farm practices adjacent to the site. Site visits confirmed a pig farm to the east of the Site which is expected to be a major contributor to current NH₃ levels. The Site varies considerably in its management and condition. The northern parcels of the woodland, intersected by ECO62, are poorly managed and in poor condition, with little floristic diversity and predominantly bare ground and a canopy comprising either locally dominant sycamore or locally dominant mature beech. One parcel, intersected by ECO38, covering the east and the south of the Site is of good condition and is of typical structure and diversity of an ancient, coppiced woodland. As no lichen or bryophyte surveys have taken place within the woodland, a precautionary approach has been taken in regard to the sensitivity of this Site.</p> <p>Despite woodland already experiencing high levels of NH₃, the increase in NH₃ levels predicted from the Proposed Scheme may cause further declines in species diversity and compromise the integrity and key characteristics of the Site. Therefore, a major adverse level of impact is concluded the most likely outcome.</p>	Large adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Primrose Grove CWS	ECO38, ECO62, ECO63	Permanent, Irreversible	<p>The Site encompasses Primrose Grove Ancient woodland and extends towards the south and into the Northern Woodlands (including Rose Carr, Long Plantation and the Nursery). The impacts on the ancient woodland part of the Site are therefore covered in the above assessment.</p> <p>Baseline NH₃ levels are more than three times higher than the assigned critical level in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects from NH₃ from farm practices adjacent to the site. Site visits confirmed a pig farm present adjacent to several boundaries to the east of the Site which is expected to be a major contributor to NH₃ levels. The Site comprises largely of a mixed woodland with some areas dominated by pine plantations ranging from poor to moderate condition. Lichen surveys were undertaken at the upper slopes of Rose Carr whereby no habitats with lichens of conservation interest were noted. One walnut tree was surveyed to find no lichen of conservation interest and <i>Opegrapha vulgata</i> locally abundant on the bark where ivy was absent.</p> <p>The CWS encompasses Primrose Grove Ancient Woodland and the large increase in NH₃ levels predicted from the Proposed Scheme may result in the further decline in condition of the woodlands and compromise the integrity of the Site. It is therefore concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
River Tud at Easton and Honigham CWS	ECO82, ECO81, ECO84, ECO83	Permanent, Irreversible	<p>Baseline NH₃ levels across the Site already significantly exceed the critical level in the absence of the Proposed Scheme.</p> <p>NH₃ levels are predicted to increase significantly regardless of the Proposed Scheme due to the realignment A47. The Proposed Scheme is predicted to significantly increase NH₃ levels across up to 0.4% of the Site.</p> <p>The magnitude and extent of the predicted N deposition impact is unlikely to affect the integrity or key characteristics of the Site. Due to the extent of the impacts, a minor adverse level of impact is concluded to be the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SAC	ECO28, ECO39	No change	<p>Baseline NH₃ levels across the Site already significantly exceed the critical level in the absence of the Proposed Scheme.</p> <p>The Proposed Scheme is predicted to significantly increase NH₃ levels across up to 1.4% of the Site. However, given the site importance, this is still a significant area to be impacted.</p> <p>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 <i>Ranunculus fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation as well as other macrophyte species and algae (English Nature, 1999) (Natural England, 2022). Phosphorus is not released by vehicle exhausts and therefore would not contribute to current phosphorus levels within the River Wensum.</p> <p>As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SAC.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SSSI	ECO28, ECO39	No change	<p>Baseline NH₃ levels across the Site already significantly exceed the critical level in the absence of the Proposed Scheme.</p> <p>The Proposed Scheme is predicted to significantly increase NH₃ levels across up to 1.4% of the Site.</p> <p>The River Wensum SSSI is designated for aquatic and associated terrestrial features, such as acidic or unimproved grasslands. No terrestrial habitat described on the SSSI citation is located within 200m of the ARN and therefore is not predicted to be impacted due to the Proposed Scheme.</p> <p>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 <i>Ranunculus fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation as well as other macrophyte species and algae (English Nature, 1999) (Natural England, 2022). Phosphorus is not released by vehicle exhausts and therefore would not contribute to current phosphorus levels within the River Wensum. As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SAC.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum Pastures CWS	ECO28, ECO39	Permanent, Irreversible	<p>River Wensum Pastures comprises inter-flooded, predominantly semi-improved, cattle-grazed pasture which is dissected by spring-fed ditches and includes several pockets of wet woodland. NVC surveys noted that grazing may accentuate the mosaic structure as many animals avoid the tough leaves and graze on the more palatable species between the tussocks.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. With the concentrations predicted under the DS scenario, direct damage to vegetation is also possible. Impacts exceeding 1% of critical level are predicted to affect 84.6% of the Site.</p> <p>Given the magnitude and extent of the impacts, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
Walsingham Plantation CWS	ECO7, ECO21	Permanent, Irreversible	<p>Baseline NH₃ levels at Walsingham Plantation CWS already significantly exceed the critical level in the absence of the Proposed Scheme. As such, it is possible that the woodland is already experiencing some negative effects due its location between Fakenham Road and Broadland Northway.</p> <p>The transect nearest Fakenham Road predicts NH₃ levels would decrease from the baseline level in DS and DM scenarios for approximately 20m into the Site, with a slower rate of decline in the DS scenario than in the DM scenario. A slight increase in NH₃ levels is predicted nearest the Broadland Northway.</p> <p>These impacts are not anticipated to affect the integrity or key characteristics despite affecting 100% of the Site due to impacts largely comprising a retardation of improvement. As such, a minor adverse level of impact is concluded the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Wensum Pastures at Morton Hall CWS	N/A	Permanent, Irreversible	<p>Wensum Pastures at Morton Hall was not subject to the initial modelling assessment as it is situated over 200m from the centreline of the ARN. It was however included in the additional modelling exercise. It is predicted the Proposed Scheme would result in a change greater than 1% for 68.9% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>As such, a major adverse level of impact is concluded.</p>	Moderate adverse



Operational Beneficial Effects – Opening Year 2029

- 5.1.6 As mentioned in paragraph 5.1.1, all Sites modelled are currently exceeding the critical level and load for N deposition and NH₃ and are predicted to continue exceeding the critical level and load for NH₃ and N deposition regardless of the Proposed Scheme.
- 5.1.7 **Table 7** assesses the potentially beneficial significant effects in regard to N deposition for 2029, the opening year of the Proposed Scheme. Of the 44 Sites assessed, 17 Sites were identified where N deposition would reduce by more than 1% change of the critical load due to the Proposed Scheme. It is considered that all Sites would experience neutral to slight beneficial effects. The modelling data is shown in Table C-3, Sub appendix C.
- 5.1.8 **Table 8** assesses the potentially beneficial significant effects in regard to NH₃ for 2029, the opening year of the Proposed Scheme. Of the 42 Sites assessed, 21 Sites were identified where NH₃ would reduce by more than 1% change of the critical level due to the Proposed Scheme. It is considered that all Sites would experience neutral to slight beneficial effects. The modelling data is shown in Table C-4, Sub appendix C.
- 5.1.9 **Table 9** assesses the potentially beneficial significant effects in regard to NO_x for 2029, the opening year of the Proposed Scheme. Of the 42 Sites assessed, 17 Sites were identified where NO_x would reduce by more than 1% change of the critical level due to the Proposed Scheme. It is considered that all Sites would experience neutral to slight beneficial effects. The modelling data is shown in Table C-5, Sub appendix C.

Table 7 Assessment of Potentially Beneficial Significant Effects from Nitrogen Deposition (N-dep) upon Sites in Opening Year (2029)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SAC / SSSI	ECO50, ECO42, ECO66, ECO75, ECO74	No change	<p>It is predicted that there would be a decrease in N deposition as a result of the Proposed Scheme. Background N deposition levels already exceed the lower critical load for the habitat. As such, the minor decreases in N deposition experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. The extent of the beneficial impact for these Site is predicted to occur across 1% or less of the total area of the Site. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, no tangible beneficial changes to the Site are anticipated as a result of the Proposed Scheme.</p>	Neutral
Sweetbriar Road Meadows SSSI	ECO48	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Snake wood Ancient Woodland	ECO68	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial
Mouse Wood CWS, Old Covert, Wood Lane CWS	ECO1, ECO18	Temporary, Reversible	<p>It is predicted that there would be a decrease in N deposition as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background N deposition levels already exceed the lower critical load for the habitat. The decrease in N deposition in exceedance of the threshold is predicted to be experienced over a significant proportion of the designated habitat and is of a relatively great magnitude. As such, there is the potential for a beneficial, long-term effect on the integrity and key features of the designated habitat.</p> <p>The decrease in N deposition is predicted to result in a moderate beneficial impact.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Attebridge Hills CWS, Intwood Carr CWS, Earlham and Colney Marshes CWS, Horsham Meadows CWS, East Hills CWS, Hellesdon Pastures CWS, Brook House Marshes CWS, Taverham Mill CWS, Church Hill Common CWS, Costessey Pits (East) CWS, Jennis' Wood & Dryhill Plantation CWS, Weston Meadow CWS	ECO36, ECO76, ECO78, ECO79, ECO80, ECO64, ECO61, ECO8, ECO65, ECO67, ECO69, ECO31	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Table 8 Assessment of Potentially Beneficial Significant Effects from Ammonia upon Sites in Opening Year (2029)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SAC / SSSI	ECO75, ECO42, ECO50, ECO66	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme.</p> <p>Background NH₃ levels already exceed the lower critical level for the habitat. As such, the minor decreases in NH₃ due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. The extent of the beneficial impact greater than 1% of critical level is predicted to occur over 1% or less of the total area of the Site. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, no tangible beneficial changes are anticipated due to the Proposed Scheme.</p>	Neutral
Sweetbriar Road Meadows, Norwich SSSI	ECO48	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme.</p> <p>Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. As such, the minor decreases in NH₃ experienced due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Snake Wood Ancient Woodland	ECO68	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. As such, the minor decreases in NH₃ experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted, although some hard to detect beneficial changes may occur in the long-term. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial
Old Covert, Wood Lane CWS, Weston Meadow CWS, Mouse Wood CWS	ECO1 ECO31, ECO18	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. The decrease in NH₃ in exceedance of the threshold is predicted to be experienced over a significant proportion of the designated habitat and is of a relatively great magnitude. As such, there is the potential for a beneficial, long-term effect on the integrity and key features of the designated habitat.</p> <p>The decrease in NH₃ is predicted to result in a moderate beneficial impact.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Jennis' Wood & Dryhill Plantation CWS, Meadow Farm Meadow CWS, Brook House Marshes CWS, Hellesdon Pastures CWS, Earlham and Colney Marshes CWS, Horsham Meadows CWS, Costessey Pits (East) CWS, Church Hill Common CWS, Taverham Mill CWS, East Hills CWS, Intwood Carr CWS, Long Dell and Westlodge Hills CWS, Attebridge Hills CWS, Botany Bay Farm CWS, Wensum Pastures at Morton Hall CWS	ECO69, ECO77, ECO61, ECO64, ECO78, ECO79, ECO67, ECO65, ECO8, ECO80, ECO76, ECO60, ECO36, ECO25, ECO74	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme.</p> <p>Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the lower critical level for the habitat. As such, the minor decreases in NH₃ experienced due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Neutral

Table 9 Assessment of Potentially Beneficial Significant Effects from Nitrous Oxides upon Sites in Opening Year (2029)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SAC / SSSI	ECO42, ECO50, ECO66, ECO75, ECO74	No change	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. The extent of the beneficial impact for these Sites is predicted to be 1% or less of the total area of the Site. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, no tangible beneficial changes are anticipated to the Sites due to the Proposed Scheme.	Neutral
Snake Wood Ancient Woodland	ECO68	Temporary, Reversible	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.	Slight beneficial
Sweetbriar Road Meadows, Norwich SSSI	ECO48	Temporary, Reversible	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Attebridge Hills CWS, Brook House Marshes CWS, Church Hill Common CWS, Costessey Pits (East) CWS, Earlham and Colney Marshes CWS, East Hills CWS, Hellesdon Pastures CWS, Horsham Meadows CWS, Intwood Carr CWS, Jennis' Wood & Dryhill Plantation CWS, Mouse Wood CWS, Old Covert, Wood Lane, CWS, Taverham Mill CWS, Weston Meadow CWS	ECO36, ECO61, ECO65, ECO67, ECO78, ECO80, ECO64, ECO79, ECO76, ECO69, ECO1, ECO18, ECO8, ECO31	Temporary, Reversible	<p>It is predicted that there would be a decrease in NO_x as a result of the Proposed Scheme. Background NO_x levels already exceed the critical levels for the majority of the features. As such, the minor decreases in NO_x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Neutral



Operational Adverse Effects – Design Year 2044

- 5.1.10 As mentioned in paragraph 5.1.1, all Sites modelled are currently exceeding the critical level and load for N deposition and NH₃ and are predicted to continue exceeding the critical level and load for NH₃ and N deposition regardless of the Proposed Scheme.
- 5.1.11 **Table 10** assesses the potentially adverse significant effects from N deposition for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, 18 Sites were predicted to have an increase in N deposition that exceed the 1% threshold as a result of the Proposed Scheme. Of these, it is considered that these changes would result in neutral (not significant) effects for nine sites, slight adverse effects for five sites and moderate adverse effects for four sites. The modelling data is shown in Table C-6, Sub appendix C.
- 5.1.12 **Table 11** assesses the potentially adverse significant effects from NH₃ for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, 19 Sites were predicted to have an increase in NH₃ that exceed the 1% threshold as a result of the Proposed Scheme. Of these, it is considered that these changes would result in neutral (not significant) effects for seven sites, slight adverse effects for six sites, moderate adverse effects for five sites and large adverse effects for one site. The modelling data is shown in Table C-7, Sub appendix C.
- 5.1.13 **Table 12** assesses the potentially adverse significant effects from NO_x for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, four sites were identified where the increase in NO_x exceeded the 1% threshold. Of these, it was considered that these changes would result in neutral (not significant) effects for three sites and moderate adverse effects for one site. The modelling data is shown in Table C-8, Sub appendix C.

Table 10 Assessment of Potentially Adverse Significant Effects from Nitrogen Deposition upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Alderford Common SSSI	ECO54	No change	Impacts greater than 1% of critical load only present up to 3m into the Site, where only woodland is present. As such, it is anticipated that no change would occur to the Site as the key characteristics and integrity of the qualifying habitats are unlikely to be affected (due to the absence of calcareous grassland in the impacted location).	Neutral
Attlebridge Hills CWS	ECO35	Temporary, Reversible	In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029. As the Proposed Scheme is predicted to contribute to higher levels of N deposition than the DM scenario, it is considered that the Proposed Scheme would contribute to the retarding of improvement with regards to N deposition. It is expected that the woodland planting proposed along the southern edge of the Site would be mature enough to attenuate changes in air quality by acting as a barrier to emissions. These barrier effects are not accounted for in the air quality model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)). As such, the magnitude and extent of N deposition is unlikely to affect the integrity or the key characteristics of the Site and therefore a minor adverse level of impact is concluded the most likely outcome.	Slight adverse
Broom & Spring Hills CWS	ECO53	Temporary, Reversible	In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029. The Proposed Scheme would not increase N deposition levels beyond that of the current baseline but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. The impacts are predicted to occur over 100% of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome.	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation CWS	ECO2, ECO3	Temporary, Reversible	<p>Baseline N deposition levels are significantly higher than the assigned critical load in the absence of the Proposed Scheme.</p> <p>N deposition levels are predicted to fall in both DS and DM scenarios, with the DS scenario predicting small increases in N deposition that would impact approximately 19.1% of the Site.</p> <p>It is anticipated that the magnitude and extent of the impact would not affect the integrity or key characteristics of the Site. Therefore, a negligible adverse level of impact is concluded to be the most likely outcome.</p>	Neutral
Fakenham Road RNR	ECO85, ECO86	Permanent, Irreversible	<p>This RNR is to be partially removed and subsequently reinstated to enable the construction of the Proposed Scheme, and therefore would be directly adjacent to the Proposed Scheme and Fakenham Road. As such, 100% of the Site would be impacted by changes in air quality due to the Proposed Scheme. Due to the RNR's proximity and associated magnitude of impact to the Proposed Scheme a major adverse level of impact is concluded.</p>	Moderate adverse
Land Adjoining Foxburrow Plantation CWS	ECO16, ECO37	Temporary, Reversible	<p>In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029.</p> <p>The Proposed Scheme would not increase N deposition levels beyond that of the current baseline, but the difference between the DM and DS scenario is larger than in 2029, and therefore may contribute to a further retarding of improvement across 94.3% of the Site. Therefore, it is concluded that a moderate adverse impact would be the most likely outcome.</p>	Slight adverse
Long Dell and Westlodge Hills CWS	ECO60	Temporary, Reversible	<p>Baseline N deposition levels are five times higher than the assigned critical load in the absence of the Proposed Scheme, likely in part due to the Site's close proximity to the A47.</p> <p>In 2044, impacts greater than 1% of critical load only present up to 45m into the Site. The N deposition levels are predicted to decline in both DS and DM scenarios; however, the N deposition level is slightly higher in the DS scenario than in the DM scenario. The impact is predicted to affect only 3.5% of the Site.</p> <p>As such the magnitude and extent of the impact is unlikely to affect the integrity, or the key characteristics of the Site. Therefore, it is concluded that no changes to the Site would occur due to the Proposed Scheme.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Marriott's Way CWS	ECO13	No change	<p>In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029, as described in Table 3.</p> <p>As the extent and magnitude of N deposition are unlikely to affect the key characteristics and integrity of the Site as a whole, it is therefore concluded that no material changes to the Site would occur due to the Proposed Scheme.</p>	Neutral
Norfolk Valley Fens SAC	ECO55	No change	<p>Approximately 30m of woodland is present along the A47 between it and fen habitat within Norfolk Valley Fens. This would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration and therefore also their contribution to deposition. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>Plant growth on alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Norfolk Valley Fens SAC is not limited 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). In addition, impacts exceeding 1% of critical load occur over less than 0.1% of the SAC.</p> <p>Taking these factors into account, no adverse change is anticipated due to the Proposed Scheme.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Potter & Scarning Fens, East Dereham SSSI	ECO55	No change	<p>Approximately 30m of woodland is present along the A47 between it and fen habitat within Norfolk Valley Fens. This would attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration and therefore also their contribution to deposition. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>Plant growth on alkaline fenland habitat (i.e., that overlying calcareous geology) such as that present at Potter and Scarning Fen is not limited 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).</p> <p>Taking these factors into account, no adverse changes are anticipated due to the Proposed Scheme.</p>	Neutral
Old Covert, Wood Lane, CWS	ECO18	Temporary, Reversible	<p>In 2044, N deposition levels are predicted to further decline from the predicted levels from 2029. Trends follow the 2029 model with the DS largest impacts occurring nearest the Proposed Scheme, whilst the changes nearest Wood Lane are predicted to be significantly lower than in the DM scenario.</p> <p>As the Proposed Scheme contribute to a retarding of improvement, it is anticipated that a negligible adverse impact is the most likely outcome.</p>	Neutral
Primrose Grove Ancient Woodland	ECO38, ECO62	Temporary, Reversible	<p>In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029.</p> <p>The Proposed Scheme would not increase N deposition levels beyond that of the current baseline but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. The impacts are predicted to occur over 100% of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome.</p>	Moderate adverse
Primrose Grove CWS	ECO38, ECO62, ECO63	Temporary, Reversible	<p>In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029.</p> <p>The Proposed Scheme would not increase N deposition levels beyond that of the current baseline but is predicted to contribute to a retarding of improvement which could affect the integrity of the Site. The impacts are predicted to occur over 100% of the Site. It is therefore concluded that a moderate adverse impact would be the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum SAC	ECO28, ECO39	No change	<p>In 2044, N deposition levels are predicted to stay elevated, substantially higher than that predicted under the DM Scenario.</p> <p>As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SAC.</p>	Neutral
River Wensum SSSI	ECO28, ECO39	No change	<p>In 2044, N deposition levels are predicted to stay elevated, substantially higher than that predicted under the DM Scenario.</p> <p>As detailed in Sub appendix B, the N:P ratio has remained well above the 7:1 ratio at all times of the year between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited within the Study Area. As such any increase in inorganic nitrogen associated with the Proposed Scheme is not predicted to have a perceptible impact on the macrophytes and algae population or other habitat features within the SAC.</p>	Neutral
River Wensum Pastures CWS	ECO28, ECO39	Permanent, Irreversible	<p>In 2044, N deposition levels are predicted to stay elevated, higher than that predicted under the DM Scenario and the baseline.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>As the changes in N deposition are not predicted to decline substantially from 2029, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
Walsingham Plantation CWS	ECO7, ECO21	Temporary, Reversible	<p>In 2044, N deposition levels are predicted to decline from the baseline and predicted levels from 2029.</p> <p>The Proposed Scheme would not increase N deposition levels beyond that of the current baseline but is predicted to contribute to a retarding of improvement. It is therefore concluded that a minor adverse impact would be the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Wensum Pastures at Morton Hall CWS	N/A	Temporary, Reversible	<p>Wensum Pastures at Morton Hall was not subject to the original modelling assessment as it is situated over 200m from the centreline of the ARN. It was however included in the additional modelling exercise. It is predicted that the Proposed Scheme would result in a retardation of improvement that would affect 46.6% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. As such, a moderate adverse level of impact is concluded.</p>	Slight adverse

Table 11 Assessment of Potentially Adverse Significant Effects from Ammonia upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Alderford Common SSSI	ECO54	No impacts	Significant exceedances are only present up to 3m into the Site, where only woodland is present (which is not a feature of the site). As such, it is anticipated that no change would occur to the Site as the key characteristics and integrity of the qualifying habitats are unlikely to be affected (due to the absence of calcareous grassland in the impacted location).	Neutral
Attebridge Hills CWS	ECO35	Permanent, Irreversible	<p>The Sites location close to Fakenham Road is likely already contributing to high baseline levels for NH₃ which significantly exceed the critical level (3ug/m³) in the absence of the Proposed Scheme.</p> <p>Woodland planting is proposed along the southern edge of the Site. In 2044, it is anticipated that the woodland would be mature enough to attenuate changes in air quality by acting as a barrier to emissions and significantly reduce their concentration. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>The magnitude and extent of impacts from NH₃ is unlikely to affect the integrity or the key characteristics of the Site. Therefore, a minor adverse level of impact is concluded the most likely outcome.</p>	Slight adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Broom & Spring Hills CWS	ECO53	Permanent, Irreversible	<p>As discussed in Table 4, baseline levels for NH₃ are more than three times higher than the assigned critical level (1ug/m³) in the absence of the Proposed Scheme. Agricultural sources of NH₃, would be contributing to these levels. Lichen surveys identified N-sensitive species in extremely low numbers, which, given the current high baseline levels, suggest that NH₃ levels are already contributing to a decline in lower plant species.</p> <p>In 2044, the Proposed Scheme would continue to contribute a further increase in NH₃, which may contribute to further loss of species diversity. A major adverse level of impact is therefore concluded the most likely outcome.</p>	Moderate adverse
Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation CWS	ECO2/ ECO3	Permanent, Irreversible	<p>The baseline levels for NH₃ are almost three times higher than the critical level (1ug/m³) in the absence of the Proposed Scheme.</p> <p>NH₃ levels are predicted to increase at ECO2 and decrease at ECO3 in 2044 due to the planned realignment of the A47. The Proposed Scheme is predicted to contribute to a small increase in NH₃ levels at ECO2 in comparison to the DM scenario. The potential impacts from NH₃ are anticipated to affect 19.1% of the Site. The extent and magnitude of the impacts from NH₃ are unlikely to affect the integrity or key characteristics of the Site. It is therefore concluded that a minor adverse impact would be the most likely outcome.</p>	Slight adverse
Fakenham Road RNR	ECO85, ECO86	Permanent, Irreversible	<p>The Site is situated directly adjacent to Fakenham Road and is designated for Hoary Mullein. Hoary Mullein is commonly found on disturbed ground, and within roadside ruderal habitats and therefore can tolerate elevated levels of NH₃. Regardless, the Proposed Scheme is predicted to elevate NH₃ levels within the Site by 2.12µg/m³ (212.5%) and impact 100% of the Site. Due to this, a major adverse level of impact is concluded.</p>	Moderate adverse
Land Adjoining Foxburrow Plantation CWS	ECO16. ECO37	Permanent, Irreversible	<p>As discussed in Table 4, this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. NH₃ is predicted to continue to increase in 2044 from 2029 levels and the extent of the impact is predicted to increase to 98.9%. Therefore, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Long Dell and Westlodge Hills CWS	ECO60	Temporary, Reversible	Impacts greater than 1% of critical level are only present up to 15m into the Site, affecting only a small portion of the Site. As such, it is anticipated that a negligible level of impact would be the most likely outcome as the key characteristics and integrity of the qualifying habitats are unlikely to be affected.	Neutral
Marriott's Way CWS	ECO13	No change	As discussed in Table 4 , the CWS is designated for an old railway line which has now been repurposed as a footpath. The Site may be experiencing some negative effects due its location close to an existing road and already high NH ₃ baseline levels. The Site spans several miles and therefore the magnitude and extent of impact remains similar in 2044 as 2029. Therefore, it is concluded that no changes to the Site would occur due to the Proposed Scheme.	Neutral
Norfolk Valley Fens SAC	ECO55	No change	<p>Impacts greater than 1% of critical level are only present 30m into the Site where only woodland is present, which is not a feature of the Site. The woodland would also attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>As the key characteristics and integrity of the qualifying habitats of the Site are unlikely to be materially affected by increased NH₃ levels from the Proposed Scheme, it is concluded that no changes to the Site would occur as a result of the Proposed Scheme</p>	Neutral
Potter & Scarning Fens, East Dereham SSSI	ECO55	Permanent, Reversible	<p>Impacts greater than 1% of critical level are only present 30m into the Site where only woodland is present, which is not a feature of the site. The woodland would also attenuate changes in air quality by acting as a barrier to emissions. Although this would not exclude nitrogen compounds from the ARN completely, it would reduce their concentration. These barrier effects are not accounted for in the ARN model (ES Chapter 6: Air Quality (Document Reference: 3.06.00)).</p> <p>As the Proposed Scheme is predicted to increase NH₃ concentration across more than 1% of the Site, a minor adverse effect is predicted.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Old Covert, Wood Lane, CWS	ECO18	Permanent, Reversible	<p>It is worth noting that for the first 50m of the transect, NH₃ levels are predicted to decrease by a maximum of -60.45% (-0.60Ug/m³) at 5m from the centreline of the road. Traffic is predicted in the DS scenario to be diverted onto the Proposed Scheme and away from the existing road, resulting in an increase in NH₃ nearest the Proposed Scheme (80 - 180m).</p> <p>As the Proposed Scheme is predicted to reduce NH₃ and N deposition at the Site nearest the existing road network, but increase in areas nearest the Proposed Scheme, it is anticipated that a minor adverse effect would be most likely.</p>	Slight adverse
Primrose Grove Ancient Woodland	ECO38	Permanent, Irreversible	<p>As discussed in Table 4, baseline levels for NH₃ are more than three times higher than the assigned critical level (1ug/m³) in the absence of the Proposed Scheme. Agricultural sources of NH₃ would be contributing to these levels.</p> <p>In 2044, the Proposed Scheme would continue to contribute a further increase in NH₃, which may contribute to further loss of species diversity and compromise the integrity and key characteristics of the Site. Impacts are predicted to affect almost 100% of the Site. Therefore, a major adverse level of impact is concluded the most likely outcome.</p>	Large adverse
Primrose Grove CWS	ECO63	Permanent, Irreversible	<p>As discussed in Table 4, baseline levels for NH₃ are more than three times higher than the assigned critical level (1ug/m³) in the absence of the Proposed Scheme. Agricultural sources of NH₃, would be contributing to these levels.</p> <p>In 2044, the Proposed Scheme would continue to contribute a further increase in NH₃, which may contribute to further loss of species diversity and in turn compromise the integrity of the Site. It is therefore concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Tud at Easton and Honingham	ECO82, ECO81, ECO84, ECO83	Permanent, Irreversible	<p>Baseline NH₃ levels across the Site already significantly exceed the critical level in the absence of the Proposed Scheme.</p> <p>NH₃ levels are predicted to increase significantly regardless of the Proposed Scheme due to the realignment A47. The Proposed Scheme is predicted to significantly increase NH₃ levels across up to 1.0% of the Site.</p> <p>The magnitude and extent of the predicted N deposition impact is unlikely to affect the integrity or key characteristics of the Site. Due to the extent of the impacts, a minor adverse level of impact is concluded to be the most likely outcome.</p>	Slight adverse
River Wensum SAC	ECO28, ECO39	No change	<p>In 2044, NH₃ levels are predicted to stay elevated, substantially higher than that predicted under the DM Scenario.</p> <p>As discussed in Table 4, the N:P ratio remains above the 7:1 ratio at all times between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited between As such any increase in inorganic nitrogen associated with the Proposed Scheme should not have an impact on macrophytes and algae population.</p>	Neutral
River Wensum SSSI	ECO28, ECO39	No change	<p>In 2044, N NH₃ levels are predicted to stay elevated, substantially higher than that predicted under the DM Scenario.</p> <p>As discussed in Table 4, the N:P ratio remains above the 7:1 ratio at all times between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited between As such any increase in inorganic nitrogen associated with the Proposed Scheme should not have an impact on macrophytes and algae population.sa</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum Pastures CWS	ECO28, ECO39	Permanent, Irreversible	<p>In 2044, NH₃ levels are predicted to stay elevated, significantly higher than that predicted for the DM Scenario.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. With the concentrations predicted under the DS scenario, direct damage to vegetation is also possible.</p> <p>Impacts exceeding 1% of critical level are predicted to increase to affect 88.4% of the Site.</p> <p>Given the magnitude and extent of the impacts, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse
Walsingham Plantation CWS	ECO7, ECO21	Permanent, Irreversible	<p>As discussed in Table 4, baseline levels for NH₃ are more than three times higher than the assigned critical level (1ug/m³) in the absence of the Proposed Scheme due to the Site's location close to Fakenham Road and Broadland Northway.</p> <p>In 2044, the Proposed Scheme would continue to contribute a slight increase in NH₃, and therefore a minor adverse level of impact is concluded the most likely outcome.</p>	Slight adverse
Wensum Pastures at Morton Hall CWS	N/A	Permanent, Irreversible	<p>Wensum Pastures at Morton Hall was not subject to the initial modelling assessment as it is situated over 200m from the centreline of the ARN. It was however included in the additional modelling exercise. It is predicted the Proposed Scheme would result in a change greater than 1% for 76.9% of the Site.</p> <p>As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site. As such, a major adverse level of impact is concluded.</p>	Moderate adverse

Table 12 Assessment of Potentially Adverse Significant Effects from Nitrous Oxides upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Long Dell and Westlodge Hills CWS	ECO60	Temporary, reversible	<p>Baseline NO_x levels are more than two times higher than the assigned critical level (30µg/m³) in the absence of the Proposed Scheme. NO_x levels are predicted to fall between the baseline year (2019) and 2044 in the DM and DS scenario.</p> <p>It is anticipated that the magnitude and extent of the impact would not affect the integrity or key characteristics of the Site. The Proposed Scheme would contribute to a small retarding of improvement, so a negligible adverse level of impact is concluded to be the most likely outcome.</p>	Neutral
River Wensum SAC	ECO28, ECO39	No change	<p>NO_x levels are predicted to increase in 2044 with the Proposed Scheme higher than that predicted under the DM Scenario.</p> <p>The N:P ratio remains above the 7:1 ratio at all times between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited between As such any increase in inorganic nitrogen associated with the Proposed Scheme should not have an impact on macrophytes and algae population.</p>	Neutral
River Wensum SSSI	ECO28, ECO39	No change	<p>NO_x levels are predicted to increase in 2044 with the Proposed Scheme higher than that predicted under the DM Scenario.</p> <p>The N:P ratio remains above the 7:1 ratio at all times between Witchingham bridge and Taverham bridge, sites either side of the Proposed Scheme, indicating that the River Wensum is P-limited between As such any increase in inorganic nitrogen associated with the Proposed Scheme should not have an impact on macrophytes and algae population.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum Pastures CWS	ECO28, ECO39	Permanent, Irreversible	<p>River Wensum Pastures CWS comprises inter-flooded, predominantly semi-improved, cattle-grazed pasture which is dissected by spring-fed ditches and includes several pockets of wet woodland. NVC surveys noted that grazing may accentuate the mosaic structure as many animals avoid the tough leaves and graze on the more palatable species between the tussocks.</p> <p>The Proposed Scheme is predicted to significantly increase NO_x levels over the majority of the Site. The magnitude of impact is not expected to decrease between opening year and design year. As this habitat type consists of a mosaic of plant communities, nitrogen is likely to differentially impact such communities and potentially disrupt the balance between them, leading to changes to the key characteristics of the Site.</p> <p>Therefore, it is concluded that a major adverse impact would be the most likely outcome.</p>	Moderate adverse



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- 5.1.14 As mentioned in paragraph 5.1.1, all Sites modelled are currently exceeding the critical level and load for N deposition and NH₃ and are predicted to continue exceeding the critical level and load for NH₃ and N deposition regardless of the Proposed Scheme.
- 5.1.15 **Table 13** assesses the potentially beneficial significant effects due to N deposition decreases for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, 20 Sites were predicted to have a decrease in N deposition that exceeds 1% of critical load due to the Proposed Scheme. It is considered that all Sites would experience neutral to slight beneficial effects.
- 5.1.16 **Table 14** assesses the potentially beneficial significant effects due to reductions in NH₃ concentrations for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, 22 Sites were predicted to have a decrease in NH₃ that exceeds 1% of the critical level due to the Proposed Scheme. It is considered that all Sites would experience neutral to slight beneficial effects.
- 5.1.17 Table 15 assesses the potentially beneficial significant effects due to NO_x for 2044, the design year of the Proposed Scheme. Of the 44 Sites assessed, 15 Sites were predicted to have a decrease in NO_x that exceeds 1% of critical level due to the Proposed Scheme. It is considered that all Sites would experience neutral effects.

Table 13 Assessment of Potentially Beneficial Significant Effects from Nitrogen Deposition upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum SAC / SSSI	ECO50, ECO42, ECO66, ECO75, ECO74	No change	<p>It is predicted that there would be a decrease in N deposition as a result of the Proposed Scheme.</p> <p>Background N deposition levels already exceed the lower critical load for the habitat. As such, the minor decreases in N deposition experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. The extent of the beneficial impact for these Site is predicted to occur across 1% or less of the total area of the Site. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, Therefore, no tangible beneficial changes to the Site are anticipated as a result of the Proposed Scheme.</p>	Neutral
Sweetbriar Road Meadows SSSI	ECO48	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Snake wood Ancient Woodland	ECO68	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial
Brook House Marshes CWS, East Hills CWS, Jennis' Wood & Dryhill Plantation CWS, Old Covert, Wood Lane, CWS, Church Hill Common CWS, Weston Meadow CWS, Mouse Wood CWS,	ECO61, ECO80, ECO69, ECO18, ECO65, ECO31, ECO1,	Temporary, Reversible	<p>It is predicted that there would be a decrease in N deposition as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background N deposition levels already exceed the lower critical load for the habitat. The decrease in N deposition in exceedance of the threshold is predicted to be experienced over a significant proportion of the designated habitat and is of a relatively great magnitude. As such, there is the potential for a beneficial, long-term effect on the integrity and key features of the designated habitat.</p> <p>The decrease in N deposition is predicted to result in a moderate beneficial impact.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Botany Bay Farm CWS, Horsham Meadows CWS, Intwood Carr CWS, Costessey Pits (East) CWS, Attebridge Hills CWS, Earlham and Colney Marshes CWS, Hellesdon Pastures CWS, Meadow Farm Meadow CWS, Taverham Mill CWS.	ECO25, ECO79, ECO76, ECO67, ECO36, ECO78, ECO64, ECO77, ECO8	Temporary, Reversible	<p>It is predicted that there would be a decrease in N-dep as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the LWS.</p> <p>Background N-dep levels already exceed the lower critical load (10kg/ha/yr) for the habitat. As such, the incremental decreases in N-dep experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Table 14 Assessment of Potentially Beneficial Significant Effects from Ammonia upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
River Wensum SAC / SSSI	ECO50, ECO42, ECO66, ECO75, ECO74	Temporary, Reversible	<p>It is predicted that there would be a decrease in N deposition as a result of the Proposed Scheme.</p> <p>Background NH₃ levels already exceed the lower critical level for the habitat. As such, the minor decreases in NH₃ due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. The extent of the beneficial impact greater than 1% of critical level is predicted to occur over 1% or less of the total area of the Site. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, no tangible beneficial changes are anticipated due to the Proposed Scheme.</p>	Neutral

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Sweetbriar Road Meadows, Norwich SSSI	ECO48	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. As such, the minor decreases in NH₃ experienced due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial
Snake Wood Ancient Woodland	ECO68	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. As such, the minor decreases in NH₃ experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted, although some hard to detect beneficial changes may occur in the long-term. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
Church Hill Common CWS, Brook House Marshes CWS, Jennis' Wood & Dryhill Plantation CWS, Old Covert, Wood Lane CWS, Mouse Wood CWS, Weston Meadow CWS	ECO65, ECO61, ECO69, ECO18, ECO1, ECO31,	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the critical level for the habitat. The decrease in NH₃ in exceedance of the threshold is predicted to be experienced over a significant proportion of the designated habitat and is of a relatively great magnitude. As such, there is the potential for a beneficial, long-term effect on the integrity and key features of the designated habitat.</p> <p>The decrease in NH₃ is predicted to result in a moderate beneficial impact.</p>	Slight beneficial
Botany Bay Farm CWS Attebridge Hills CWS Intwood Carr CWS Lenwade Pits (West) CWS Horsham Meadows CWS East Hills CWS Taverham Mill CWS Earlham and Colney Marshes CWS Costessey Pits (East) CWS Hellesdon Pastures CWS Meadow Farm Meadow CWS, Wensum Pastures at Morton Hall CWS	ECO25, ECO36, ECO76, ECO30, ECO79, ECO80, ECO8, ECO78, ECO67, ECO64, ECO77, ECO74	Temporary, Reversible	<p>It is predicted that there would be a decrease in NH₃ as a result of the Proposed Scheme. Decreases in pollutants exceed 1% of the critical level for the habitat. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the CWS.</p> <p>Background NH₃ levels already exceed the lower critical level for the habitat. As such, the minor decreases in NH₃ experienced due to the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Neutral

Table 15 Assessment of Potentially Beneficial Significant Effects from Nitrous Oxides upon Sites in Design Year (2044)

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
River Wensum SAC / SSSI	ECO42, ECO50, ECO66, ECO75, ECO74	No change	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. The extent of the beneficial impact for these Sites is predicted to be 1% or less of the total area of the Site. Any subtle effects that do occur are not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, no tangible beneficial changes are anticipated to the Sites due to the Proposed Scheme.	Neutral
Snake Wood Ancient Woodland	ECO68	Temporary, Reversible	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.	Slight beneficial
Sweetbriar Road Meadows, Norwich SSSI	ECO48	Temporary, Reversible	It is predicted that there would be a decrease in NO _x as a result of the Proposed Scheme. Background NO _x levels already exceed the critical level for the habitat. As such, the minor decreases in NO _x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition due to the minor decreases predicted. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.	Slight beneficial

Site Name	Transect no.	Duration and reversibility	Comment on integrity / Level of Impact	Effect Significance
Hellesdon Pastures CWS, Taverham Mill CWS, Attebridge Hills CWS, Earlham and Colney Marshes CWS, East Hills CWS, Church Hill Common CWS, Costessey Pits (East) CWS, Brook House Marshes CWS, Jennis' Wood & Dryhill Plantation CWS, Mouse Wood CWS, Weston Meadow CWS	ECO64, ECO8, ECO36, ECO78, ECO80, ECO65, ECO67, ECO61, ECO69, ECO1, ECO31	Temporary, Reversible	<p>It is predicted that there would be a decrease in NO_x as a result of the Proposed Scheme.</p> <p>Background NO_x levels already exceed the critical levels for the majority of the features. As such, the minor decreases in NO_x experienced as a result of the Proposed Scheme are unlikely to lead to long-term perceptible improvements to the habitat, for example through an increase in species diversity or a beneficial change in community composition. Any subtle effects that do occur are therefore not predicted to significantly affect the integrity or key features of the designated habitat. Therefore, a minor beneficial level of impact is concluded the most likely outcome.</p>	Neutral



Ancient / Veteran Trees

Operational Effects – Opening Year 2029

- 5.1.18 A total of 73 trees were scoped into the assessment. All trees modelled are currently exceeding the critical level and load for N deposition and NH₃ and are predicted to continue exceeding the critical level and load for N deposition and NH₃ regardless of the Proposed Scheme.
- 5.1.19 **Table 16** overleaf assesses the potentially significant effects in regard to N deposition for 2029, the opening year of the Proposed Scheme. In summary, it is predicted that 33 trees would not be impacted by the Proposed Scheme i.e., they would experience neutral effects. An increase in N deposition is predicted for 30 trees and a decrease is predicted for 10 trees.
- 5.1.20 **Table 17** assesses the potentially significant effects in regard to NH₃ for 2029, the opening year of the Proposed Scheme. In summary, it is predicted that 33 trees would not be impacted by the Proposed Scheme i.e., they would experience neutral effects. An increase in NH₃ levels is predicted for 29 trees and a decrease is predicted for 11 trees.
- 5.1.21 No trees modelled within the assessment would exceed the critical level for NO_x. Three trees, T46, T5 and T30 (Sub appendix A Figure A-2) are predicted to experience significantly decreased NO_x levels due to the Proposed Scheme.

Table 16 Assessment of Potentially Significant Effects from Nitrogen Deposition upon Ancient / Veteran Trees - Opening Year 2029. Tree numbers in brackets denote the tree reference used within the ES Chapter 10: Biodiversity Appendix 35: Arboricultural Impact Assessment (Document Reference: 3.10.35).

Tree Reference Number (Sub appendix A Figure A-2)	Change in N deposition	Change in N deposition (kg N/ha/yr)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T32, T44, T27, T51, T48, T68, T33, T72, T29, T34, T40, T59, T64, T67, T73, T52, T54, T50, T36, T35, T37, T49, T65, T47, T62, T7 (T112), T28, T63, T41, T57, T53, T43, T69	No significant change	-0.10 – 0.10	No change	These trees are not subject to significant changes in N deposition since changes in N deposition do not exceed the threshold of 1% of the critical load.	Neutral
T15 (T68), T14 (T62), T60, T39, T2 (T306), T4 (T230), T8 (T178), T1, T20 (T33), T22 (T47), T45, T71, T56, T38, T21 (T34), T6 (T160), T18 (T72), T17 (T96), T26 (T152), T25 (T113), T9 (T295), T19 (T74), T16 (T99), T13 (T277), T23 (T45), T12 (T278), T11 (T279), T3 (T268), T10 (T281), T24 (T105).	Increase	0.18 – 1.98	Temporary/ Reversible	<p>Baseline N deposition at the location of the trees ranges between 42.79 and 46.04 kg N/ha/yr and therefore already significantly exceeds the critical load of 10 kg N/ha/yr.</p> <p>Nitrogen deposition can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of individuals may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree. Given the magnitude of the changes in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality or significant declines in condition of these trees given that N deposition levels are predicted to decline from that of the baseline N deposition for trees. The Proposed Scheme is, however, contributing to a retardation of improvement and therefore a minor adverse level of impact is the most likely outcome.</p>	Slight adverse

Tree Reference Number (Sub appendix A Figure A-2)	Change in N deposition	Change in N deposition (kg N/ha/yr)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T5 (T131), T30, T58, T70, T42, T31, T61, T66, T55.	Decrease	-0.98 - -0.12	Temporary/ Reversible	<p>A decrease in N deposition is predicted in the opening year for these ancient/veteran trees. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the trees.</p> <p>The decreases predicted in N deposition are unlikely to lead to long-term perceptible changes in the health or condition of these trees, given that the background N deposition levels they are already subject to (between 40.08 and 47.45 kg N/ha/yr) significantly exceed the lower critical load. Therefore, a negligible level of impact is predicted.</p>	Neutral
T46	Decrease	-5.38	Temporary / Reversible	<p>As above, a decrease in N deposition is predicted in the opening year for T46. This tree is predicted have a 53.8% decrease in N deposition relative to the lower critical load when compared to the DM scenario, and a 82.1% decrease in N deposition relative to the lower critical load when compared to the baseline. As such, a minor beneficial level of impact is predicted.</p>	Slight beneficial

Table 17 Assessment of Potentially Significant Effects from Ammonia upon Ancient/Veteran Trees - Opening Year 2029 Tree numbers in brackets denote the tree reference used within the ES Chapter 10: Biodiversity Appendix 35: Arboricultural Impact Assessment (Document Reference: 3.10.35).

Tree Reference Number (Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T7 (T112), T27, T51, T48, T68, T29, T34, T40, T59, T64, T67, T73, T33, T72, T52, T54, T50, T36, T35, T37, T49, T65, T47, T62, T63, T57, T28, T41, T53, T43, T15 (T68), T69, T32.	No significant change	-0.01 – 0.01	No change	These trees are not subject to significant changes in NH ₃ since changes in NH ₃ concentrations do not exceed the threshold of 1% of the critical level (1.00µg/m ³).	Neutral
T39, T2 (T306), T60, T4 (T230), T8 (T178), T22 (T47), T20 (T33), T1 (T309), T45, T71, T56, T21 (T34), T6 (T160), T17 (T96), T18 (T72), T26 (T152) T38, T25 (T113), T14 (T62).	Increase	0.01 – 0.09	Permanent, Reversible	<p>Baseline NH₃ at the location of the trees ranges between 3.01µg/m³ and 3.31µg/m³ and therefore already significantly exceeds the critical level (1.00µg/m³).</p> <p>NH₃ can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of an individual may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree as a habitat. Given the magnitude of the changes in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality of these trees, although it cannot be ruled out on a tree-by-tree basis. It is concluded that where the magnitude of increases is greatest, it is most likely that such effects may occur. A minor adverse level of impact is the most likely outcome.</p>	Slight adverse

Tree Reference Number (Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T13 (T277), T12 (T278), T11 (T279), T3 (T268), T10 (T281), T24 (T105), T23 (T45), T16 (T99), T19 (T74), T9 (T295).	Increase	0.10 – 0.17	Permanent, Reversible	<p>Baseline NH₃ at the location of the trees ranges between 3.01µg/m³ and 3.21µg/m³ and therefore already significantly exceeds the critical level (1.00µg/m³).</p> <p>NH₃ can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of individual may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree as a habitat. Given the magnitude of the changes in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality of these trees, although it cannot be ruled out on a tree-by-tree basis. It is concluded that where the magnitude of increases is greatest, it is most likely that such effects may occur. Therefore, a minor adverse level of impact is the most likely outcome.</p>	Moderate adverse
T55, T42, T58, T70, T30, T31, T61, T66, T5 (131), T44.	Decrease	-0.01 - -0.09	Permanent, Reversible	<p>A decrease in NH₃ is predicted in the opening year for these ancient/veteran trees. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the trees.</p> <p>The decreases predicted in NH₃ are unlikely to lead to long-term perceptible changes in the health or condition of these trees, given that the background NH₃ levels they are already subject to (between 2.66µg/m³ and 3.46µg/m³) significantly exceed the critical level. Therefore, a negligible level of impact is predicted.</p>	Neutral

Tree Reference Number (Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T46	Decrease	-0.55	Permanent, Reversible	As above, a decrease in NH ₃ is predicted in the opening year for T46. NH ₃ levels are predicted to decrease by almost 55.0% relative to the critical level when compared to the DM scenario and decrease more than 21.7% when compared to the baseline, a minor beneficial level of impact is therefore predicted.	Slight beneficial



Operational Effects – Design Year 2044

- 5.1.22 A total of 73 trees were scoped into the assessment. All trees modelled are currently exceeding the critical level and load for N deposition and NH₃ and are predicted to continue exceeding the critical level and load for N deposition and NH₃ regardless of the Proposed Scheme.
- 5.1.23 **Table 18** below assesses the potentially significant effects in regard to N deposition for 2044, the design year of the Proposed Scheme. In summary, it is predicted that 27 trees would not be impacted by the Proposed Scheme i.e., they would experience neutral effects. An increase in N deposition is predicted for 32 trees and a decrease is predicted for 13 trees.
- 5.1.24 **Table 19** overleaf assesses the potentially significant effects in regard to NH₃ for 2044, the design year of the Proposed Scheme. In summary, it is predicted that 29 trees would not be impacted by the Proposed Scheme i.e., they would experience neutral effects. An increase in NH₃ levels is predicted for 30 trees and a decrease is predicted for 14 trees.
- 5.1.25 No trees modelled within the assessment would exceed the critical level for NO_x. Five trees, T5 (T131), T30, T46, T55 and T70 (as presented in Sub appendix A Figure A-2), are predicted to experience significantly decreased NO_x levels as a result of the Proposed Scheme.

Table 18 Assessment of Potentially Significant Effects from Nitrogen Deposition upon Ancient/Veteran Trees - Design Year 2044 Tree numbers in brackets denote the tree reference used within the ES Chapter 10: Biodiversity Appendix 35: Arboricultural Impact Assessment (Appendix 10.35).

Tree Reference Number (as presented Sub appendix A Figure A-2)	Change in N deposition	Change in N- deposition (kg N/ha/yr)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T28, T29, T32, T33, T34, T35, T36, T37, T40, T41, T47, T49, T50, T51, T52, T53, T54, T57, T59, T62, T63, T64, T65, T67, T68, T69, T72, T73	No significant change	-0.09 – 0.10	No change	These trees are not subject to significant changes in N deposition since changes in N deposition do not exceed the threshold of 1% of the critical load.	Neutral
T43, T60, T14 (T62), T15 (T68), T39, T2 (T306), T4 (T230), T8 (T178), T1 (T309), T20 (T33), T22 (T47), T45, T71, T38, T21 (T34), T6 (T160), T18 (T72), T17 (T96), T26 (T152), T25 (T113) T9 (T295), T19 (T74), T16 (T99), T13 (T277), T23 (T45), T24 (T105), T10 (T281), T3 (T268), T11 (T279), T12 (T278), T56, T7 (T112).	Increase	0.11 – 2.54	Temporary, Reversible	<p>Baseline N deposition at the location of the trees ranges between 42.79 and 46.04 kg N/ha/yr and therefore already significantly exceeds the critical load of 10 kg N/ha/yr.</p> <p>N deposition can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of individuals may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree. Given the magnitude of the change in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality or significant declines in condition of these trees given that N deposition levels are predicted to decline from that of the baseline. The Proposed Scheme is, however, contributing to a retardation of improvement and therefore a minor adverse level of impact is the most likely outcome.</p>	Slight adverse

Tree Reference Number (as presented Sub appendix A Figure A-2)	Change in N deposition	Change in N-deposition (kg N/ha/yr)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T30, T5 (T131), T70, T55, T42, T58, T44, T31, T61, T66, T27, T48.	Decrease	-0.14 - -1.10	Temporary, Reversible	<p>A decrease in N deposition is predicted in the opening year for these ancient/veteran trees. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the trees.</p> <p>The decreases predicted in N deposition are unlikely to lead to long-term perceptible changes in the health or condition of these trees, given that the background N deposition levels they are already subject to (between 40.08 and 47.45 kg N/ha/yr) significantly exceed the lower critical load. Therefore, a negligible level of impact is predicted.</p>	Neutral
T46	Decrease	-6.44	Temporary, Reversible	<p>As above, a decrease in N deposition is predicted in the opening year for T46. This tree is predicted to experience a greater than 64.4% decrease in N deposition relative to the lower critical load when compared to the DM scenario and a 155.4% decrease in N deposition relative to the lower critical load when compared to the baseline. As such, a minor beneficial level of impact is predicted.</p>	Slight beneficial

Table 19 Assessment of Potentially Significant Effects from Ammonia upon Ancient/Veteran Trees - Design Year 2044. Tree numbers in brackets denote the tree reference used within the ES Chapter 10: Biodiversity Appendix 35: Arboricultural Impact Assessment (Appendix 10.35).

Tree Reference Number (as Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ Concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T7 (T112), T28, T29, T32, T33, T34, T35, T36, T37, T40, T41, T43, T47, T49, T50, T52, T53, T54, T57, T59, T62, T63, T64, T65, T67, T68, T69, T72, T73	No significant change	-0.01 – 0.01	No change	<p>These trees are not subject to significant changes in NH₃ since changes in NH₃ concentrations do not exceed the threshold of 1% of the critical level (1.00µg/m³).</p>	Neutral

Tree Reference Number (as Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ Concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T14 (T62), T15 (T68), T60, T39, T2 (T306), T4 (T230), T8 (T178), T1 (T309), T22 (T47), T20 (T33), T45, T71, T56, T38.	Increase	0.02 – 0.09	Permanent, Reversible	<p>Baseline NH₃ at the location of the trees ranges between 2.92µg/m³ and 3.31µg/m³ and therefore already significantly exceeds the critical level (1.00µg/m³).</p> <p>NH₃ can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of individual may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree as a habitat. Given the magnitude of the changes in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality of these trees, although it cannot be ruled out on a tree-by-tree basis. It is concluded that where the magnitude of increases is greatest, it is most likely that such effects may occur. Therefore, a minor adverse level of impact is the most likely outcome.</p>	Slight adverse

Tree Reference Number (as Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ Concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T26 (T152), T25 (T113) T19 (T74), T9 (T295), T16 (T99), T13 (T277), T23 (T45), T12 (T278), T11 (T279), T3 (T268), T10 (T281), T24 (T105), T18 (T72), T17 (T96), T6 (T160), T21 (T34).	Increase	0.10– 0.23	Permanent, Reversible	<p>Baseline NH₃ at the location of the trees ranges between 3.01µg/m³ and 3.21µg/m³ and therefore already significantly exceeds the critical level (1.00µg/m³).</p> <p>NH₃ can have negative effects upon tree health, although the manifestation of significant effects, such as declines in tree health leading to the earlier mortality of individual trees may not be readily predicted due to the multitude of factors which influence it. For example, lichen communities above ground and mycorrhizal fungi below ground can be altered following changes in air quality, which can then in turn indirectly affect the veteran tree as a habitat. Given the magnitude of the changes in comparison to background levels, it is considered highly unlikely that the Proposed Scheme would cause widespread mortality of these trees, although it cannot be ruled out on a tree-by-tree basis. It is concluded that where the magnitude of increases is greatest, it is most likely that such effects may occur. Therefore, a minor adverse level of impact is the most likely outcome.</p>	Moderate adverse
T51, T48, T27, T31, T61, T66, T44, T42, T58, T55, T70, T5 (T131), T30.	Decrease	-0.01 – -0.12	Permanent, Reversible	<p>A decrease in NH₃ is predicted in the design year for these ancient/veteran trees. This is due to the Proposed Scheme diverting traffic from other roads and thereby reducing associated vehicular emissions in proximity to the trees.</p> <p>The decreases predicted in NH₃ are unlikely to lead to long-term perceptible changes in the health or condition of these trees, given that the background NH₃ levels they are already subject to (between 2.66µg/m³ and 3.46µg/m³) significantly exceed the critical level. Therefore, a negligible level of impact is predicted.</p>	Neutral

Tree Reference Number (as Sub appendix A Figure A-2)	Change in NH ₃	Change in NH ₃ Concentration (µg/m ³)	Duration and reversibility	Comment on integrity / Level of Impact	Effect significance
T46	Decrease	-0.67	Permanent, Reversible	As above, a decrease in NH ₃ is predicted in the opening year for T46. This tree is predicted to decrease by 67.33% relative to the critical level when compared to the DM scenario and decrease more than 16.9% when compared to the baseline, a minor beneficial level of impact is therefore predicted.	Slight beneficial



6 Summary

6.1.1 Of the 44 Sites scoped into the assessment, five sites were predicted to experience no changes in N deposition, NH₃ or NO_x greater than 1% of the critical load or level for the pollutants and therefore would not experience significant effects due to the Proposed Scheme. The remaining Sites were all assessed for the effects of the impacts of air quality changes that they would experience.

6.1.2 Of the Sites assessed, the Proposed Scheme is concluded to have moderate and above adverse effects, i.e., significant effects on the following Sites:

- Primrose Grove Ancient Woodland - N deposition (moderate adverse - 2029 and 2044) and NH₃ (large adverse - 2029 and 2044).
- Broom and Spring Hills CWS – NH₃ (moderate adverse - 2029 and 2044).
- Fakenham Road RNR - N deposition (moderate adverse - 2029 and 2044) and NH₃ (moderate adverse - 2029 and 2044).
- Land Adjoining Foxburrow Plantation CWS – N-dep (moderate adverse – 2029) and NH₃ (moderate adverse - 2029 and 2044).
- Primrose Grove CWS - NH₃ (moderate adverse - 2029 and 2044).
- River Wensum Pastures CWS - N deposition (moderate adverse - 2029 and 2044), NH₃ (moderate adverse - 2029 and 2044) and NO_x (moderate adverse 2044).
- Wensum Pastures at Morton Hall CWS - NH₃ (moderate adverse – 2029 and 2044).

6.1.3 The maximum effect that each Site is expected to experience is shown on Figure C-1, Sub appendix C.



6.1.4 Of the 73 veteran and / or ancient trees assessed, the Proposed Scheme is concluded to have moderate adverse effects i.e., significant effects on the following 12 trees:

- T13 (T277), T12 (T278), T11 (T279), T3 (T268), T10 (T281), T24 (T105), T23 (T45), T16 (T99), T19 (T74), and T9 (T295) – NH₃ (moderate adverse - 2029 and 2044).
- T26 (T152), T25 (T113), T18 (T72), T17 (T96), T6 (T160), and T21 (T34) – NH₃ (moderate adverse – 2044 only).

6.1.5 The maximum effect that each veteran and / or ancient tree is expected to experience is shown on Figure C-2, Sub appendix C.

6.1.6 No Sites or ancient / veteran trees within the assessment were found to have significant beneficial effects in 2029 or 2044 as a result of the Proposed Scheme, although a number of non-significant beneficial effects were identified.

6.1.7 Mitigation and compensation are not covered in this report and will be covered within the separate Outline Air Quality Compensation Strategy (Document Reference: 6.01.00).



7 References

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