A47 North Tuddenham to Easton Dualling

Scheme Number: TR010038

Volume 6
6.1 Environmental Statement
Chapter 5 – Air Quality

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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

ENVIRONMENTAL STATEMENT CHAPTER 5 AIR QUALITY

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5. Air Quality

5.1. Introduction

5.1.1. Highways England (the Applicant) has submitted an application for an order to grant a development consent order (DCO) for the North Tuddenham to Easton Dualling Scheme (hereafter referred to as 'the Proposed Scheme'). The Proposed Scheme comprises the dualling of a section of the A47 between North Tuddenham and Easton, including the creation of two grade separated junctions (Wood Lane junction and Norwich Road junction), associated side road alterations and walking, cycling and horse-riding connections. This section of A47 road is currently unable to cope with the high traffic volume and there are limited opportunities to overtake slower moving vehicles on the single carriageway. This section of the A47 also has a poor safety record. The Proposed Scheme aims to reduce congestion related delay, improve safety, improve journey time reliability and increase the overall capacity of the A47. Full details of the Proposed Scheme are provided in Environmental Statement Chapter 2 (The Proposed Scheme) (**TR010038/APP/6.1**).

5.1.2. Under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, the Proposed Scheme is an Environmental Impact Assessment (EIA) development and as such requires submission of an Environmental Statement (ES) presenting the likely significant environmental effects of the Proposed Scheme.

5.1.3. Air quality is a consideration when the introduction of a scheme results in a change of emissions in the air. Air quality is assessed by measuring concentrations of select pollutants in the air, and the impact these pollutants have on sensitive receptor locations at relevant human and ecological exposure. These pollutants include nitrogen oxides (NO_x) nitrogen dioxide (NO_2) and particulate matters (PM_{10} and $PM_{2.5}$), all which originate from vehicle exhaust emissions.

5.1.4. As part of the EIA process, this ES chapter reports the potential significant effects for air quality as a result of the Proposed Scheme. This assessment includes a review of the existing baseline conditions and considers the potential impacts of air quality associated with the Proposed Scheme on human health and ecosystems. Proportionate mitigation and enhancement have also been identified.

5.1.5. The approach to this assessment follows the Scoping Report (September 2019) (**TR010038/APP/6.5**) and subsequent agreed Scoping Opinion (November 2019) for the Proposed Scheme (**TR010038/APP/6.6**). The approach follows the most

up to date Design Manual for Roads and Bridges (DMRB), LA 105 Air Quality (hereafter referred to as LA 105).

5.1.6. The main chapter text is supported by appendices 5.1 to 5.3, which contain:

- Appendix 5.1 – Air quality dispersion modelling process (**TR010038/APP/6.3**)
- Appendix 5.2 – Air quality verification and model adjustment (**TR010038/APP/6.3**)
- Appendix 5.3 – Air quality receptor results (**TR010038/APP/6.3**)

5.2. Competent expert evidence

5.2.1. The competent expert for this chapter and all supporting appendices is an air quality specialist (BSc, Member of the Institute of Air Quality Management (MIAQM) and a Full Member of the Institution of Environmental Sciences (MIEnvSc)) with over 25 years' experience in the air quality field. They have prepared multiple road traffic assessments following best practice for EIA over the length of their career and have used their EIA knowledge and professional judgement in identifying the likely significant impacts associated with the Proposed Scheme and providing technical guidance through the assessment process.

5.3. Legislation and policy framework

5.3.1. Throughout this assessment EU limit values have applied notwithstanding the UK's withdrawal from the European Union and the end of the Transition Period. The limit values continue to have legal effect by virtue of EU Exit legislation. It is understood that the Environment Bill should receive Royal Assent in Autumn 2021 and that a new framework for air quality will be developed following that although it is not known if a different approach to limit values will be taken. Therefore, EU limit values will continue to apply unless and until Parliament legislates otherwise. The protection of public health is covered by the following criteria:

- Legally binding mandatory limit values set by the European Union (EU) – implemented by the 2010 Air Quality Standards Regulations.
- Objectives outlined in the UK National Air Quality Strategy (NAQS) where local authorities are required to achieve the limit values set by the EU – implemented by the 2015 Air Quality (England) Regulations.
- The air quality limit objectives relevant to this assessment are outlined in
- Table 5.1. The national air quality objectives (AQO) for nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) are the same as the EU limit values.

Table 5.1: Air quality objectives and EU limit values for NO_2 and PM_{10} for protection of human health

Pollutant	Air quality objectives	
	Concentration	Averaging time
NO_2	200 µg/m^3	One-hour mean concentration should not be exceeded greater than18 times a year
	40 µg/m^3	Annual mean concentration
PM_{10}	50 µg/m^3	Twenty-four-hour mean concentration should not exceed greater than 35 times a year
	40 µg/m^3	Annual mean concentration
$PM_{2.5}$	25 µg/m^3	Annual mean concentration
NOx	30 µg/m^3	Annual mean concentration (target value for the protection of vegetation and ecosystems)

5.3.2. Table 5.2 summarises the legislation, regulatory and policy framework applicable in this assessment and air quality.

Table 5.2: Summary of legislation, regulatory and policy framework

Scale	Legislation or regulation	Summary
European	EU Directive on ambient air quality (2008/50/EC)	The EU directives outlines the mandatory limit values for different pollutants including NO_2 and PM_{10}, which are considered key pollutants related to traffic. The directive supersedes previous air quality directives (excluding the Fourth Daughter Directive) and outlines a new regulatory framework for $PM_{2.5}$. Member states can postpone attainment deadlines under the directive. DEFRA assesses and reports annually on compliance with the limit values to the European Commission. The UK is divided into 43 zones, where the status of each zone in relation to the EU limit values is determined by the maximum measured or modelled concentration of that zone. The key pollutants of concern are NO_2 and PM_{10}. Zones can achieve compliance when everywhere within the zone does not exceed the EU limit value, there are exceptions to where the EU limit value applies.
National	Part IV of the Environment Act 1995	Sets guidelines for managing and protecting air quality within the UK and for local air quality management. It requires local authorities to regularly review and assess their local air quality and identify any exceedances of the Air Quality Strategy (AQS). The AQOs only apply to locations where members of the public may be regularly exposed. Where an AQMA has been declared, it requires local authorities to prepare an air quality action plan (AQAP) describing the pollutant reducing measures which have been put in place.
	The National Policy Statement for National Networks (NSP NN)	The NSP NN sets out planning guidance for promoters of nationally significant infrastructure projects (NSIPs), and the basis for the examination by the Examining Authority and decisions by the Secretary of State It recognises that *"increases in emissions of pollutants during the construction or operation phases of projects on the national networks can result in the*

Scale	Legislation or regulation	Summary
		worsening of local air quality (though they can also have beneficial effects on air quality, for example through reduced congestion). Increased emissions can contribute to adverse impacts on human health, on protected species and habitats." The environmental statement for a proposed project should describe: • The existing air quality levels • Air quality forecast at the time of the scheme opening, assuming the scheme is not built and then taking into account the impact of the scheme • Detail any significant air quality effects, their mitigation and any residual effects discussing both the operational and construction stages and the impacts of road traffic generated by the project. Paragraphs 5.12 and 5.13 of the NSP NN provides advice for decision makers: "*The secretary of State must give air quality considerations substantial weight where, after taking into account mitigation, a project would lead to a significant air quality impact in relation to EIA and/or where they lead to a deterioration in air quality in a zone/agglomeration."* *"the secretary of State should refuse consent where, after taking into account mitigation, the air quality impact of the scheme will:* • *Result in a zone/agglomeration which is currently reported as being compliant with the Air Quality Directive becoming non-compliant.* *Affect the ability of a non-compliant area to achieve compliance within the most recent timescales reported to a European Commission at the time of the decision."*
	Quality Strategy (AQS)	Outlines air quality standards and objectives to protect people's health and the environment.
	The Air Quality (Standards) Regulations 2010 (SI 2010/2001)	Provides statuary backing to the UK National Air Quality Standards (AQS) in England.
	Clean Air Strategy 2019	National strategy outlining the actions required from both the government and society to improve air quality. It includes updated goals to reduce public exposure to $PM_{2.5}$ as recommended by the World Health Organisation
	Highways England Air Quality Strategy 2017	Outlines Highways England's approach to improving air quality as part of the 2015 to 2020 Road Investment Strategy. The strategy details the following actions to improve air quality: • Exploring new and innovative approaches to improve air quality, such as air quality barriers. • Working with key stakeholders such as DfT and DEFRA to develop and deliver policies to improve air quality. • Where appropriate, designing out or mitigating poor air quality for Highways England road schemes.

Scale	Legislation or regulation	Summary
		• Improving air quality monitoring across the Highways England road network for example by installing 50 new continuous air quality monitoring stations. • Working to optimise use of the road network for example by informing customers of alternative routes for journeys to avoid sensitive area.
	UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations 2017	This plan details the government's plan to reduce NO_2 concentrations within statutory limits within the shortest possible time. The plan identifies several local authorities with exceedances of the NO_2 objective and requires them to undertake a local assessment to consider the best options to achieve compliance.
Local	South Norfolk Local Plan – Development Management Policies Document 2015	The Development Management Policies document forms part of a set of documents that together constitute a local plan for the future development of the South Norfolk area. It sets out policies which will help the local council promote sustainable development and help determine planning applications. Policy DM 3.14 Pollution and, health and safety states: *"a) All development should minimise and where possible reduce the adverse impact of all forms of emissions and other forms of pollution and ensure that there is no deterioration in water quality or water courses.* *b) When assessed individually or cumulatively, development proposals should ensure that there will be no unacceptable impacts on:* *i. Air quality* *ii. Surface and ground water quality* *iii. Land quality and condition* *iv. Health and safety of the public* *d) Developments which may impact on air quality will not be permitted where they have an unacceptable impact on human health, sensitive designated species or habitats, and general amenity, unless adequate mitigation can be ensured. Development will not be granted in locations where it is likely to result in an Air Quality Management Area being designated or the worsening of air quality in an existing Air Quality Management Area.*

5.4. Assessment methodology

5.4.1. This section describes the methodology which has been used for the assessment of air quality for both the construction and operational phase of the Proposed Scheme. The assessment methodology for the air quality assessment is based on the following:

- DMRB LA 105 Air Quality published by Highways England, November 2019 now superseded by HA207/07 and corresponding IANs
- The Department for Environment, Food and Rural Affairs' (DEFRA) Local Air Quality Management (LAQM) technical guidance (hereafter referred to as LAQM.TG(16))

5.4.2. The level of assessment was identified using all of the criteria as set out in the "flow chart for the determination of simple or detailed assessment" provided in LA 105. This allowed for the level of assessment to be classified, which is based on the risk potential of the project with the sensitivity of the receiving environment. The project's risk potential was classified as high risk as the Proposed Scheme falls into the category of "major bypass and motorway junction improvements". The Proposed Scheme is not located in an AQMA and no exceedances of the AQS objectives have been measured. However, due to the proximity of sensitive receptors the receiving environment sensitivity was also classified as high due to the large numbers of human and ecological receptors identified within 50m of the roads triggering the traffic screening criteria (over 1000 receptors). Based on this review it was determined that a detailed assessment was required.

5.4.3. Sensitive human receptor locations and designated sites within 200m of the road links triggered by the screening criteria were selected to be included in the air quality assessment. Sensitive receptors include residential properties, schools and hospitals closest to the road, junction and anticipiated to experience highest pollutant concentrations.

5.4.4. The air quality assessment, following the outlined guidance, includes:

- the discussion of existing baseline conditions
- the identification of sensitive receptors and Air Quality Management Areas (AQMA), shown on constrainsts maps
- a qualitative assessment of the effect on air quality during the construction phase
- a detailed assessment of the changes in pollutant concentrations on local air quality, including nitrogen deposition rates, during the operational phase at selected sensitive receptors
- the determination of significant air quality effects, including a compliance assessment with the EU Air Quality Directive
- the identification of mitigation measures where appropriate

Construction phase

5.4.5. Following a review of the new DMRB guidance, the construction dust methodology outlined in the Scoping Opinion, which follows the Institute of Air Quality Management (IAQM) guidance on the assessment of dust from demolition and construction, has now been superseded by LA 105.

Construction dust

5.4.6. A qualitative assessment of potential dust effects was undertaken in accordance with section 2.56 onwards in LA 105. The assessment determined the

construction dust risk potential of the Proposed Scheme to the receiving environment. The receiving environment sensitivity to construction dust was also determined. The appropriate measures were identified to support mitigation, these are outlined in section 5.9.

Construction traffic

5.4.7. LA 105 advises where construction activities are programmed to last less than two years, it is unlikely there will be a significant effect on air quality or affect the UK's ability to comply with the Air Quality Directive. As construction activities are programmed to last less than two years the assessment of construction traffic was screened out, in line with paragraph 2.60 in LA 105.

Operational phase – local air quality

Assessment scenarios

5.4.8. The local air quality assessment was undertaken using the Atmospheric Dispersion Modelling System (ADMS) Roads Dispersion modelling software (version 5.0.0.1) and focuses on concentrations of air pollutants which can have an impact at local level. The assessment considered emissions of NO_x, NO_2 and PM_{10}. The key scenarios included in the assessment were:

- baseline year 2015 - for model verification
- projected base year 2025 – for long term trends assessment
- opening year without the scheme – Do-Minimum (DM) 2025
- opening year with the scheme – Do-Something (DS) 2025

5.4.9. Where there are no PM_{10} exceedances of the air quality annual mean objective observed in the base year, no further assessment of PM_{10} in the Do-Minimum and Do-Something scenarios is required.

5.4.10. LA 105 states that there is no need to model $PM_{2.5}$ as the UK currently meets its legal requirements for the achievement of the $PM_{2.5}$ air quality annual mean objective. However, PM_{10} concentrations will be used to demonstrate the project does not impact on the $PM_{2.5}$ air quality objectives. For comparison with the $PM_{2.5}$ air quality objective all predicted PM_{10} concentrations are assumed to be $PM_{2.5}$. Therefore, if the predicted PM_{10} concentration is less that the $PM_{2.5}$ annual mean objective it can be assumed that there will be no exceedances of the $PM_{2.5}$ air quality objective and therefore, screened out from further assessment.

5.4.11. The baseline conditions were determined by reviewing air quality information in annual status reports, published by the local authorities. Information provided in these reports include historic monitoring data and current air quality concerns such as pollution hotspots reporting exceedance of the NO_2 and PM_{10} annual mean

objectives within the local authority. This information has allowed current baseline pollutant concentrations within the study area to be mapped. These data were used to verify the model against air quality monitoring data. A model verification year of 2015 has been used in accordance with the traffic data provided for the Proposed Scheme.

5.4.12. The local air quality assessment has been undertaken for the opening year. This is when pollutants are expected to be worst-case in terms of local air quality impacts, continued improvements in emissions are expected in future years. The local air quality assessment has compared the predicted NO_2 and PM_{10} annual mean concentrations against the relevant air quality objectives, this approach is consistent with LA 105.

Traffic data

5.4.13. Outputs from a strategic transport model developed for the Proposed Scheme have been used for this assessment. Details of the transport model used can be found in North Tuddenham to Easton transport assessment, in section 4 of the Case for the Scheme (**TR010038/APP/7.1**). Data on vehicle flows, speed bands and percentage heavy duty vehicles (HDV) were available for the following periods in the assessed scenarios:

- AM peak period (07:00 to 10:00)
- Inter-peak period (10:00 to 16:00)
- PM peak period (16:00 to 19:00)
- Off-peak period (19:00 to 07:00)

5.4.14. The hourly diurnal traffic flow characteristics were used to estimate the emissions data using the Highways England Speed Band Emissions Factors Toolkit (EFT V2.3). This spreadsheet used the hourly flows of both heavy duty vehicles (HDV) and light duty vehicles (LDV) for each time period along with speed data for each speed band category to derive the emissions data. In addition, information on road alignment, road width and local meteorological data (taken from Norwich Airport for the base year 2015) were included in the dispersion model.

Background concentrations

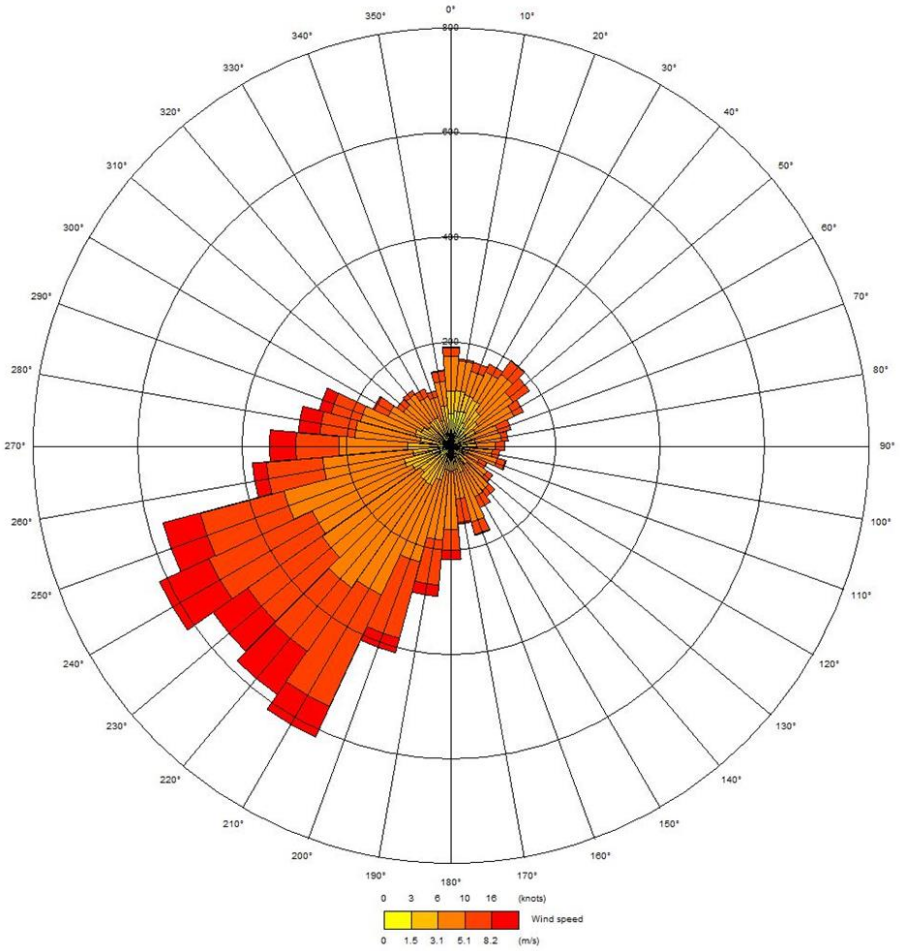
5.4.15. The results output from the air quality dispersion model estimates the contribution from road traffic emissions to annual mean concentrations of NO_x and PM_{10} at selected sensitive receptors. These concentrations are combined with background concentration estimates, to account for other sources of air pollution not being modelled. This derives a total annual mean concentration which can then be compared against the relevant air quality objective.

5.4.16. Background concentrations have been taken from DEFRA[1]'s background maps; further details can be found in section 5.7.

Met Office data

5.4.17. Hourly sequential meteorological data for the base year of 2015, measured at the closest meteorological site at Norwich Airport was used for the air quality assessment. The wind rose for 2015 is presented in Diagram 5.1 which highlights predominant wind directions from the west and south-west, which are associated with the highest wind speeds. For full details on the model input parameters for this study see Appendix 5.1 (Air quality dispersion modelling process) (**TR010038/APP/6.3**).

Diagram 5.1: Norwich 2015 wind rose



NO_x to NO_2 conversion

5.4.18. NO_2 annual mean concentrations were derived from the modelled road NO_x concentrations using DEFRA's NO_x to NO_2 calculator (version 7.1.1 for HE), which was the most recent version at the time of the assessment. The South

[1] Department for Environment Food and Rural Affairs (DEFRA)

Norfolk District was selected as the local authority data used for the conversion, as this is where most selected receptors are located. “All other urban UK traffic” was selected for the traffic mix.

Verification

5.4.19. The model verification process has been conducted in accordance with the guidance outlined in LAQM.TG (16). The annual mean NO_2 concentrations for the 2015 base year were verified by comparing against available monitored data. The modelled road NO_x was compared against measured Road NO_x and adjusted accordingly, in line with the guidance to account for systematic bias. The adjustment factor produced by the model verification has been applied to the modelling outputs. For full details on verification see Appendix 5.2 (Air quality verification and model adjustment) (**TR010038/APP/6.3**).

5.4.20. Due to the absence of monitored PM_{10} concentrations within the study area, the adjustment factor derived from the modelled road NO_x comparison was applied to the modelled PM_{10} concentrations. This approach is consistent with the guidance outlined in LAQM TG.(16).

Long-term trends

5.4.21. To ensure that the modelled roadside NO_2 concentrations are not too optimistic and to account for uncertainties in predicted future roadside nitrogen dioxide concentrations, a process known as “gap analysis” is completed, as outlined in LA 105. An additional scenario is included within the air quality assessment to enable the gap analysis. Gap analysis is the application of adjustment factors which take into account the assumed roadside rates of reduction in NO_x and NO_2 within DEFRA’s modelling tools when compared to observed roadside monitoring trends.

5.4.22. The additional scenario is called the projected base year and is modelled using the base year traffic data with the opening year vehicle emission factors and background concentrations. The final results for the opening year are then adjusted accordingly from the gap factors produced to reflect the long-term trend profile. The Interim Highways Agency Long Term Gap Analysis Calculator v1.1 (LTTE6) is used to produce the gap factor and adjust the opening year results.

Compliance with EU Directive on ambient air quality

5.4.23. Evaluation of compliance with EU limit values has been undertaken in accordance with guidance outlined in LA 105. The compliance risk assessment is based on identifying qualifying features which meet DEFRA’s interpretation of the Air Quality Directive. This includes public access and sensitive receptors

(residential properties, schools & hospitals) that reside within 15m of the running lane/kerbside, but not within 25m of a junction.

5.4.24. Where qualifying features along each Pollution Climate Mapping (PCM) link are identified, the air quality assessment will model NO_2 concentrations for:

- the nearest qualifying feature along the PCM link where concentrations are highest
- a 4m point from the running lane in the same location as the qualifying feature to be compared against the national PCM modelled point

Update to guidance and scope of assessment

5.4.25. The scope of this assessment has been updated from the Scoping Report (September 2019) (**TR010038/APP/6.5**) and subsequent Scoping Opinion (November 2019) (**TR010038/APP/6.6**) for the Proposed Scheme. Following changes to DMRB guidance in 2019 from HA207/07 to LA 105. A summary of these key changes has been provided in Table 5.3. The key change is with regards to the designated sites and compliance risk assessments.

Table 5.3: Update to guidance and scope of assessment

Scoping Report (old DMRB HA207/07)	Update (new DMRB LA 105)
Screening criteria for study area for local assessment: • Road alignment will change by 5m or more • Daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more • Heavy duty vehicles (HDV) flows will change by 200 AADT or more • Daily average speed will change by 10km/hr or more • Peak hour speed will change by 20km/hr or more	Screening criteria for study area for local assessment: • Road alignment will change by 5m or more • Daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more • Heavy duty vehicles (HDV) flows will change by 200 AADT or more • A change in speed band
Guidance from IANs published by Highways England	Now superseded by LA 105
Compliance risk assessment (outlined in IAN 175/13): • All road links which intersect the PCM model to be considered • Identify opening year NO_2 concentrations from the PCM model • Calculate total NO_2 concentrations with formula • Scheme NO_2 calculated by modelling receptors within 200m of road links intersecting PCM model • Identify any exceedances of EU limit value with increases greater than 0.4 µg/m^3 as a result of the project in the opening year	Compliance risk assessment: • Only road links which trigger the screening criteria on PCM links to be considered • Selection of nearest qualifying features to be modelled • The area 25m around junctions shall be excluded from the compliance risk assessment, irrespective of whether there are any sensitive receptors or public access within 15m of the edge of the roads within the junction • Local model 4m point validation to compare against the national PCM modelled output

Scoping Report (old DMRB HA207/07)	Update (new DMRB LA 105)
	• Identify any exceedances of EU limit value with increases greater than 0.4 µg/m^3 as a result of the project in the opening year
Designated site assessment: • Identify all sites sensitive to nitrogen within 200m of study area • Obtain total average nitrogen deposition for 5km grid square • Calculate NO_2 for all transects in habitats • Estimate dry deposition of NO_2 in transects • Compare deposition rates with critical loads	Designated site assessment: • Identify all sites sensitive to nitrogen within 200m of study area • Additional designated habitats to be assessed • Calculate road NO_x and NO_2 of all transects in habitats • Convert road NOx into nitrogen deposition rate • Identify if N deposition with the project is less than the applicable lower critical load • Identify if change in nitrogen deposition with and without the project is less than 1% of the lower critical load
Regional assessment	No longer required in LA 105

Consultation

5.4.26. Consultation was undertaken in March 2020 with specialists at Highways England to discuss the base year traffic data of 2015 and the assessment approach for the ES. It was concluded the most recent available tools for assessment will be used in the assessment alongside the 2015 baseline traffic data.

Assessment criteria

Human health

5.4.27. LA 105 outlines guidance for evaluating significant air quality effects for a project for sensitive human receptors.

5.4.28. Only sensitive receptors where the outputs from the air quality modelling predict an exceedance in the Do-Minimum (DM) (opening year without Proposed Scheme) or the Do-Something (DS) (opening year with Proposed Scheme) scenario are assessed for significance. The differences in concentrations between the DM and DS scenarios, along with the numbers of receptors, are used to determine the level of significance as outlined in Table 5.4.

Table 5.4: Information required for judgement of significant air quality effects

Magnitude of change in concentration (µg/m^3 *)	Value of change in annual average NO_2 and PM_{10}	Total Number of receptors with:	
		Worsening of an air quality at sensitive receptor above the air quality threshold or the creation of a new exceedance	Improvement of an air quality at sensitive receptor above the air quality threshold or the removal of an existing exceedance
Large	Greater than 4 µg/m^3		
Medium	Greater than 2 µg/m^3		
Small	Greater than 0.4µg/m^3		
Total change		Sum of above	Sum of above

5.4.29. A conclusion of no likely significant effect for human health receptors can be determined if:

- modelled concentrations for human health are less than the air quality thresholds
- the difference in the concentrations between the Do-Minimum and Do-Something scenarios are imperceptible that is less than 1% (or 0.4 µg/m^3) of the air quality threshold

5.4.30. LA 105 outlines a framework to provide guidance on the number of receptors which might result in a significant effect for each category within the magnitude of change criteria. Should the change in concentrations be greater than 1% of the air quality threshold then sensitive receptors will be assigned to the select criteria in Table 5.5.

Table 5.5: Guidance to the number of properties informing a judgement of significant air quality effects

Magnitude of change in annual mean NO_2 or PM_{10} (µg/m^3)	Guideline bands for number of receptors with:	
	Worsening of an air quality objective already above the objective or the creation of a new exceedance	Improvement of an air quality objective already above the objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2)	10 to 30	10 to 30
Small (>0.4)	30 to 60	30 to 60

5.4.31. The guidelines set out in Table 5.5 provide a guide to the change in concentrations at receptors along with the numbers of receptors affected. Consideration of both has determined whether the Proposed Scheme is likely to trigger a significant effect.

5.4.32. Where the number of properties resides between the lower and upper guideline bands for any of the magnitude of change bands, as outlined in Table 5.5, the following criteria has been used:

- The absolute concentration at each receptor. That is the modelled concentration 40 µg/m^3 or 60 µg/m^3.
- How many receptors are there in each of the magnitude of change criteria, does the project create more worsening than improvements.
- The magnitude of change in concentration at each receptor for example 0.6 µg/m^3 or 1.8 µg/m^3.

5.4.33. Where the total number of receptors are greater than the upper guideline band in any of the magnitude categories the project is likely to trigger a significant air quality effect.

5.4.34. Where the numbers of receptors are less than the guideline band for each magnitude of change then the project is unlikely to trigger a significant air quality effect for human health.

5.4.35. The air quality assessment has therefore determined the number of properties falling between the lower and upper guideline bands for any magnitude of change criteria.

5.4.36. Should the project trigger the traffic change criteria on any PCM links, the compliance risk assessment of the Proposed Scheme will be undertaken. The assessment will follow the criteria detailed in the flow diagram and guidance outlined in in Figure 2.79 in LA 105.

Ecological

5.4.37. Following guidance outlined in LA 105, all designated sites within 200m of the Affected Road Network (ARN) sensitive to nitrogen (N) deposition have been assessed within the air quality assessment. The professional judgment of the competent expert for biodiversity has been used to determine which habitats are sensitive to N deposition.

5.4.38. Transects were created on designated sites which are nearest roads triggering the highest change in flows with the Proposed Scheme. These transects represent the most sensitive location to changes in air quality concentrations and subject to the highest pollutant concentrations. A transect was created within

each qualifying designated site at 10m from roadside at the closest location within the designated site. Then at 10m intervals up to a maximum distance of 200m. This approach is consistent with LA 105.

5.4.39. An assessment of significant impacts shall be determined if the N deposition with the project exceeds the lower critical load, or the change in nitrogen deposition with and without the project is greater than 1% of the lower critical load. The competent expert for biodiversity shall assess the air quality attribute of the designated site to confirm whether it should be restored or maintained. The determination of a likely significant effect shall then be concluded by the biodiversity expert.

5.5. Assessment assumptions and limitations

5.5.1. Air quality modelling predictions will be based on the most reasonable, robust and representative methodologies in accordance with best practice guidance. However, there is an inherent level of uncertainty associated with model predictions:

- Uncertainties with traffic forecasts – baseline data provided was for the year 2015. This adds extra uncertainty with the data as traffic flows and background concentrations will not be representative of the current climate.
- Uncertainties with vehicle emissions predictions.
- At the time of undertaking the air quality assessment the most recently available tools were used.
- 2017 background maps were back casted to the year 2015, using a factor produced by DEFRA. This factor may add a margin of error to the background maps used in this assessment.
- The suitability of meteorological data.
- Simplifications made within modelling calculations or post processing of the data that represent atmospheric dispersion or chemical reactions.
- Whilst there are these uncertainties in the air quality modelling. The modelling has been verified against baseline year measurement data in accordance with LAQM TG(16). This verification factor is applied to the baseline and Do-Minimum and Do-Something scenarios.
- The identification of sensitive receptors was based on OS Address Base Plus data. There is the possibility that these data do not contain properties which have been recently built and therefore may not been considered within the air quality assessment. All efforts were made to identify and consider such properties within the assessment.

5.6. Study area

Construction phase

5.6.1. The following criteria, outlined in Table 2.58a in LA 105, was used to determine the construction dust risk potential of the project:

Table 5.6: Construction dust risk potential

Risk	Examples of the types of project
Large	large smart motorway projects, bypass and major motorway junction improvements.
Small	junction congestion relief project i.e. small junction improvements, signalling changes. short smart motorway projects.

5.6.2. The dust risk potential for the project was classified as large due to the nature of the improvements of the Proposed Scheme, involving major bypass and motorway junction improvements.

5.6.3. Once the construction dust risk potential has been classified, the receiving environment sensitivity was determined using the criteria outlined in Table 5.7. The receiving environment sensitivity for the Proposed Scheme was classed as high due to the presence of receptors within 50m and 100m from construction activities. A constraints map identifying sensitive receptors within 0-50m, 50-100m and 100-200m of construction activities can be found in Figure 5.1 (**TR010038/APP/6.2**).

Table 5.7: Receiving environment sensitivity to construction dust

Construction dust risk potential	Distance from construction activities		
	0-50m	50-100m	100-200m
Large	High	High	Low
Small	High	Low	Low

5.6.4. The dust risk potential and receiving environment sensitivity was used to inform the measures to support the proposed mitigation.

Operational phase – local air quality

5.6.5. The location of the Proposed Scheme can be found in Figure 5.2 (**TR010038/APP/6.2**).

5.6.6. The following screening criteria, outlined in LA 105, was used to identify roads which are likely to be impacted by the Proposed Scheme. Roads which triggered the screening criteria below are required to be considered within the air quality assessment:

- an annual average daily traffic (AADT) flow change of 1,000 or more
- a heavy duty vehicle (HDV) flow change of 200 or more
- a change in speed band
- a change in carriageway alignment by greater than 5m

5.6.7. Once the road links triggering the screening criteria are identified, all adjoining roads, with modelled traffic data, within 200m of the Proposed Scheme are required to be selected. This forms the air quality study area and is known as the affected road network (ARN). The ARN is shown in Figure 5.3 (**TR010038/APP/6.2**).

5.6.8. The ARN was selected from the traffic model known as the traffic reliability area (TRA). The TRA spanned a large spacial extent and covered all areas sensitive to changes in air quality appropriate for this assessment.

5.6.9. The level of assessment was identified using guidance outlined in LA 105 and the flow diagram in Figure 2.10 of LA 105. The level of assessment is based on the risk of the project with the sensitvity of the receiving environment. The project's risk potential was classified as high risk as the Proposed Scheme fell into the category of "major bypass and motorway junction improvements" given in LA 105. The receiving environmental sensitivity was also classified as "high" due to over 1000 sensitive receptors identified within 50m of the roads triggering the traffic screening criteria. Based on this assessment it was determined that a detailed assessment was required.

5.6.10. The locations which represent human exposure for each triggered link were identified. These were predominantly residential receptors, but also include hospitals and schools. The receptor locations are shown in Figure 5.4 (**TR010038/APP/6.2**).

5.6.11. All designated sites which include Special Areas of Conservation (SACs), Ramsar sites and Special Protection Areas (SPAs), local wildlife sites, ancient woodland and veteran trees within 200m of the triggered links were identified. Designated sites contain features which may be sensitive to pollutants in the air

which have the potential to adversley affect vegetation. The designated sites were assessed by the competent expert for biodiversity for those sensitive to nitrogen deposition and included in the assessment. The designated sites identified for this air quality assessment are shown in Figure 5.5 (**TR010038/APP/6.2**).

5.6.12. The modelled road NO_x concentrations for each ecological transect were converted to Road NO_2 for each point along each transect for the Do- Minimum and Do Something scenarios. The Road NO_2 was converted to dry nutrient N deposition rate (kg N/ha/yr). Full details of the nitrogen deposition assessment are provided from paragraph 5.8.14 of this chapter.

5.7. Baseline conditions

5.7.1. To determine the significance of an impact, it is important to outline and understand baseline conditions in and around the study area. This allows a comparison to be drawn against any potential changes in the assessment of the air quality.

5.7.2. For the purpose of this assessment, a desk-based study was undertaken where air quality data has been obtained from the following sources:

- DEFRA – LAQM 1km x 1km grid background maps
- South Norfolk Council Annual Status Reports - 2016-2019
- Breckland Council Annual Status Reports – 2016-2019
- Broadland District Council Annual Status Reports – 2016-2019
- Norwich City Council
- DEFRA Pollution Climate Mapping (PCM)
- DEFRA Air Quality Management Areas (AQMA) interactive map

Local air quality

5.7.3. The Proposed Scheme is located within the administrative boundary of South Norfolk Council, Broadland District Council and Breckland Council with a small area north of the ARN spanning into the administrative district of Norwich City Council.

5.7.4. There are currently no AQMAs declared in the Broadland District Council or South Norfolk Council boundaries.

5.7.5. There is one AQMA declared in Breckland Council in Swaffham town centre. This is approximately 24km west of the site and is not expected to be impacted upon as a result of the Proposed Scheme.

5.7.6. The closest AQMA is located over 3km to the north-east, within Norwich City Centre. Norwich City Council declared the AQMA for the exceedances of the annual mean nitrogen dioxide (NO_2) objective in 2012. The AQMA is not within the ARN.

Air quality monitoring

Local authority monitoring

5.7.7. For the purpose of this assessment, a baseline year of 2015 has been modelled in accordance with the baseline traffic data provided.

5.7.8. There are no automatic monitoring sites within Broadland District Council or South Norfolk Council boroughs. Breckland Council undertakes continuous automatic monitoring at two sites however, these sites are not located within the study area.

5.7.9. The nearest automatic site is Lakenfields and is located approximately 1.5km north-west of the study area. This site is part of the DEFRA automatic and urban rural network (AURN) and classified as an urban background site. The other automatic monitoring site is Castle Meadow which is classified as a roadside monitoring site.

5.7.10. Due to the distance from the ARN and the Proposed Scheme, these automatic monitoring sites were not used within the assessment for model verification. However, they were used within the assessment for quality assurance and background concentrations.

5.7.11. The Lakenfields urban background monitoring site was used for comparison against the DEFRA background maps to demonstrate the reliability of the maps in predicting the local background concentrations around the ARN. The Castle Meadow roadside monitoring location was used to undertake a co-location study for the scheme specific monitoring. This roadside location was identified as being representative of the Proposed Scheme study area, as the locations where Proposed Scheme specific monitoring was undertaken were roadside locations.

5.7.12. Breckland Council, Broadland District Council and South Norfolk Council undertake diffusion tube monitoring for NO_2 within their respective borough's. There are no Broadland District Council monitoring sites within the ARN.

5.7.13. For a full summary of South Norfolk Council's and Breckland Council's monitoring data ranging from years 2015 to 2018, refer to Appendix 5.1 (**TR010038/APP/6.3**). At the time of the assessment, 2018 was the most recent year of published monitoring data.

5.7.14. In 2015, South Norfolk Council undertook non-automatic diffusion tube monitoring at 29 sites to assess compliance with the annual mean NO_2 air quality objective. There are eight diffusion tubes located within the ARN, six of which are classified as suburban monitoring sites, one is a kerbside site and one a roadside site.

5.7.15. The closest monitoring point to the Proposed Scheme is a suburban monitoring location, located north of the A1074. The other diffusion tubes are located on the outskirts of Norwich.

5.7.16. There were no exceedances of the NO_2 annual mean objective in the year 2015. Due to the suitability of the monitoring locations, none of the local authority monitoring sites were used for model verification purposes, as outlined in Appendix 5.2 (**TR010038/APP/6.3**).

5.7.17. For full details and reasoning on why the local authority monitoring locations were excluded from model verification, refer to Appendix 5.2 (**TR010038/APP/6.3**).

5.7.18. South Norfolk Council and Broadland District Council did not monitor PM_{10} or $PM_{2.5}$ concentrations in 2015.

5.7.19. Breckland Council monitored PM_{10} at one site in East Wretham. The site is not within the ARN. Breckland Council did not monitor $PM_{2.5}$ in 2015.

Scheme specific monitoring

5.7.20. To determine the current baseline conditions around the study area, a six-month nitrogen dioxide survey was conducted for the purpose of this air quality assessment. The diffusion tube survey ran from September 2019 to March 2020. This monitoring was conducted to supplement the existing monitoring.

5.7.21. The monitoring was measured and reported at seven locations, all located near the Proposed Scheme along the existing A47. Due to the proximity of the ARN to the A47 Thickthorn Junction scheme, the results from the scheme specific diffusion tube survey near Thickthorn was also used in this assessment. The monitoring at Thickthorn was measured and reported at four locations, with three of the four locations within the ARN and therefore included within the assessment. The first on Cantley Lane South, the second located at East Lodge, B1172 Norwich Road and the third adjacent to Thickthorn Interchange. These locations were representative of sensitive receptors and road emission sources where pollutant concentrations are high.

5.7.22. As outlined above, for quality control purposes triplicate tubes were collocated at the automatic site at Castle Meadow in Norwich, this follows LAQM TG(16) best practice. The locations of all scheme-specific monitoring sites in relation to the

Proposed Scheme are shown in Figure 5.6 (**TR010038/APP/6.2**) for Tuddenham and Figure 5.7 (**TR010038/APP/6.2**) for the Thickthorn scheme monitoring.

5.7.23. The results from the monitoring locations were bias adjusted and annualised in accordance with LAQM.TG(16) to provide a 2019 annual mean NO_2 concentration. The monitoring survey concluded that there were no exceedances of the annual mean NO_2 objective within the vicinity of the Proposed Scheme.

5.7.24. The highest concentration measured within the study area was 31.7 µg/m^3 at Tuddenham 3, located on the A47 roundabout at Norwich Road, in 2019. This is well below the NO_2 annual mean objective of 40 µg/m^3. Final bias adjusted and annualised results for the monitoring survey can be found in Table 5.8. The full methodology for bias adjustment and annualisation can be found in Appendix 5.2 (**TR010038/APP/6.3**).

Table 5.8: Diffusion tube monitoring results for 2019

Site	Location	Site classification	National grid		2019 annual mean NO_2 concentration (µg/m^3)
			X	Y	
Tuddenham 1	A47 cycle path sign opposite low road	Roadside	606758.6	313299.3	19.1
Tuddenham 2	A47 speed camera post at Sandy Lane	Roadside	608783.6	312603.7	22.2
Tuddenham 3	A47 roundabout at Norwich Road, lamp post at roundabout western arm approach	Roadside	611063	311328	31.7
Tuddenham 4	A47 on solar post at parking layby to the west of hall drive	Roadside	610263.2	311985.5	18.9
Tuddenham 5	Residential receptor closer to proposed new road alignment, Church Lane, telegraph pole opposite church lane house	Suburban	608735.2	312359.6	7.9
Tuddenham 6	Low Road A47 Junction give way sign post	Roadside	606735	313281	12.7
Tuddenham 7	Telegraph pole at Blind Lane. Previous monitoring location, Tuddenham C. Across from Taverham Road	Roadside	611829	311134	9.9

Site	Location	Site classification	National grid		2019 annual mean NO_2 concentration ($\mu g/m^3$)
			X	Y	
Thickthorn 1	Cantley Lane South	Roadside	618571.8	305055	12.8
Thickthorn 2	East Lodge, B1172 Norwich Road	Roadside	618094.2	305580.1	19.3
Thickthorn 3	B1172 Norwich Road leading to Thickthorn Interchange	Roadside	618311.1	305481.2	24.0
Colocation 1	Norwich Castle Meadow Automatic Station	Roadside	623202	308615	39
Colocation 2		Roadside	623202	308615	39
Colocation 3		Roadside	623202	308615	40

5.7.25. The results of the 2019 monitoring survey were factored backwards to 2015 in line with the baseline year and to be used for model verification purposes. The full methodology for producing the back casting factor can be found in Appendix 5.2 (**TR010038/APP/6.3**). The results from this monitoring survey were also used to determine 2015 equivalent pollutant concentrations around the Proposed Scheme and assess whether there were any areas close to the NO_2 annual mean objective. The back casted 2015 monitoring survey results are presented in Table 5.9.

5.7.26. The highest measured concentration around the Proposed Scheme was predicted to be 42.5 $\mu g/m^3$ in 2015 at Tuddenham 3. Although this exceeds the AQO of 40 $\mu g/m^3$, this concentration is representative of its monitored location along a busy stretch of the western arm on the A47 roundabout on Norwich Road. This monitoring location is not representative of a location where relevant exposure is present.

Table 5.9: Back casted 2015 monitoring survey results

Site	Location	Site classification	National grid		2015 annual mean NO_2 concentration ($\mu g/m^3$)
			X	Y	
Tuddenham 1	A47 cycle path sign opposite low road	Roadside	606758.6	313299.3	25.7
Tuddenham 2	A47 speed camera post at Sandy Lane	Roadside	608783.6	312603.7	29.8

Site	Location	Site classification	National grid		2015 annual mean NO_2 concentration ($\mu g/m^3$)
			X	Y	
Tuddenham 3	A47 roundabout at Norwich Road, lamppost at roundabout western arm approach	Roadside	611063	311328	42.5
Tuddenham 4	A47 on solar post at parking layby to the west of hall drive	Roadside	610263.2	311985.5	25.4
Tuddenham 5	Residential receptor closer to proposed new road alignment, Church Lane, telegraph pole opposite church lane house	Suburban	608735.2	312359.6	10.6
Tuddenham 6	Low Road A47 Junction give way sign post	Roadside	606735	313281	17.0
Tuddenham 7	Telegraph pole at Blind Lane. Previous monitoring location, Tuddenham C. Across from Taverham Road	Roadside	611829	311134	13.3
Thickthorn 1	Cantley Lane South	Roadside	618571.8	305055	17.2
Thickthorn 2	East Lodge, B1172 Norwich Road	Roadside	618094.2	305580.1	25.9
Thickthorn 3	B1172 Norwich Road leading to Thickthorn Interchange	Roadside	618311.1	305481.2	32.2
Colocation 1	Norwich Castle Meadow Automatic Station	Roadside	623202	308615	52.8
Colocation 2		Roadside	623202	308615	51.9
Colocation 3		Roadside	623202	308615	53.4

Background mapping

5.7.27. Background pollutant maps provide estimates of background concentrations for specific pollutants. They are used to better understand the contribution of local sources to pollutant concentrations. DEFRA provides estimates of background pollution concentrations for NO_x, NO_2 and PM_{10} across the UK for each 1km grid

square for every year from 2017 to 2030. Background pollution maps have been obtained from DEFRA for this assessment.

5.7.28. The most recent 2017 based background maps were used for this assessment. Due to a baseline year of 2015, the DEFRA background back-casting NO_x factor was used to produce 2015 annual mean NO_x concentrations from the 2017 based background maps. The nearest urban background monitoring site at Lakenfields was used to calculate a 2017 to 2015 back casting factor for PM_{10}.

5.7.29. A comparison between the back casted 2015 background values against the concentrations recorded at the nearest urban background monitoring site at Lakenfields can be found in Table 5.10. Full details of the factors used can be found in Appendix 5.1 (**TR010038/APP/6.3**).

5.7.30. The range of background NO_x and PM_{10} concentrations for the study area and around the Proposed Scheme can be found in Table 5.11. Concentrations for the base year (2015) and opening year (2025) have been presented in Table 5.10.

Table 5.10: Background concentration comparison

Grid square (x,y)	NO_x (µg/m^3)		PM_{10} (µg/m^3)	
	Back-casted 2015 background mapped concentration	Measured NO_x concentration	Back-casted 2015 background mapped concentration	Measured PM_{10} concentration
623500, 306500	20.0	16.0	13.3	15.0

Table 5.11: Background mapped concentrations for baseline and opening year

Year	Range	NO_x (µg/m^3)	PM_{10} (µg/m^3)
2015	Across the study area	10.8 – 24.6	12.6 – 16.1
2025	Across the study area	8.0 – 17.1	12.4 – 16.1

Pollution Climate Mapping model

5.7.31. DEFRA's Pollution Climate Mapping (PCM) is used to report compliance with the EU Directive (EU directive 2008/50/EC) and provides NO_2 concentrations for several roads across the UK for a selection of futures. The PCM model projections used in the assessment were released in 2019, with a reference year of 2017.

5.7.32. To determine whether the project is at risk of compliance with the EU directive, the study area is compared with the PCM network published by DEFRA. There were no road links from the PCM model in the study area for the project and therefore the project does not affect the UK's reported ability to comply with the Air Quality Directive in the shortest timescales possible.

Selected sensitive receptors

5.7.33. Sensitive receptors have been chosen following the guidance outlined in LA 105. For each scenario a mixture of residential receptors and schools have been chosen for this assessment. A selection of receptors representative of committed development receptors have also been included in the DM and DS scenarios. A degree of professional judgement was used when selecting the receptors, where receptors located nearest to the roads triggering the screening criteria were selected. For each triggered link only one receptor representing the closest receptor was chosen. These receptors were considered the most sensitive to changes in air quality concentrations, and subject to the highest road traffic emissions. A summary of the number and types of receptors per scenario is detailed in Table 5.12. A full detailed summary of receptor locations can be found in Appendix 5.3 (Receptor results) (**TR010038/APP/6.3**).

Table 5.12: Receptor summary per modelled scenario

Modelled scenario	Receptor type	Count	Total
Base – 2015	Residential	49	49
DM & DS 2025	Residential	49	58
	Committed Developments	9	

Ecological receptors

5.7.34. There were twelve designated ecological sites identified as being sensitive to nitrogen deposition within 200m of the ARN:

- Hockering Wood SSSI/ AWI
- Days Grove AWI
- Snake Wood AWI
- Potter Scarning North Valley SSSI
- Potters Fen CWS
- Neatherd Moor CWS
- Lakes Near Lyng CWS
- Sparham Pools CWS

- Lenwade Pits CWS
- Hall Hills CWS
- Ringland Hills CWS
- Bawburgh CWS

5.7.35. The location of these ecological transects can be found in Figure 5.8 (**TR010038/APP/6.2**), along with the full results along each transect in Appendix 5.3 (**TR010038/APP/6.3**).

5.8. Potential impacts

5.8.1. This section presents the findings of the assessment of potential impacts on air quality.

Operational

Local air quality: human health

NO_2 results

5.8.2. This section presents the potential impacts of the Proposed Scheme on local air quality within the study area. The presentation of annual mean NO_2 concentrations include sensitive receptors along locations with the greatest change resulting with the Proposed Scheme in place. Modelled sensitive receptors can be found in Figure 5.4 (**TR010038/APP/6.3**).

5.8.3. Modelling has been undertaken using the approach outlined in LA 105, using the Interim Highways Agency Long Term Gap Analysis Calculator v1.1 (LTTE6). This approach is considered the most robust in projecting and estimating the future concentrations in 2025 and considers the uncertainty associated in long-term trends. These results have formed the basis in estimating the impact and significance of the Proposed Scheme on selected sensitive receptors, alongside determining compliance with the EU directive for annual mean NO_2 concentrations.

5.8.4. The full set of results for annual mean concentrations and the changes (increases and decreases) in NO_2 concentrations between the DM 2025 and DS 2025 opening years can be found in Appendix 5.3 (**TR010038/APP/6.3**).

5.8.5. The total annual mean NO_2 concentrations were estimated for the opening year with and without the scheme at 49 sensitive human receptors. The NO_2 concentrations were adjusted following verification outlined in Appendix 5.2 (**TR010038/APP/6.3**). The final concentrations were compared to the AQOs to determine whether there are any exceedances.

5.8.6. There are no exceedances of the NO_2 annual mean objective at any of the selected sensitive human receptors in the opening year with and without the scheme. Annual mean NO_2 concentrations were well below the AQO of 40 µg/m^3 across all modelled receptors in the DM 2025 and DS 2025 scenarios.

5.8.7. The maximum modelled annual mean NO_2 concentration in the DM scenario was 14.0 µg/m^3 at receptor 45 on Dereham Road in East Tuddenham. The maximum modelled NO_2 concentration in the DS scenario was 14.7 µg/m^3 again at receptor 45 located on Dereham Road in East Tuddenham. This receptor is located close to the A47 and Dereham Road, which are predicted to trigger a higher level of flow change as a result of the Proposed Scheme in place. The predicted NO_2 annual mean in both scenarios are well below the AQO of 40 µg/m^3.

5.8.8. The greatest increase in annual mean NO_2 concentration is expected to occur at receptor 43, located on Carsinal Close, Easton, with an increase in annual mean NO_2 concentration from 11.5 µg/m^3 to 12.9 µg/m^3, resulting in an increase of 1.4 µg/m^3. This receptor is located on a road which triggers higher level of traffic flow changes (an increase of just over 4000 vehicles per day) due to the Proposed Scheme in place. However, the predicted annual mean concentration is well below the AQO of 40 µg/m^3 in both the DM and DS scenarios.

5.8.9. The greatest improvement in annual mean concentrations is expected to occur at receptor 27 located on Meadow View in Hockering. Receptor 27 shows a decrease from 10.2 in the DM scenario to 7.2 in the DS scenario. This is due to traffic moving away from the receptor and away from the existing A47 once the Proposed Scheme is in place, resulting in traffic moving over 200m away from the receptor. This results in an improvement in annual mean NO_2 concentrations.

5.8.10. Overall, 25 of the 49 receptors are expected to show a slight deterioration in air quality, with 24 showing an improvement in air quality with the Proposed Scheme in place. All concentrations are well below the AQO of 40 µg/m^3.

PM_{10} results

5.8.11. The PM_{10} concentrations were adjusted according to the methodology outlined in Appendix 5.2 (**TR010038/APP/6.3**). There are no predicted exceedances of the PM_{10} annual mean AQOs in the baseline year. The highest concentration was recorded at receptor 27, with 16.7 µg/m^3. All annual mean concentrations are predicted to be well below the 40 µg/m^3 AQO. In line with LA 105 and with no exceedances being reported in the baseline scenario, PM_{10} was not modelled in the Do-Minimum and Do-Something scenarios.

5.8.12. If we assume, as worst case, that all of the predicted PM_{10} concentrations are $PM_{2.5}$ for the baseline scenario at all specified receptors, this would also indicate that there would be no exceedances of the $PM_{2.5}$ air quality objective of 25 µg/m^3.

Ecological Receptors

5.8.13. One of the 12 ecological sites modelled in the assessment (Bawburgh CWS) shows a predicted annual mean NO_x concentration which is greater than the annual mean NO_x objective of 30 µg/m^3 in the Baseline, Do-Minimum and Do-Something scenarios.

Nitrogen deposition assessment

5.8.14. A nitrogen deposition assessment was conducted to assess whether there was potential for a significant impact to be predicted. The background nitrogen deposition rates (kg N/ha/yr) were sourced from the Air Pollution Information System (APIS). The APIS website was used and the competent expert for biodiversity was consulted to identify which feature of the identified designated habitats is sensitive to nitrogen deposition.

5.8.15. The relevant nitrogen critical load values and background information used in this assessment is presented in Table 5.13.

Table 5.13: Background nitrogen deposition rates and critical load values

Designated habitat	Nitrogen critical load class	Critical Load (kg N/ha/yr)	Average background nitrogen deposition rate (kg N/ha/yr)	Species sensitive to nitrogen deposition?
Hockering Wood SSSI	Broadleaved, Mixed and Yew Woodland	10-20	11.6	Yes
Days Grove AWI	Broadleaved, Mixed and Yew Woodland	10-20	11.6	Yes
Snake Wood AWI	Broadleaved, Mixed and Yew Woodland	10-20	12.3	Yes
Potter Scarning North Valley SSSI	Fen, Marsh and Swamp	10-15	13.9	Yes
Potters Fen CWS	Fen, Marsh and Swamp	10-15	13.9	Yes
Neatherd Moor CWS	Broadleaved, Mixed and Yew Woodland	10-20	14.0	Yes
Lakes Near Lyng CWS	Coastal and floodplain grazing marsh	10-20	11.2	Yes
Sparham Pools CWS	Bogs	10-15	11.3	Yes
Lenwade Pits CWS	Coastal and floodplain grazing marsh	10-20	13.9	Yes

Designated habitat	Nitrogen critical load class	Critical Load (kg N/ha/yr)	Average background nitrogen deposition rate (kg N/ha/yr)	Species sensitive to nitrogen deposition?
Hall Hills CWS	Broadleaved, Mixed and Yew Woodland	10-20	11.8	Yes
Ringland Hills CWS	Broadleaved, Mixed and Yew Woodland	10-20	12.6	Yes
Bawburgh CWS	fen, marsh and swamp	10-15	17.8	Yes

5.8.16. The modelled road NO_x was converted to road NO_2 using the NO_x-NO_2 calculator. The following equations, taken from paragraph 2.43 onwards in LA 105, outlines the steps taken to obtain a total receptor nitrogen deposition rate.

$$1.\ Conversion\ rate\ for\ grassland\ and\ similar\ habitats = 0.14\ \frac{kg\ \frac{N}{ha}}{yr}\ (obtained\ from\ LA105)$$

$$2.\ Road\ NO_2\ x\ conversion\ rate\ (0.14) = dry\ nutrient\ (N) deposition\ rate\ (\frac{kg\ \frac{N}{ha}}{yr})$$

$$3.\ Dry\ nutrient\ (N)\ deposition\ rate + background\ nitrogen\ deposition\ rate = \boldsymbol{total\ receptor\ nitrogen\ deposition\ rate}$$

5.8.17. The total receptor nitrogen deposition rate was compared against the critical load values of the most sensitive site feature for the designated habitat. This approach is consistent with LA 105.

5.8.18. The comparison of the total nitrogen deposition rate to the critical load is presented in Table 5.14. The first point of each modelled transect is presented as this represented the highest and worst-case concentrations.

Table 5.14: Comparison of total nitrogen deposition to critical load

Transect receptor ID	Distance from road (m)	Total nitrogen deposition rate (kg N/ha/yr)				DM-DS as % of lower critical load
		Base 2015	DM 2025	DS 2025	DM-DS	
Hockering Wood SSSI	10	11.7	11.7	11.6	-0.06	-0.6%
Days Grove AWI	10	11.8	11.7	11.7	-0.06	-0.6%

Transect receptor ID	Distance from road (m)	Total nitrogen deposition rate (kg N/ha/yr)				DM-DS as % of lower critical load
		Base 2015	DM 2025	DS 2025	DM-DS	
Snake Wood AWI	10	12.6	12.6	12.4	-0.14	-1.4%
Potter Scarning North Valley SSSI	10	16.0	14.7	14.8	0.06	0.6%
Potters Fen CWS	10	14.5	14.2	14.2	0.02	0.2%
Neatherd Moor CWS	10	14.9	14.5	14.6	0.09	0.9%
Lakes Near Lyng CWS	10	11.2	11.2	11.2	0.01	0.1%
Sparham Pools CWS	10	11.4	11.3	11.4	0.08	0.8%
Lenwade Pits CWS	10	14.1	14.0	14.0	-0.01	-0.1%
Hall Hills CWS	10	12.0	11.9	11.8	-0.03	-0.3%
Ringland Hills CWS	10	12.9	12.8	12.7	-0.09	-0.9%
Bawburgh CWS	10	19.9	19.1	19.2	0.15	**1.5%**
Bawburgh CWS	20	19.5	18.8	18.9	0.12	**1.2%**
Bawburgh CWS	30	19.2	18.6	18.7	0.1	0.97%

5.8.19. The nitrogen deposition assessment concluded the total nitrogen deposition rate with the project was above the applicable lower critical load for each designated site. However, the change in nitrogen deposition with and without the project was less than 1% of the lower critical load for most designated site assessed. In line with the criteria outlined in Figure 2.98 in LA 105, no significant effects on designated sites were identified.

5.8.20. There was one site where the change in nitrogen deposition was greater than 1% of the lower critical load up to 20m from the existing A47. This was Bawburgh CWS to the east of the A47. Following further discussion with the competent expert for biodiversity, it was concluded, from a desk based review, that due to an existing treeline that was located 20m from the A47, it is unlikely that species sensitive to nitrogen will be present in the 20m between the A47 and the treeline. Therefore, no further assessment was required.

Assessment of significant effects

Construction

5.8.21. As construction activities are programmed to last less than two years, it is unlikely there would be a significant effect on air quality or affect the UK's ability to comply with the Air Quality Directive. The construction traffic assessment was therefore screened out of the assessment.

5.8.22. With the recommendation of best practice construction mitigation measures in place, the impact of construction dust is considered highly unlikely to trigger a significant air quality effect. Therefore, in accordance with LA 105, no significant effects on sensitive receptors have been identified.

Operation

5.8.23. There are no receptors expected to exceed the annual mean NO_2 AQO in the opening year scenarios, all modelled receptors have predicted annual mean NO_2 concentrations well below the objective. The nitrogen deposition assessment concluded the change in nitrogen deposition with and without the project was less than 1% of the lower critical load for all designated sites, other than Bawburgh CWS. Following further discussion with the competent expert for biodiversity, from a desk based review it is evident that there is a tree line (approximately 20m from the road) along the verge followed by marshy grassland. It is unlikely that species sensitive to nitrogen will be present in the 20m prior to the treeline due to the proximity to the existing A47. In accordance with LA 105, no significant effects on human health and ecological receptors have been identified as a result of the Proposed Scheme in place.

5.9. Design mitigation and enhancement measures

Construction

5.9.1. The construction dust assessment has concluded there are no significant effects with the Proposed Scheme for human and ecological receptors. The assessment has been used to inform the best practice mitigation measures in the Environmental Management Plan (EMP). Based on a construction dust risk potential of high for the project, the following activities are recommended to monitor the effectiveness of the proposed mitigation measures which will be included in the EMP:

1. Development of dust management plan with measures to monitor effectiveness of mitigation as part of the EMP

2. Daily onsite and off-site inspections to be included in EMP

3. Record of complaints/exceptional dust events to be included in EMP

Operation

5.9.2. The air quality assessment has concluded there are no significant adverse effects with the Proposed Scheme for human health and ecological receptors. With no significant effects being reported, no mitigation measures have been proposed.

5.10. Assessment of likely significant effects

5.10.1. In line with paragraphs 5.12 and 5.13 in the NPS NN document and the relevant Council's local development policy plans, the findings of this air quality assessment are consistent with the requirements outlined in said documents. No significant effects have been identified in the air quality assessment, and no mitigation measures been recommended, there will not be any significant residual effects on the assessed human health or ecological sensitive receptors.

5.11. Monitoring

5.11.1. As no significant effects on human health receptors have been identified as a result of the Proposed Scheme in place, additional air quality monitoring is not required.

5.12. Summary

5.12.1. A detailed air quality assessment has been undertaken to assess the air quality impact during the operational phase of the Proposed Scheme.

5.12.2. A baseline desk study identified there were no AQMAs within close proximity to the Proposed Scheme. The nearest AQMA is located over 3km to the north-east within Norwich City Centre, declared by Norwich City Council. A review of the local monitoring data shows there are no exceedances of the annual mean NO_2 AQO. There were no monitoring sites measuring PM_{10} data within the study area. A Highways England six-month monitoring study was conducted to supplement current available monitoring data and identify pollutant conditions. There were no exceedances of the annual mean NO_2 AQO observed from the monitoring study.

5.12.3. The air quality assessment predicted concentrations at all human health receptors to be well below the AQO of 40 µg/m^3. Overall, 25 of the 49 receptors are expected to show a slight deterioration in air quality, with 24 showing an improvement in air quality with the Proposed Scheme in place. Although 25 receptors are showing a deterioration, the predicted air quality concentrations are well below the AQO at all receptors.

5.12.4. The greatest increase in annual mean NO_2 concentration is expected to occur at receptor 43, located on Carsinal Close, Easton, with an increase in an annual

mean NO_2 concentration from 11.5 µg/m^3 to 12.9 µg/m^3, resulting in an increase of 1.4 µg/m^3. This receptor is located on a road which triggers higher level of traffic flow changes (an increase of just over 4000 vehicles per day) due to the Proposed Scheme in place.

5.12.5. At the time of undertaking the assessment, the most recently available tools were used however since completion of the assessment new tools have been made available. It is unlikely that the conclusions discussed in this report would change the significance, had the assessment used these latest versions. Particularly given the maximum impact from the Proposed Scheme is less than 1.5 µg/m^3, and all concentrations were below the AQO.

5.12.6. Baseline results have shown annual mean PM_{10} concentrations to be well below the AQO. As a result, PM_{10} was not included in the opening year modelling scenarios.

5.12.7. The nitrogen deposition assessment concluded the total nitrogen deposition rate with the project was above the applicable lower critical load for each designated site. However, the change in nitrogen deposition with and without the project was less than 1% of the lower critical load for most designated site assessed.

5.12.8. There was one site where the change in nitrogen deposition was greater than 1% of the lower critical load. This was Bawburgh CWS to the east of the A47. Following further discussion with the competent expert for biodiversity, it was concluded that from a desk based review it is evident that there is a tree line (approximately 20m from the road) along the verge followed by marshy grassland. It is unlikely that species sensitive to nitrogen will be present in the 20m prior to the treeline due to the proximity to the A47. Therefore, no further assessment was required.

5.12.9. The air quality assessment has concluded there would be no significant effects on air quality at human and ecological receptors as a result of the Proposed Scheme.

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5.14. Glossary

AADT: Annual Average Daily Traffic

HDV: Heavy Duty Vehicles defined as vehicles with gross weight above 3.5 tonnes

ARN: Affected Road Network

Air Quality Management Area (AQMA): An area identified by a local authority where the local air quality objectives not being achieved or are not likely to be achieved within the relevant period. As required by Part IV of the Environment Act 1995.

Air Quality Standards (AQS) objectives: Ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale

Air Quality Strategy: The Government's air quality policy document for England, Scotland, Wales and Northern Ireland

DEFRA: Department for Environment Food and Rural Affairs

Diffusion tube: Simple monitoring device for air pollutants that absorbs substances from the air by diffusion (e.g. nitrogen dioxide) into a liquid film coated onto the inside of a plastic tube.

EMP: Environmental Management Plan

Exceedance: Infringement environmental protection standards by exceeding allowable limits or concentration levels.

Nitrogen oxides (NO_x): Nitrogen oxides is a term used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2), referred to collectively as NO_x. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The most important sources in the UK are road traffic and power generation.

Particulate Matter (PM_{10}): Particulate Matter less than 10 microns, tiny solid or liquid particles of soot, dust, smoke, fumes, and aerosols. The size of the particles (10 microns or smaller, about 0.0004 inches or less) allows them to easily enter the air sacs in the lungs where they may be deposited, resulting in adverse health effects.