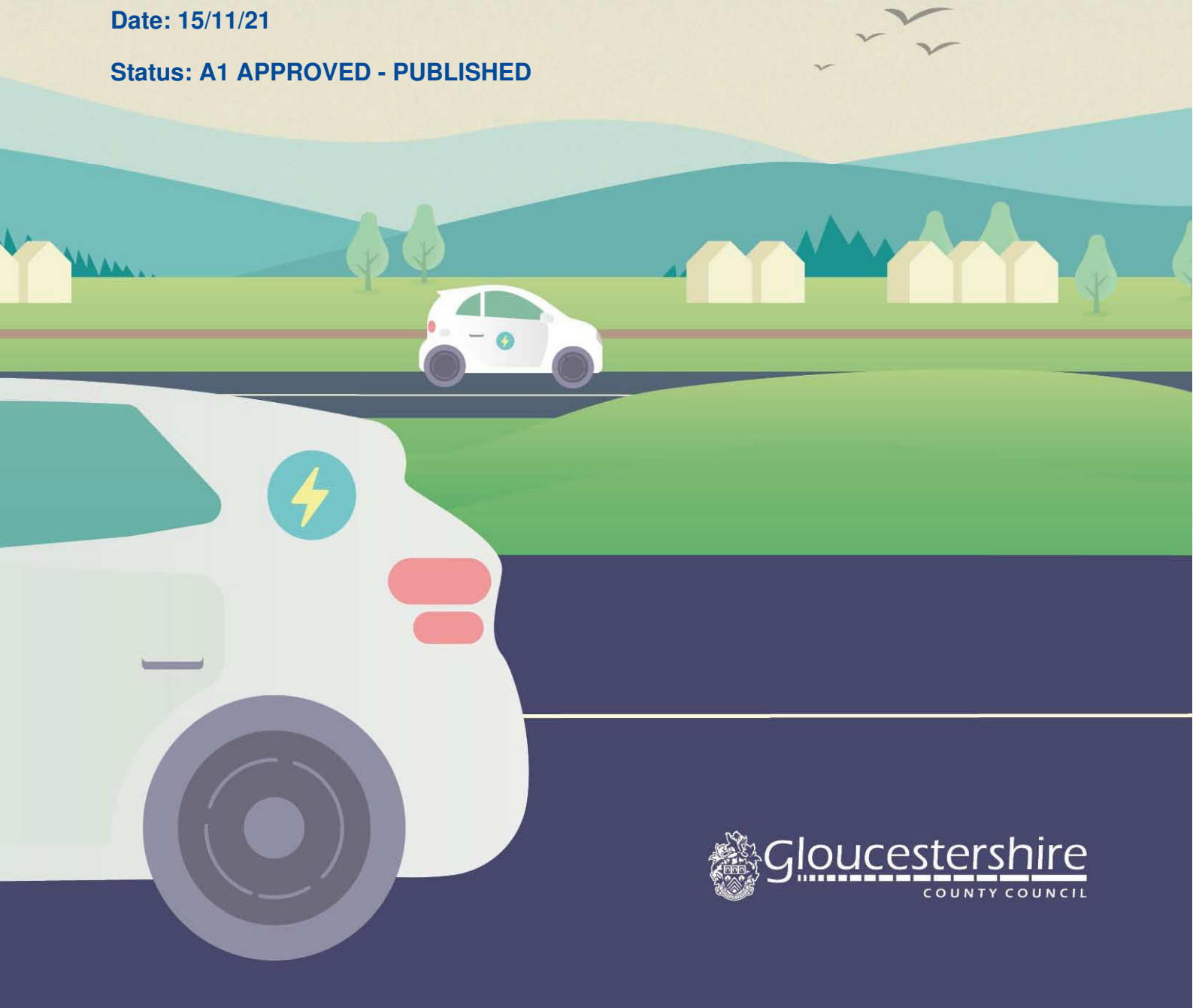
M5 Junction 10 Improvements Scheme

Preliminary Environmental Information Report (PEIR)

Air Quality chapter

Date: 15/11/21

Status: A1 APPROVED - PUBLISHED



Gloucestershire COUNTY COUNCIL

Notice

This document and its contents have been prepared and are intended solely for the Client's information and use in relation to M5 Junction 10 Improvements Scheme.

SNC Lavalin assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 61 pages including the cover.

Document history

Revision	Status	Purpose description	Originated	Checked	Reviewed	Authorised	Date
C02	A1	For issue	MDL	JAG	VS	TT	15/11/21
C01	A1	For review	MDL	JAG	CDC	TT	08/11/21

Client signoff

Client	**Gloucestershire County Council**
Project	**M5 Junction 10 Improvements Scheme**
Job number	**5206696**
Client signature / date	

Contents

Tables

Figures

Document accessibility

If you need to access this report in a different format like accessible PDF, large print, easy read, audio recording or braille, please get in touch with our team who will do their best to assist.

You can contact us by email on M5Junction10@atkinsglobal.com, leave us a voicemail on 01454 667900 or write to us at M5 Junction 10 Team, Atkins, 500 Park Avenue, Bristol, BS32 4RZ. You can also view Gloucestershire County Council's Accessibility Statement on our website at https://www.gloucestershire.gov.uk/accessibility/

Glossary

Term	Description
AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekday Traffic
AEP	Annual Exceedance Probability
ALC	Agricultural Land Classification
AMP	Archaeological Management Plan
AONB	Area of Outstanding Natural Building
ARN	Affected Road Network
ASPT	Average Score Per Taxon
AQAL	Air Quality Assessment Level
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
BAP	Biodiversity Action Plan
BCT	Bat Conservation Trust
BEIS	Department of Business, Energy and Industrial Strategy
BGS	British Geological Survey
BMV	Best and Most Versatile
BoQ	Bill of Quantities
BS	British Standards
BTO	British Trust for Ornithology
CAMS	Catchment Abstraction Management Strategy
CBC	Cheltenham Borough Council
CBC	Common Birds Census
CCC	Committee on Climate Change
CD&E	construction, Demolition and Excavation
CEMP	Construction Environmental Management Plan
CEA	Cumulative Effects Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CIRIA	Construction Industry Research and Information Association
CL:AIRE	Contaminated Land: Applications in Real Environments
CLP	Classification, Labelling and Packaging
CMS	Continuous Monitoring Station
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Conference of the Parties
COSHH	Control of Substances Hazardous to Health
CPS	Connecting Places Strategies
CRoW	Countryside and Rights of Way
CRTN	Calculation of Road Traffic Noise
CSZs	Core Sustenance Zones
DCO	Development Consent Order
DfT	Department for Transport
DM	Do Minimum
DMOY	Do Minimum Scenario in the Opening Year
DMFY	Do Minimum Scenario in the Future Assessment Year
DMRB	Design Manual for Roads and Bridges
DoE	Department of the Environment
DoWCoP	Definition of Waste: Development Industry Code of Practice
DS	Do Something
DSFY	Do Something in the Future Assessment Year
DSOY	Do Something Scenario in the Opening Year
EC	European Commission
ECoW	Ecological Clerk of Works

Term	Description
eDNA	environmental DNA
EEA	European Economic Area
EFT	Emissions Factors Toolkit
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
END	Environmental Noise Directive
EPA	Environmental Protection Act
EPS	European Protected Species
EPUK	Environmental Protection UK
EQS	Environmental Quality Standards
EU	European Union
ES	Environmental Statement
FRA	Flood Risk Assessment
ES	Environmental Statement
GCC	Gloucester City Council
GCER	Gloucestershire Centre for Environmental Records
GCN	Great Crested Newt
GFirst LEP	Gloucestershire Local Enterprise Partnership
GHER	Gloucestershire Historic Environment Record
GHGs	Greenhouse Gases
GLNP	Gloucestershire Local Nature Partnership
GLVIA3	Guidelines for Landscape and Visual Impact Assessment
GLTA	Ground Level Tree Assessment
GPLC	Guiding Principles for Land Contamination
GWDTE	Groundwater Dependant Terrestrial Ecosystems
GWT	Gloucestershire Wildlife Trust
HDV	Heavy Duty Vehicles
HER	Historic Environment Record
HEWRAT	Highways England Water Risk Assessment Tool
HGVs	High Good Vehicles
HIF	Housing Infrastructure Fund
HLC	Historic Landscape Characterisation
HMC	Habitat Modification Class
HMS	Habitat Modification Score
HRA	Habitat Regulations Assessments
HSI	Habitat Suitability Index
IAQM	Institute of Air Quality Management
IDB	International Drainage Board
IPCC	International Panel on Climate Change
JCS	Joint Core Strategy
JNCC	Joint Nature Conservation Committee
LAQM	Local Air Quality Management
LCAs	Landscape Character Assessments
LCRM	Land Contamination: Risk Management
LCT	Landscape Character Type
LDV	Light Duty Vehicles
LLFA	Lead Local Flood Authority
LNR	Local Nature Reserves
LOAEL	Lowest observed adverse effect level
LTP	Local Transport Plans
LVIA	Landscape and Visual Impact Assessment
MAFF	Ministry of Agriculture, Fisheries and Food
MCHW	Manual of Contract Documents for Highway Works
MHCLG	Ministry of Housing, Communities and Local Government
MMP	Materials Management Plan
MSA	Mineral Safeguarding Areas

Term	Description
MW	Minor Watercourse
NCA	National Character Area
NERC	Natural Environment and Rural Communities
NHLE	National Heritage List for England
NIAs	Noise Important Areas
NMP	National Mapping Programme
NMU	Non- Motorised User
NNR	National Nature Reserves
NPS NN	National Policy Statement for National Networks
NOEL	No Observed Effect Level
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPSE	Noise Policy Statement for England
NSIP	Nationally Significant Infrastructure Projects
NSR	Noise Sensitive Receptors
NVC	National Vegetation Classification
OS	Ordnance Survey
PAH	Polyaromatic Hydrocarbons
PAS	Portable Antiquities Scheme
PCBs	Polychlorinated Biphenyls
PCF	Project Control Framework
PCL	Potential Contaminant Linkage
PCM	Pollution Climate Mapping
PCSM	Preliminary Conceptual Site Model
PEAOR	Preliminary Environmental Assessment of Options Report
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PPE	Personal Protective Equipment
PPGs	Pollution Prevention Guidelines
PPG	Planning Practice Guidance
PPS10	Planning Policy Statement 10
PPGN	Planning Practice Guidance: Noise
PRA	Preliminary Roost Assessment
PRoW	Public Right of Way
Q_{95}	The 5 percentile flow
RAMS	Risk Assessments, Method Statements
RBD	River Basin Districts
RBMP	River Basin Management Plans
RCP	Relative Concentration Pathway
RCS	River Corridor Survey
RFFPs	Reasonably Foreseeable Future Projects
RHS	River Habitat Survey
RNAG	Reason for not Achieving Good
RoWIP	Rights of Way Improvement Plan
SAC	Special Area of Conservation
SHMP	Soil Handling Management Plan
SM	Scheduled Monument
SOAEL	Significant Observed Adverse Effect Level
SoCC	Statement of Community Consultation
SPD	Supplementary Planning Document
SPA	Special Protection Area
SPZ	Source Protection Zones
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SWMP	Site Waste Management Plan
TAMP	Transport Asset Management Plan

Term	Description
TBC	Tewkesbury Borough Council
TAR	Technical Appraisal Report
TSCS	Thin Surface Course System
UKCP18	United Kingdom Climate Projections 2018
UNFCCC	United Nations Framework Convention on Climate Change
UXO	Unexploded Ordnance
VfM	Value for Money
WCH	Walkers, Cyclists and Horse Riders
WEEE	Waste Electrical and Electronic Equipment
WER	Water Environment Regulations
WFD	Water Framework Directive
WHTP	Whalley, Hawkes, Paisley & Trigg
WSI	Written Scheme of Investigation
ZTV	Zone of Theoretical Visibility

Chapters 1-4 of this PEIR have been produced as a separate document.

1. Introduction

2. The Scheme

3. Assessment of Alternatives

4. Environmental Assessment Methodology

Table 4-1 - Significance Matrix

Sensitivity of receptor	Magnitude of impact				
	Major	Moderate	Minor	Negligible	No change
Very high	Very large	Large or very large	Moderate or large	Slight	Neutral
High	Large or very large	Moderate or large	Slight or moderate	Slight	Neutral
Medium	Moderate or large	Moderate	Slight	Neutral or slight	Neutral
Low	Slight or moderate	Slight	Neutral or slight	Neutral or slight	Neutral
Negligible	Slight	Neutral or slight	Neutral or slight	Neutral	Neutral

Table Source: DMRB LA 104 Environmental assessment and monitoring Table 3.8.1

Table 4-2 - Significance categories and typical descriptions

Value	Typical descriptors
Very Large	Effects at this level are material in the decision-making process.
Large	Effects at this level are likely to be material in the decision-making process.
Moderate	Effects at this level can be considered to be material decision-making factors.
Slight	Effects at this level are not material in the decision-making process.
Negligible	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Table Source: DMRB LA 104 Environmental assessment and monitoring Table 3.7

5. Air Quality

5.1. Introduction

5.1.1. This chapter presents the preliminary environmental assessment of the M5 Junction 10 Improvements Scheme (the Scheme) for Air Quality based on the Scheme as it is described in Chapter 2 (and detailed in the Design Fix 2 drawings in Appendix 2.1).

5.1.2. The Scheme, which comprises improvements to Junction 10 on the M5 and a new road linking Junction 10 to west Cheltenham and widening of the A4019 east of Junction 10, has the potential to alter vehicle flows on the road network which may change air quality at sensitive receptors. As demonstrated in the Environmental Scoping Report, changes to vehicle flows exceed commonly adopted air quality assessment screening levels. Detailed consideration of air quality impacts is therefore included as part of the PEIR and subsequent EIA. In addition, allocated land at West and North-west Cheltenham and the safeguarded land area where development is enabled as a result of the Scheme, (referred to as Scheme dependent development) would result in additional traffic on the improved network and new receptors in the vicinity of existing roads and improved roads.

5.1.3. To determine the potential air quality impacts, this assessment includes:

- Identification of baseline air quality conditions referencing Department for Environment, Food and Rural Affairs (DEFRA) background[1] and Pollution Climate Mapping (PCM)[2], and Local Authority Local Air Quality Management (LAQM) reports, and a Scheme-specific air quality monitoring survey;
- Identification of air quality constraints and sensitive receptors, including both human health receptors and designated habitats;
- Qualitative consideration of construction phase effects;
- Assessment of the likely changes in air pollutant concentrations during operation of the Scheme at selected human health receptors. The assessment follows the 'detailed' assessment methodology outlined in DMRB guidance, and a dispersion model has been used to estimate NO_2 at selected receptors in the Scheme base year (2019) and opening year (2025). Particulate matter concentrations have been estimated in the Scheme base year (2019) only;
- Assessment of the likely changes in nitrogen deposition rates during operation of the Scheme at selected ecological receptors;
- Assessment of significance of the air quality effects in the Scheme opening year (2023), including an assessment of compliance with air quality limit values set within the EU Air Quality Directive, and now implemented through the EU (Withdrawal Agreement) Act 2020; and
- Recommendations for mitigation to prevent or reasonably minimise any potentially significant effects identified at this stage.

5.2. Study Area

5.1.4. The air quality study area, for assessment of both construction traffic and the operational phase, is determined in accordance with traffic change screening criteria set out in the National Highways (previously Highways England) guidance DMRB LA105 Air Quality[3] .

5.1.5. For the potential effects of construction dust, the study area was defined as the area within 200 m of the boundary of the footprint of the Scheme's construction activities (DMRB LA

[1] Uk-air.defra.gov.uk. Background Mapping Data For Local Authorities - DEFRA, UK. [online] Available at: https://uk-air.defra.gov.uk/data/laqm-background-home [Accessed March 2021].
[2] Uk-air.defra.gov.uk. 2020. 2020 NO_2 and PM Projections Data (2018 Reference Year) - DEFRA, UK. [online] Available at: https://uk-air.defra.gov.uk/library/no2ten/2020-no2-pm-projections-from-2018-data [Accessed March 2021].
[3] Highways England (2019). Design Manual for Roads and Bridges (DMRB) 'LA 105 Air Quality', November 2019. Retrieved 2021 from https://www.standardsforhighways.co.uk/prod/attachments/10191621-07df-44a3-892e-c1d5c7a28d90

105 paragraph 2.57). The study area for construction dust for the Scheme is provided in Figure 5-2.

5.1.6. The air quality study area for the operational phase has been defined as the area within 200 m of roads meeting the traffic screening criteria within DMRB LA 105 (paragraph 2.1). The following traffic screening criteria have been applied based on the comparison between the 'with Scheme' (Do Something) and 'without Scheme' (Do Minimum) traffic data as defined in DMRB LA 105:

- Road alignment will change by 5 m or more; or
- Daily traffic flows (two way) will change by 1,000 annual average daily traffic (AADT) or more; or
- Heavy Duty Vehicle (HDV) flows (two way) will change by 200 AADT or more; or
- A change in speed band.

5.1.7. The changes are applied to roads, rather than modelled links, and so where relevant are determined under two-way traffic conditions. The AADT and HDV criteria have been applied to two-way traffic data (the sum of the carriageways not individual carriageways). The speed band criteria have been applied to both one way and two-way traffic data and have considered speeds for all modelled time periods (AADT, AM (0700-1000), inter peak (1000-1600), PM (1600-1900) and off-peak (1900-0700).

5.1.8. The Affected Road Network (ARN) is based on all roads meeting the traffic screening criteria and adjoining roads within 200 m. An assessment is required for air quality where there are receptors identified within 200 m of roads that trigger the traffic screening criteria. All road links within 200 m of these relevant receptors have been included (where traffic data were available) in the air quality assessment and form part of the overall study area. This distance of 200 m from roads is industry best practice guidance specified in DMRB LA 105. The Scheme extent is situated within the administrative boundaries of Cheltenham Borough Council (CBC) and Tewkesbury Borough Council (TBC). The ARN extends into the Gloucester City Council (GCC) boundary, however there were no sensitive receptors within this section of the study area.

5.1.9. The air quality study area is shown in Figure 5-1.

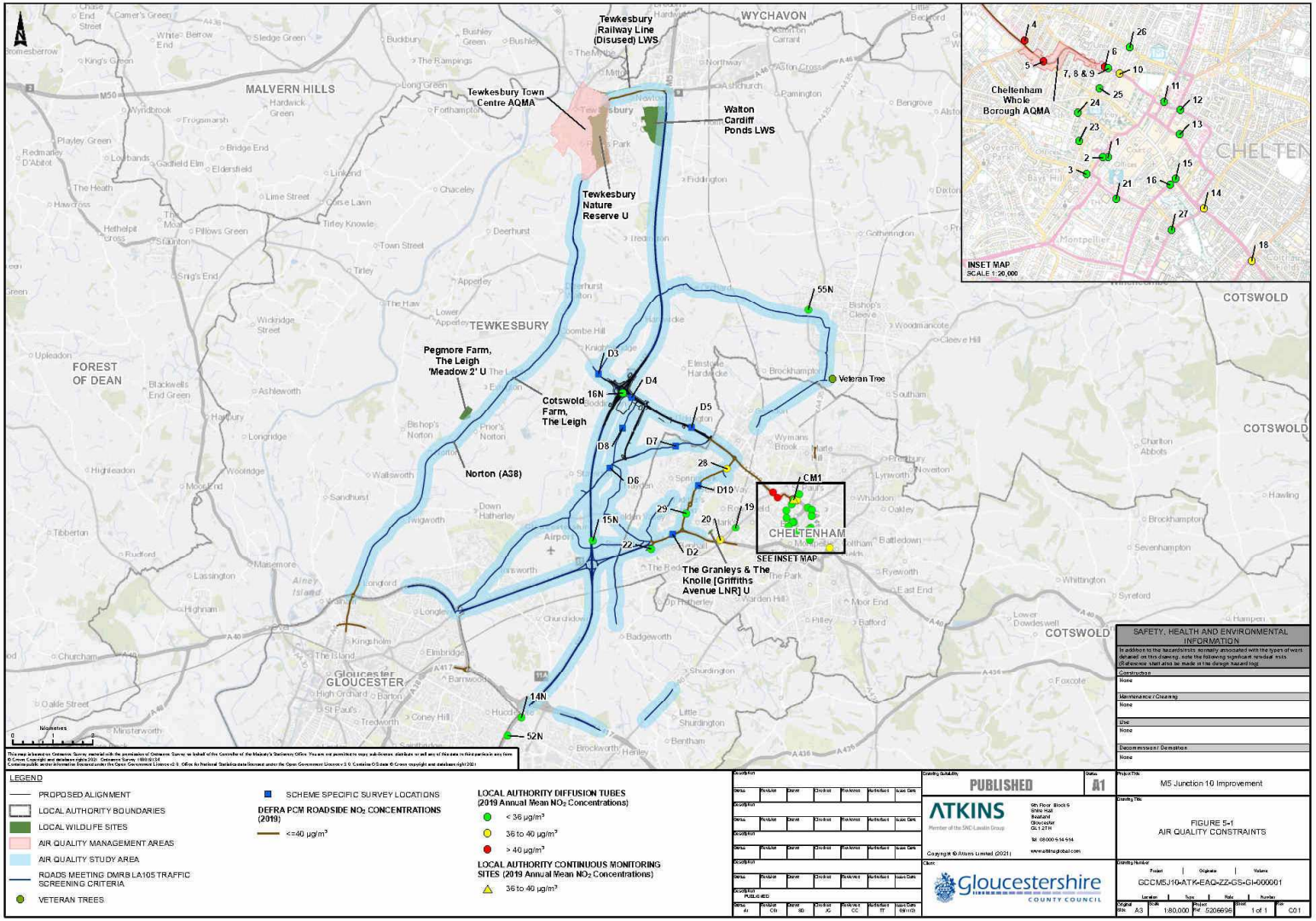


Figure 5-1 - Air Quality Constraints

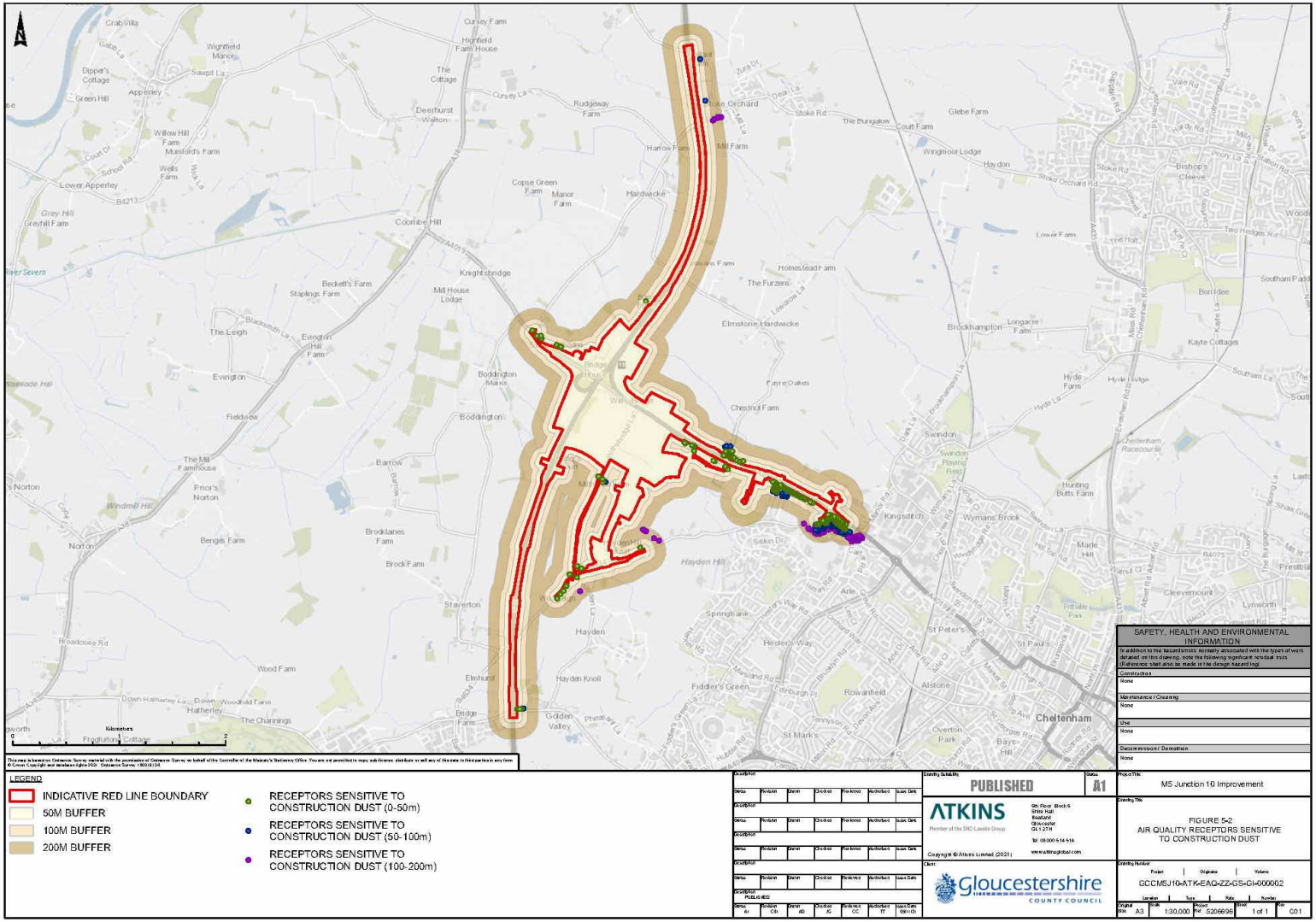


Figure 5-2 - Construction Dust Assessment

5.3. Planning policy and topic legislative context

UK Air Quality Legislation

5.1.10. There are two types of air quality legislation that apply in England:

- The EU (Withdrawal Agreement) Act 2020 which implements air quality limit values that are included in the EU Directive on ambient air quality and cleaner air for Europe (2008/50/EC), included in Air Quality Regulations (SI 2010 No.1001)[4] and as amended (SI 2016 No.1184)[5]. The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 (SI 2019 74)[6] and the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 (SI 2020 1313)[7] amend the Air Quality Regulations (SI 2010 No.1001) to account for EU withdrawal; and
- Regulations implementing national air quality objectives: Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment) Regulations 2002 (SI 2002 No. 3043).

Air Quality Limit Values

5.1.11. The EU (Withdrawal Agreement) Act 2020 implements the air quality limit values that are included in the EU Directive on ambient air quality and cleaner air for Europe (2008/50/EC) and were previously included in air quality regulations[8] (Statutory Instrument (SI) 2010 No. 1001) and as amended (SI 2016 No. 1184). The relevant limit values in the context of this assessment for the protection of human health for NO_2 and fine particulate matter are presented in Table 5-1.

5.1.12. Local authorities have no responsibility for achieving the national air quality criteria, although they should contribute to this through local action plans designed to reduce pollution levels in AQMAs, and through the recent targeted feasibility studies[9], including clean air zones where appropriate, to supplement the government's air quality plan for nitrogen dioxide in the UK[10].

National Air Quality Strategy

5.1.13. The 2007 Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland[11] sets out the national air quality standards and objectives for a number of local air pollutants. The standards are set by expert organisations with regard to scientific and medical evidence on the effects of the particular pollutant on health and define the level of pollution below which health effects are expected to be minimum or low risk even for the most sensitive members of the population. The objectives are targets for air pollution levels to be achieved by a specified timescale, which take account of the costs and benefits of achieving the standard, either without exception or, for certain short-term averaging period standards, with a permitted number of exceedances. Local authorities have a responsibility (under Part IV of the Environment Act 1995, see below) to review

[4] The National Archives (2010). The Air Quality Standards Regulations 2010. Available from: http://www.legislation.gov.uk/uksi/2010/1001/contents/made [Accessed April 2021].
[5] The National Archives (2016). The Air Quality Standards (Amendment) Regulations 2016. Available from : https://www.legislation.gov.uk/uksi/2016/1184/contents/made [Accessed February 2021].
[6] The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 (legislation.gov.uk). Available from: https://www.legislation.gov.uk/uksi/2019/74/contents/made [Accessed April 2021]
[7] The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 (legislation.gov.uk). Available From: https://www.legislation.gov.uk/uksi/2020/1313/contents/made [Accessed April 2021]
[8] The Air Quality Standards Regulations 2010. Available at http://www.legislation.gov.uk/uksi/2010/1001/contents/made [Accessed August 2021].
[9] Uk-air.defra.gov.uk. Supplement to the UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations: Local Authorities Feasibility Studies - Defra, UK. [online] Available at: https://uk-air.defra.gov.uk/library/no2ten/2018-la-tfs-documents [Accessed August 2021].
[10] DEFRA, UK plan for tackling roadside nitrogen dioxide concentrations, July 2017, Available at: https://uk-air.defra.gov.uk/library/no2ten/index [Accessed August 2021]
[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf

and assess local pollution levels against these objectives. These criteria are defined in Regulations SI 2000 No. 928 and SI 2002 No. 3043.

5.1.14. It should be noted that the AQS objectives only apply in locations likely to have 'relevant exposure' i.e. where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. For this assessment, locations of relevant exposure include building façades of residential premises, schools, public buildings and medical facilities; places of work (other than certain community facilities) are excluded.

5.1.15. In January 2019, the UK Government published its Clean Air Strategy[12], which sets out actions proposed by the Government to improve air quality by reducing pollution from a wide range of sources. Within the strategy, the Government sets an ambitious target to reduce the population exposed to concentrations of $PM_{2.5}$ above 10 µg/m^3 by 50% by 2025.

Local Air Quality Management

5.1.16. Under Part IV of the Environment Act 1995 all local authorities are responsible for LAQM, the mechanism by which the Government's AQS objectives are to be achieved. As part of this LAQM role, local authorities are required to periodically review air quality in their area and to assess present and likely future air quality against the objectives defined in Regulations. Where a local authority anticipates an objective is expected to be breached within their area, they must designate an AQMA and develop an action plan to improve pollution levels and work towards achieving the AQS objectives. Under the current LAQM regime, a local authority is responsible for regular review and assessment of local air quality, reports on which are published following public consultation and review by the DEFRA.

5.1.17. Statutory responsibility for achieving air quality limit values rests with the Secretary of State and local authorities have no responsibility for achieving the national air quality criteria, although they should contribute to this through local action plans designed to reduce pollution levels in AQMAs.

5.1.18. The relevant air quality criteria for the protection of human health are outlined in Table 5-1.

[12] DEFRA, 2019. Clean Air Strategy 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf.

Table 5-1 - Relevant Air Quality Criteria

Pollutant	Criteria
NO_2	Hourly mean concentration should not exceed 200 µg/m^3 more than 18 times a year Annual mean concentration should not exceed 40 µg/m^3
PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 35 times a year Annual mean concentration should not exceed 40 µg/m^3
$PM_{2.5}$	UK (Except Scotland) annual mean concentration should not exceed 25 µg/m^3†° Exposure reduction^ (UK urban areas): target of 15% reduction in concentrations at urban background between 2010 and 2020*
† AQS objective is 25 µg/m^3 to be met by 2020. Limit value is 25 µg/m^3 to be met by 2015, with a requirement in urban areas to bring exposure down to below 20 µg/m^3 by 2020. ° The Limit Value is 20 µg/m^3 to be achieved by January 2020 under Directive 2008/50/EC[13] ^ Limit value exposure reduction target of 20% reduction between 2010 and 2020. * 25 µg/m^3 is a cap to be seen in conjunction with 15% reduction.	

Dust Deposition

5.1.19. There are no national standards or guidelines for dust deposition currently set for the UK, nor by the EU or any international organisation. This is mainly due to the difficulty in setting a standard that needs to relate to dust being a perceptual problem rather than being specifically related to health effects. Typically, assessments use an indicative threshold for the 'likelihood of complaint' for instance, in residential areas a dust deposition flux (as an average measured over a month using a passive deposition gauge) of 200 mg/m^2/day or greater.

Ecological Criteria

5.1.20. The critical level for annual mean concentrations of nitrogen oxides (NO_x) to protect sensitive vegetation is included in the Air Quality Standards Regulations. Assessment of compliance with this critical level is undertaken at locations more than 20 km from towns with more than 250,000 inhabitants or more than 5 km from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50,000 vehicles per day. For this study, the critical level of 30 µg/m^3 was applied on a precautionary basis to all designated habitats included in the assessment.

5.1.21. Critical loads for nitrogen deposition have been set by the United Nations Economic Commission for Europe. A critical load is a quantitative estimate of an 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 loads vary by type of habitat and species. The critical load for deposition (eutrophication) is given as a range and is quoted in units of kg/ha/year, however the lower value of the critical load range is typically used in assessment.

National Policy

National Policy Statement for National Networks (NPS NN, 2014)

5.1.22. Paragraphs 5.3 – 5.15 relate to air quality assessment of transport schemes. Paragraph 5.11 states "Air quality considerations are likely to be particularly relevant where schemes are proposed: within or adjacent to AQMAs; roads identified as being above Limit Values or nature conservation sites; and where changes are sufficient to bring about the need for a new AQMA or change the size of an existing AQMA; or bring about changes to exceedances of the Limit Values, or where they may have the potential to impact on nature conservation sites."

[13] https://ec.europa.eu/environment/air/quality/directive.htm

5.1.23. Paragraph 5.12 states that air quality considerations must be given substantial weight where a project would lead to a significant air quality impact and/or lead to a deterioration in air quality in a zone/agglomeration.

5.1.24. Paragraph 5.13 of the NPS NN is particularly relevant and sets out that the Secretary of State should refuse consent, if including mitigation measures, the Scheme will 'result in a zone/agglomeration which is currently reported as being compliant with the Air Quality Directive becoming non-compliant.' Furthermore, consent should be refused where air quality impacts will 'affect the ability of a non-compliant area to achieve compliance within the most recent timescale reported to the European Commission at the time of the decision'.

National Planning Policy Framework (NPPF, 2021)

5.1.25. The National Planning Policy Framework (NPPF)[14] does not contain specific policies for nationally significant infrastructure projects. However, it is considered to be material to the Secretary of State's consideration of the application for development consent for the Scheme. It provides guidance for local authorities on incorporating air quality considerations into planning decisions and aims to protect the environment and to promote sustainable growth.

5.1.26. Paragraph 105 refers to sustainable transport:

"*The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health. However, opportunities to maximise sustainable transport solutions will vary between urban and rural areas, and this should be taken into account in both plan-making and decision-making*."

5.1.27. Paragraph 186 considers impacts on local air quality:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

Regional Policy

Gloucestershire Local Transport Plan 2020–2041

5.1.28. LTP PD PD0.2 – Environment states that the County Council will work with District Councils to improve air quality on the highway network. This will be achieved through developing, adopting and delivering 'Air Quality Action Plans required where Air Quality Management Areas have been declared, in relation to transport emissions.

[14] Ministry of Housing, Communities & Local Government, National Planning Policy Framework (NPPF), July 2021, from: National Planning Policy Framework - GOV.UK (www.gov.uk)

Local Policy

Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031

5.1.29. Policy SD3 Sustainable Design and Construction states that proposals should demonstrate how they contribute to the aims of sustainability by a number of factors, including the unnecessary pollution of air.

5.1.30. Policy SD14 Health and Environmental Quality states that development should protect and seek to improve environmental quality through development resulting in no unacceptable levels of air pollution.

5.1.31. Strategic Objective 9 – Promoting healthy communities outlines the stance that a healthy population will be maintained through 'ensuring that environmental quality and air quality is protected.'

Cheltenham Borough Council Local Plan 2011-2031 – Adopted July 2020

5.1.32. No borough wide air quality specific policies are included. Location specific guidance is provided for the protection of the Beechwoods Special Area of Conservation (SAC) as below:

5.1.33. Policy BG2: Cotswold Beechwoods SAC air quality development - Development which is likely to generate additional road traffic emissions to air which are capable of affecting the Cotswold Beechwoods SAC will be screened against the HRA Framework in line with Natural England's guidance 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001)'"

Tewkesbury Borough Local Plan – Saved Policies (2011)

5.1.34. Policy EVT4: Air Quality states that 'appropriate measures should be taken to ensure there is no risk to public health from the release of airborne pollutants'.

Gloucester City Council Local Plan – Saved Policies (2002)

5.1.35. Policy FRP.11 Pollution states that 'Development that may be liable to cause pollution of water, air or soil, or pollution through noise, dust, vibration, light, heat or radiation will only be permitted if the quality and enjoyment of the environment would not be unduly damaged or put at risk.

Cheltenham Borough - Planning for Air Quality Guidance 2013

5.1.36. A good practice guide for planners and developers was published by CBC in May 2013. This local guidance identifies which developments should assess air quality within the borough of Cheltenham and what an air quality assessment should include.

Cheltenham Borough - Air Quality Action Plan 2014

5.1.37. The air quality action plan identifies road transport as the principal source of air pollution and encourages sustainable travel following a series of transport measures within the Local Sustainable Transport Plan (LSTP). Measures identified in the Air Quality Action Plan (AQAP) include highway improvements, air quality awareness by publishing air quality data and encouraging sustainable transport choices, promoting the use of park-ride schemes, personalised travel plans, promoting bike use to commute to school for parents and kids, car sharing, greener vehicles, HGV and LGV restrictions, school and business travel grants, wayfinding initiatives, adopting an air quality policy to ensure impact of significant developments are assessed and mitigation measures in places where necessary, traffic light appraisal, bus and taxi quality partnership, reducing speed limit to 20mph in busier roads, low emission bus fleets and improvement of road layouts and greener areas. The Council is currently revising their AQAP, which is now in the process of being finalised and is expected to be released for consultation later in 2021.

5.4. Methodology

5.1.38. The Scheme, which comprises improvements to Junction 10 on the M5 and a new road linking Junction 10 to west Cheltenham and widening of the A4019 east of Junction 10, is designed to enable allocated land at west and north-west Cheltenham and the safeguarded land area, (referred to as Scheme dependent development) to be developed following implementation. The air quality assessment has to consider the change to existing local traffic patterns as a result of providing better connectivity around M5 Junction 10, particularly through Cheltenham and Tewkesbury town centres which both include designated AQMAs.

5.1.39. The air quality assessment for both the construction and the operational phase of the Scheme has been undertaken in line with the DMRB methodology detailed in LA105[3] adopted by National Highways for road schemes, given that the Scheme falls within the Strategic Road Network (SRN).

5.1.40. The air quality assessment has been undertaken as follows:

Construction Phase

5.1.41. A qualitative assessment of the effects on air quality from construction has been undertaken in line with DMRB LA 105, taking into account the nature of any proposed construction activities that have the potential to generate dust and the location of sensitive receptors, as detailed in Appendix 5.1.

5.1.42. The air quality study area for assessing potential impacts of construction dust during the construction phase is defined as the area within 200 m of the boundary of the footprint of the Scheme's construction activities, considering sensitive receptors within the relevant distance bands (0-50 m, 50-100 m and 100-200 m) from construction activities as per DMRB LA 105 (paragraph 2.57).

5.1.43. For construction dust the number of sensitive receptors and their distance from the footprint of the construction works have been considered to determine the risk of potential construction dust impacts. Sensitive receptor locations are shown in Figure 5-2.

5.1.44. The duration of construction works is expected to last 18 months i.e. less than two years, therefore, further quantitative assessment of construction traffic has not been undertaken in accordance with DMRB LA 105.

Operational Phase

5.1.45. The air quality assessment has been undertaken following the relevant guidance given in DMRB LA 105, as well as Department for Environment, Food and Rural Affairs (Defra) Local Air Quality Management Technical Guidance (LAQM.TG16)[15].

5.1.46. The assessment has used the latest Defra air quality assessment tools and datasets (released 19 August 2020) and latest National Highways speed band emission rates which account for the August 2020 Defra tools update (4 September 2020).

5.1.47. The assessment has been undertaken for NO_x, NO_2 and PM_{10}.

5.1.48. As per the DMRB LA 105 (paragraphs 2.21.2 and 2.21.3), only where PM_{10} concentrations exceed air quality thresholds in the base year (2019) should PM_{10} be included in the opening year (2025) assessment. As PM_{10} concentrations did not exceed air quality thresholds in the base year, no opening year assessment for PM_{10} concentrations has been undertaken.

5.1.49. As per the DMRB LA 105 (paragraph 2.21.4), there is no requirement to include $PM_{2.5}$ in the air quality assessment as: the UK currently meets its legal requirements for the achievement of the $PM_{2.5}$ air quality threshold; and PM_{10} concentrations can be used to demonstrate that the project does not have an impact on the $PM_{2.5}$ air quality threshold. Details on the modelled PM_{10} concentrations are summarised in paragraph 5.1.131 and presented in Appendix 5.1 Table 11. Furthermore, although there is not monitoring of

[15] Defra (2021) Local Air Quality Management Technical Guidance (TG16), April 21. Retrieved 2021 from https://laqm.defra.gov.uk/documents/LAQM-TG16-April-21-v1.pdf

particular matter undertaken by CBC and TBC, the estimated background and roadside concentrations presented in section 5.6 are less than half of the annual mean thresholds. Hence, $PM_{2.5}$ has not been included in the assessment as it is not considered to be at risk of exceeding current relevant air quality thresholds, either with or without the Scheme.

5.1.50. The assessment of operational effects was undertaken using Cambridge Environmental Research Consultants' ADMS Roads v5.0.0.1 (latest version at the time of assessment) dispersion modelling software to estimate the impact of the proposed Scheme at identified representative sensitive receptor locations.

- The key scenarios included in the assessment were:
- the base year (2019) for model verification (NO_x, NO_2 and PM_{10})
- Projected Base Year (2025) for long term trends assessment (NO_x and NO_2)
- First full opening year (2025) for both without the Scheme (Do Minimum) and with the Scheme (Do Something) (NO_x and NO_2)

5.1.51. The local air quality assessment is undertaken for the opening year, rather than the design year, as pollutant concentrations are likely to be higher in earlier years, due to expected improvements in emissions in future years.

5.1.52. The hourly emissions data input to the dispersion model have been estimated using:

- National Highways speed band emission factors (based on EFT v10.1).
- Annual Average Daily Traffic flows of Light Duty Vehicles (LDV) and Heavy Duty Vehicles (HDV).
- Traffic speeds input as a speed band category, determined in accordance with DMRB LA 105 (paragraph 2.29 – 2.38 and Appendix A) on speed banding.

5.1.53. In addition, information on road alignment, road width and local meteorological data (taken from Gloucestershire Airport for the base year 2019) have been input into the dispersion model. Further details on modelling setup are in Appendix 5.1.

Receptors

5.1.54. Representative receptors have been selected for the air quality assessment and included those closest to the roads that trigger the traffic change criteria (defined in Section 5.2), and therefore likely to be most affected by changes, as well as those likely to experience the highest total concentrations.

5.1.55. Sensitive human health and ecological receptors for the purposes of air quality assessment are defined in DMRB LA 105 (paragraph 2.18 and 2.25) as:

- Residential properties, locations of susceptible populations e.g. schools, hospitals and care homes for the elderly, or any other location where a member of the public may be exposed to an air pollutant for the relevant regulated time period.
- Designated ecological sites with statutory designations (special protection areas (SPA), special areas of conservation (SAC), Ramsar sites, sites of special scientific interest (SSSI), and local nature reserves (LNR)), and ecological sites with non-statutory designations (local wildlife sites (LWS), nature improvement areas (NIA), ancient woodland (AW) and veteran trees) containing habitats sensitive to nitrogen deposition.

5.1.56. There are no ecological sites with a national and/or international statutory designation within the air quality study area. There are, however, ecological receptors representing local sites and one veteran tree, which may contain habitats sensitive to nitrogen deposition, and so have been included in the air quality assessment. A receptor point at the site boundary closest to the road edge has been included to represent the following ecological sites:

- Norton (A38) (Local Wildlife Site)
- Pegmore Farm, The Leigh 'Meadow 2' LWS (Local Wildlife Site)
- Cotswold Farm, The Leigh (Local Wildlife Site)

- Tewkesbury Nature Reserve (Local Wildlife Site)
- Tewkesbury Nature Reserve (Local Wildlife Site)
- Tewkesbury Railway Line (Disused) (Local Wildlife Site)
- Walton Cardiff Ponds (Local Wildlife Site)
- Veteran Tree

5.1.57. Receptor details are provided in Appendix 5.1 and receptor locations are shown in Figure 5-3.

Assessment Scenarios

5.1.58. Traffic data were provided for the three without Scheme scenarios in 2019 (base year), 2025 (opening year) and 2041 (design year), the two with Scheme scenarios in 2025 and 2041, and one with Scheme and Scheme dependent development in the design year.

5.1.59. Pollutant concentrations have been modelled at selected sensitive receptors for each the base year and opening year to determine the impact of the Scheme on local air quality.

5.1.60. Traffic data were provided to allow the without Scheme (do-minimum (DM)) and with Scheme (do-something (DS)) scenarios to reflect the changes after implementation of the M5 Junction 10 scheme. The DM scenarios for the opening and design years include committed developments and highway improvements which are expected to be completed within the relevant timescales.

Traffic Conditions

5.1.61. Traffic conditions vary throughout the course of a day and a 24-hour profile has been applied in the model to improve the estimation of vehicle emissions in each hour of the year, based on the AADT 24 hour traffic flows. The ADMS-Roads model has been set up with the emission rate calculated based on the AADT 24 hour traffic data entered into the model for each road link and a time varying factor file created to represent how the AADT is apportioned over a 24 hour period.

Background Concentrations

5.1.62. The output from the ADMS dispersion model provides the contribution from road traffic emissions to annual mean concentrations at discrete receptor points. These incremental concentrations are combined with estimates of background concentrations, to account for other sources of air pollution, and derive total annual mean concentrations.

5.1.63. Background concentrations were derived from DEFRA's background maps with a 2018 reference year. To avoid double counting, the contribution from modelled emission sources (i.e. the in-square contributions from Motorways, Trunk A roads and Primary A-roads) within DEFRA's background maps were removed from the total background concentrations, using the NO_2 Adjustment for NO_x sector removal tool v8.0, August 2020 for the NO_2 concentrations.

NOx to NO_2 conversion

5.1.64. To derive total NO_2 concentrations from modelled road NO_x concentrations, and allow comparison with the air quality criteria, the method described in DEFRA's Technical Guidance LAQM.TG(16)[15] has been used. Total annual mean NO_2 concentrations have been calculated from modelled road NO_x and background NO_2 concentrations, using the latest version of the 'NO_x to NO_2 calculator v8.1[16] (August 2020).

5.1.65. In addition to the modelled road NO_x and background NO_2 data, DEFRA's NO_x to NO_2 calculator requires a local authority area to be specified to determine regional oxidant concentrations, and a traffic mix to determine the proportion of primary NO_2. The local authority areas selected in the conversion tool were "Cheltenham" and "Tewkesbury"

[16] https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator

based on the location of the relevant receptors; the traffic mix selected was "All other urban UK traffic" for the modelled roads".

Verification

5.1.66. Model verification is the process of determining the local area performance of the base year model in comparison with measured data. The verification step involves comparison of modelled pollutant concentrations at suitable monitoring sites with monitored values that are representative of the base model period (in this case 2019).

5.1.67. Where there is a disparity between modelled and measured concentrations, and where further improvements to input data are not possible an appropriate adjustment factor is determined to correct for systematic bias. This adjustment is applied to the base year and future year model outputs.

5.1.68. Verification has been undertaken in accordance with DEFRA's Technical Guidance LAQM.TG(16)[15]. Details of the adjustment factors and the model adjustment zones are presented in Appendix 5.1.

5.1.69. In the absence of PM_{10} monitoring data for the study area against which modelled concentrations can be verified, the model adjustment factor derived for NO_x was also applied to modelled PM_{10} concentrations. This approach is suggested within LAQM.TG(16)[15], which states that "In the absence of any PM_{10} data for verification, it may be appropriate to apply the road-NO_x adjustment to the modelled road-PM_{10}" and is considered likely to provide a conservative estimate of the contribution of modelled roads to ambient PM_{10} concentrations.

Long Term Trends

5.1.70. An assessment has been undertaken in accordance with DMRB LA 105 (paragraph 2.47 – 2.55) on the assessment of future NO_x and NO_2 projections on Long Term Trends (LTT), to account for future year uncertainties in emissions. Air quality assessments following the latest Defra emission factors have been considered to be overly optimistic in some cases. An additional scenario (projected base year) is required to enable the gap analysis to be completed. The projected base year scenario is modelled using the base year traffic data with the opening year vehicle emission factors and background concentrations. The results for the opening year are then adjusted to represent the observed long-term trend profile.

5.1.71. The Highways England Long Term Trend Euro 6 (LTTE6) projection factors have been applied to modelling results for annual mean total NO_2 at human health receptors and annual mean total NO_x and road NO_2 at ecological receptors.

5.1.72. Analysis of trends in monitored annual mean NO_2 concentrations has been undertaken to confirm the use of the LTTE6 projection factors is robust. Further details are provided in paragraph 5.1.106.

Designated Habitats Assessment

5.1.73. Assessment of potential effects of changes in nitrogen deposition rates has been undertaken at identified sensitive designated habitats, in accordance with DMRB LA 105 (paragraph 2.43 – 2.46). The background nitrogen deposition rates at each designated site have been obtained from the APIS website. Relevant habitat types and critical loads have been obtained from APIS where available or in consultation with a competent expert for biodiversity. These are shown in Appendix 5.1 - Table 9. Further details on the assessment methodology for designated habitats are provided in Appendix 5.1.

Comparison with Short-Term Objectives

Nitrogen Dioxide

5.1.74. Since only annual mean concentrations have been calculated using the air dispersion model, commentary on potential exceedances of the hourly mean NO_2 standard has been

made with reference to DEFRA's Technical Guidance LAQM.TG(16)[15]. The guidance suggests that if annual mean concentrations of NO_2 do not exceed 60 µg/m³ then it is unlikely that hourly mean concentrations would exceed the relevant objective, which allows for 18 exceedances of the hourly standard in a calendar year.

Particulate Matter

5.1.75. Annual mean PM_{10} concentrations are used to derive the number of exceedances of the 24-hour mean PM_{10} criterion, of which 35 are allowed in a calendar year. The method described in LAQM.TG(16)[15] was applied. This method is based on the relationship between the number of 24-hour exceedances of 50 µg/m³ and the annual mean concentration derived from UK Automatic Network Sites. This is described in Equation 1.

Equation 1 – Calculation of PM_{10} 24-Hour Mean Exceedances

Number of exceedances of 24-hour mean of 50 µg/m³ = -18.5 + 0.00145 * a^3 + (206/a)

Where 'a' = total annual mean PM10 concentration

Compliance Risk

5.1.76. A PCM Compliance Risk Assessment was undertaken in accordance with guidance detailed in DMRB LA 105. The assessment examined the latest reported information from Defra's Pollution Climate Mapping (PCM) model at links identified within the ARN.

Significance Criteria

Magnitude of Impacts

5.1.77. Descriptors for magnitude of change in ambient concentrations of NO_2 and PM_{10} are provided in DMRB LA 105 (Table 2.91). Only those receptors predicted to exceed relevant air quality thresholds have been considered when determining significance for human health.

5.1.78. The changes in magnitude descriptors depend on the change in concentration relative to the air quality thresholds shown in Table 5-2. Where the change in concentrations is 1% or less of the objective (≤0.4 µg/m³) this is considered an imperceptible change.

Table 5-2 - Magnitude of Change Criteria for Local Air Quality Human Health receptors

Magnitude of change in concentration	Value of change in annual mean NO_2 and PM10
Large (>4 µg/m³)	Greater than 10% of the air quality objective (4 µg/m³)
Medium (>2 µg/m³)	Greater than 5% of the air quality objective (2 µg/m³)
Small (>0.4 µg/m³)	Greater than 1% of the objective (0.4 µg/m³)
Imperceptible (≤0.4 µg/m³)	Less than or equal to 1% of objective (0.4 µg/m³)

Table source: DMRB LA 105 (Table 2.91)

Significance of effect

Local Air Quality

5.1.79. Evaluation of the significance of the effect of the Scheme on human health has been undertaken in accordance with DMRB LA 105 (paragraph 2.89 to 2.96). The number of receptors that exceed relevant air quality thresholds and fall within the 'small', 'medium' and 'large' magnitude of change categories has been calculated and compared to the guidelines presented in Table 5-3.

5.1.80. Significant air quality effects are only identified for receptors where AQS objectives are exceeded with or without the proposed Scheme. Where the changes in concentrations are less than 1% of the AQS objective (i.e. less than 0.4 µg/m^3) then the change at these receptors is considered to be 'imperceptible' and can be scoped out of the judgement on significance.

Table 5-3 - Number of Receptors Constituting a Significant Effect for Air Quality

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large (>4 µg/m^3)	1 to 10	1 to 10
Medium (>2 to 4 µg/m^3)	10 to 30	10 to 30
Small (>0.4 to 2 µg/m^3)	30 to 60	30 to 60

Table Source: DMRB LA 105 (Table 2.92)

5.1.81. Evaluation of the significance of the effect of the Scheme on designated habitats has been undertaken in accordance with DMRB LA 105 (paragraph 2.97 to 2.102, and Figure 2.98). Where the nitrogen deposition lower critical load for the relevant habitat is both exceeded and the change in nitrogen deposition is expected to be greater than 1% of the lower critical load, then the magnitude of change of the nitrogen deposition was considered further. Where the change in nitrogen deposition was greater than 1% of the lower critical load then the significance of air quality impacts on designated habitats has been assessed by a competent expert for biodiversity.

5.1.82. The overall evaluation of the significance of the effect has been undertaken in accordance with DMRB LA 105 (paragraph 2.103 to 2.106) based on a combination of the effects of the Scheme on human health and designated habitats. and the outcome of the compliance risk assessment.

Assessment Assumptions and Limitations

5.1.83. Any air quality model has inherent areas of uncertainty, including:

- The traffic data used in the air quality model
- The suitability of emissions data
- Simplifications in model algorithms and empirical relationships that are used to simulate complex physical and chemical processes in the atmosphere
- The suitability of background concentrations
- The suitability of meteorological data.

5.1.84. Uncertainty associated with traffic data has been minimised by using a validated traffic model with data only used from within the defined traffic reliability area (TRA) (all links which meet the DMRB LA 105 traffic change screening criteria are located within the TRA).

5.1.85. Uncertainty around the age of the validated traffic model (its base year) was addressed by using a forecast base year of 2018 from the traffic model, to be in accord with air quality guidance on acceptable base years at the time of the assessment.

5.1.86. Uncertainties associated with emissions data have been minimised by using the most up to date speed-band emission factors available at the time the air quality modelling was undertaken, and by using Highways England LTTE6 projection factors as referenced in DMRB LA 105 (paragraph 2.47 – 2.55).

5.1.87. Uncertainties associated with model algorithms and empirical relationships have been minimised by using algorithms and relationships that have been independently validated and judged as fit for purpose.

5.1.88. Another uncertainty is with using historical meteorological data to estimate future concentrations. The key limiting assumption is that conditions in the future will be the same as in the past; however, in reality no two years are the same. In line with best practice, the base year meteorology (as used in the model verification and adjustment process) has been used in future year modelling to allow any adjustments to be applied in future cases.

5.1.89. Any air quality model has inherent areas of uncertainty, including those detailed above; the estimates of background concentrations, and meteorological data and simplifications in model algorithms and empirical relationships used to simulate complex physical and chemical processes in the atmosphere. Uncertainty associated with these parameters has been minimised by using validated models and data and following best practice. The air quality model used in the assessment does not include terrain, however specific conditions (such as valleys) have been addressed through localised model validation zones where relevant.

5.1.90. Given the above, the approach taken to this assessment is considered to be robust and is in line with good practice.

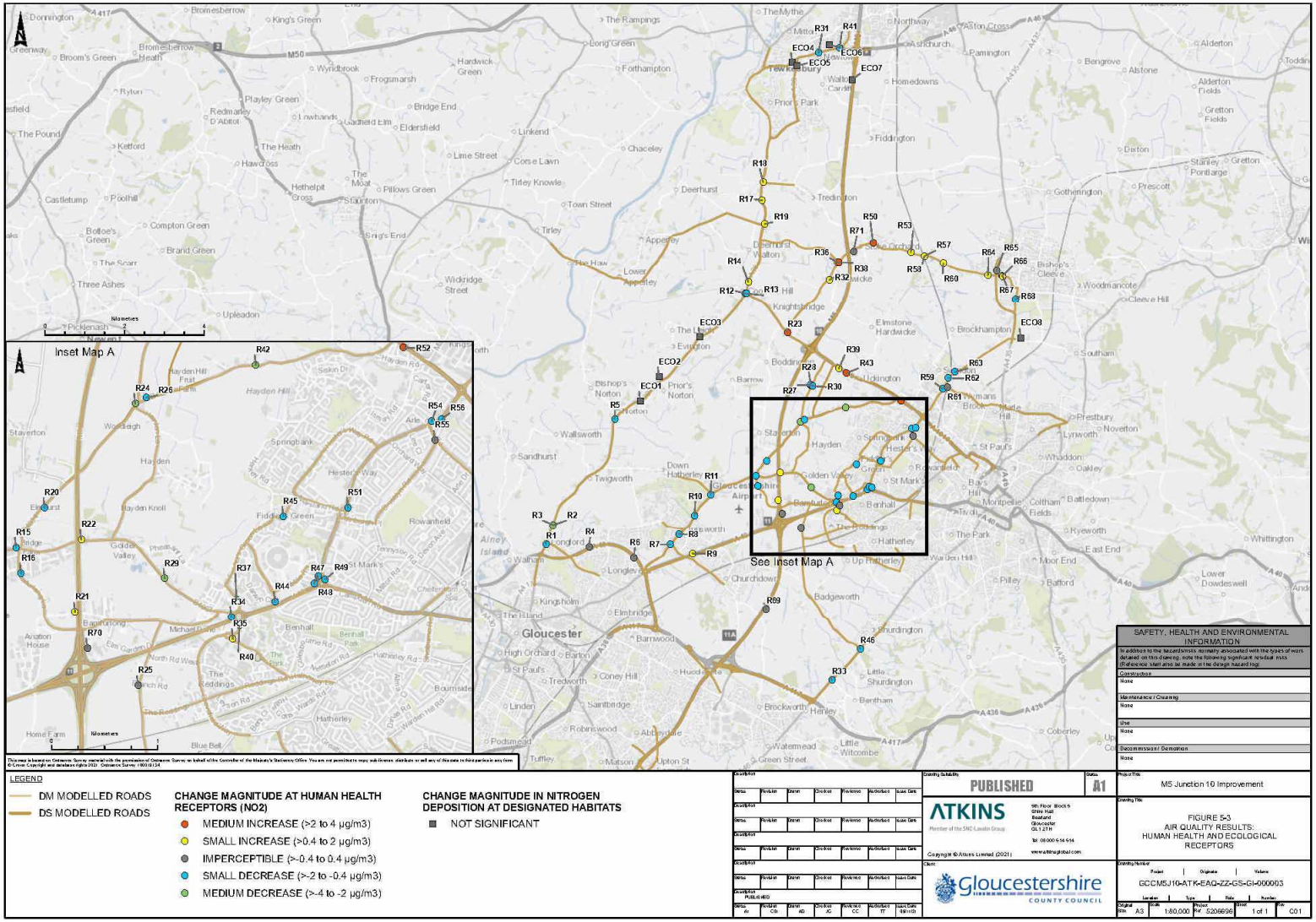


Figure 5-3 - Air Quality Modelling Results for Human Health Receptors and Designated Habitats

5.5. Consultation

5.1.91. Consultation on the proposed methodology has been undertaken with CBC and TBC Environmental Health teams. This included a description of the proposed methodology, in line with that presented in the Scoping Report, and the intended information sources and scenarios to be used and considered.

5.1.92. Responses were provided by CBC and TBC which included provision of baseline air quality monitoring data and local knowledge to ensure that the assessment included specific receptors of concern.

5.1.93. Consultation with National Highways has also been undertaken, which required the assessment methodology to follow the DMRB LA105, as the Scheme falls within the Strategic Road Network (SRN). This has been complied with.

5.6. Baseline conditions

5.1.94. The Scheme extent is located within the administrative areas of CBC and TBC, with a small section of the air quality study area being located within GCC. As such this baseline conditions section focusses on information within the CBC and TBC administrative areas. Baseline information is shown in Figure 5-1.

5.1.95. The CBC AQMA 2020 declared in September 2020 due to exceedances of the NO_2 annual mean AQS objective, is 1.5km from the Scheme. The AQMA includes the High Street from the junction of Gloucester Road and Tewkesbury Road to the junction of Burton Street; Poole Way; and Swindon Road from junction of Poole Way to St Georges Street. This designation replaces the previous CBC borough-wide AQMA which was declared in 2011.

5.1.96. TBC declared one AQMA in 2008 encompassing individual roads within Tewkesbury town centre. This AQMA is located approximately 5 km north west of the Scheme and within 200 m of the ARN .

5.1.97. A summary of the AQMAs is presented in Table 5-4.

Table 5-4 - AQMAs declared by CBC and TBC in proximity to the Scheme

Name	AQ Criteria Exceeded	Description
Cheltenham Borough Council AQMA 2020	Annual mean nitrogen dioxide NO_2	High Street from the junction of Gloucester Road and Tewkesbury Road to the junction of Burton Street; Poole Way; and Swindon Road from the junction of Poole Way to St Georges Street.
Tewkesbury Town Centre AQMA	Annual mean nitrogen dioxide NO_2	An area encompassing parts of Tewkesbury town centre, including parts of High Street, Barton Street Church Street and the Eastern Relief Road.

SOURCE: https://uk-air.defra.gov.uk/aqma/

Continuous Monitoring

5.1.98. Air quality monitoring is undertaken at a national and local authority level and is a key component of local air quality management. Measurements of pollutant concentrations include analytical instruments that measure continuously, and simpler sampling devices such as diffusion tubes which give longer period results (typically monthly, to calculate an annual mean concentration).

5.1.99. The nearest Continuous Monitoring Station (CMS) to the Scheme is located at St Georges Street, in Cheltenham town centre approximately 5 km southwest of the location of the current M5 Junction 10. The CMS monitors concentrations of NO_2, as shown in Table 5-5.

Table 5-5 - Annual mean NO_2 concentrations - CMS monitoring results (µg/m^3)

Site ID	Site Name	Site Type	X	Y	2015	2016	2017	2018	2019
CM1	St Georges Street	Kerbside	394760	222878	35.0	34.0	36.0	32.7	36.0

5.1.100. The monitored values show that NO_2 concentrations as an annual mean approached but did not exceed the AQS objective of 40 µg/m^3. There were no reported exceedances of the short-term hourly objective of 200 µg/m^3 between 2015 and 2019.

Passive Monitoring

5.1.101. Annual mean NO_2 concentrations are also measured by both CBC and TBC using passive diffusion tubes. There are several diffusion tubes located in the proximity of the Scheme. Concentrations of NO_2 measured at the closest diffusion tube locations to the Scheme are presented below in Table 5-6.

5.1.102. The diffusion tube results show that NO_2 concentrations at roadside locations approach and in some cases exceed the annual mean AQS objective of 40 µg/m^3. The data shows a general improvement in conditions with a reduction in the number of locations exceeding the 40 µg/m^3 annual mean objective between 2015 (where six out of 18 sites exceeded) and 2019 (where three out of 31 sites exceeded).

5.1.103. It is notable that the locations with NO_2 concentrations exceeding the 40 µg/m^3 annual mean NO_2 objective in 2017, 2018 and 2019 (Site ID 4, 5 and 6) were along the northern access routes to northern areas of Cheltenham town centre, A4019 High Street and Swindon Road and are in the vicinity of the revised AQMA area. These areas, which have relevant areas of public exposure at roadside locations, are likely to be the most sensitive to air quality impacts of the Scheme.

Table 5-6 - NO_2 Diffusion Tube monitoring results (µg/m^3)

Site	Site Name	Type	X	Y	2015	2016	2017	2018	2019
14N	69 Sussex Gardens	Urban	387915	217389	25.4	26.8	24.7	27.0	23.6
15N	Comus Bamfurlong	Urban	389714	221845	28.5	25.6	26.2	27.9	25.7
16N	15 Withybridge Gardens	Urban	390461	225544	26.5	29.0	25.7	25.1	22.0
52N	43 Stocken Close	Roadside	387570	216935	25.1	26.2	25.6	24.2	21.2
55N	Stokes Road, Bishops Cleve	Roadside	395123	227638	No Data	No Data	No Data	19.0	18.8
1	Municipal Offices (Front)	Roadside	394757	222320	No Data	No Data	26.4	22.9	23.8
2	Municipal Offices (Back)	Roadside	394724	222320	No Data	No Data	32.9	28.0	27.6
3	Ladies College	Roadside	394621	222215	36.6	33.8	32.8	27.5	29.6
4	2 Gloucester Road	Roadside	394235	223055	**46.5**	**43.2**	**45.4**	**41.2**	**43.1**

Site	Site Name	Type	X	Y	2015	2016	2017	2018	2019
5	422 High St	Roadside	394350	222923	**47.3**	**45.5**	**49.9**	**45.2**	**46.5**
6	New Rutland	Roadside	394738	222888	**42.4**	**40.8**	**41.6**	37.9	**40.3**
7, 8 & 9	Triple Co-location – 1	Roadside	394760	222878	34.6	33.3	36.4	32.9	35.1
10	2 Swindon Road	Kerbside	394830	222845	37.9	38.2	39.4	35.6	39.2
11	Portland Street	Roadside	395110	222670	36.8	35.7	35.9	32.6	34.1
12	Winchcombe/Fairview	Roadside	395210	222618	33.0	32.2	32.8	31.8	34.4
13	Albion Street (outside no. 54)	Kerbside	395207	222465	No Data	No Data	34.8	31.3	30.4
14	2 London Road	Roadside	395362	222000	**40.0**	38.0	37.1	37.4	37.4
15	YMCA - High St	Roadside	395182	222183	34.5	32.9	31.9	29.1	28.5
16	8a Bath Road	Roadside	395146	222149	**41.1**	38.4	38.0	34.5	34.4
18	81 London Road	Roadside	395660	221670	**41.4**	39.6	38.4	37.3	37.6
19	264 Gloucester Road	Roadside	393296	222170	36.7	32.2	34.4	30.6	33.4
20	340 Gloucester Road	Roadside	392912	221862	38.7	35.9	38.6	35.3	36.2
21	14 Imperial Square	Roadside	394807	222058	No Data	No Data	No Data	23.4	23.9
22	Hatherley Lane	Roadside	391177	221638	No Data	No Data	35.1	34.9	33.4
23	St James Square	Roadside	394576	222425	No Data	No Data	29.6	30.9	32.6
24	St Gregorys Church	Roadside	394566	222602	No Data	No Data	26.7	27.9	25.1
25	St Georges Street	Roadside	394704	222755	No Data	No Data	30.5	31.9	31.6
26	St Pauls Road	Roadside	394894	223011	No Data	No Data	27.7	29.0	31.3
27	St Lukes College Road	Roadside	395157	221865	No Data	No Data	23.7	24.8	27.6
28	Princess Elizabeth Way North	Roadside	393077	223644	No Data	No Data	36.7	38.4	38.2
29	Princess Elizabeth Way South	Roadside	392055	222527	No Data	No Data	29.8	31.2	33.7

Bold values exceed Annual NO_2 mean concentration of 40 µg/m^3

Scheme Specific Air Quality Monitoring

5.1.104. A site-specific six-month monitoring survey, conducted between July and December 2019, was conducted to provide baseline pollutant information and Scheme specific monitoring for model verification purposes. The survey comprised ten locations, sampled using passive NO_2 diffusion tubes in triplicate. The locations were selected to provide positions to allow model verification on road links outside the Cheltenham town central urban area and near to the Scheme. With permission of CBC, one of the locations is co-located with the St Georges Street CMS (CMS1), to allow bias adjustment to be conducted using local data.

5.1.105. Annualised and bias-adjusted concentrations over the six months are provided in Table 5-7. A map of the selected locations is presented in Figure 5-1. Roadside locations on principal roads within the AQMA show concentrations approaching 40 µg/m^3 (D1 and D2) however these locations are not positions of relevant public exposure. All other locations, those outside and those on minor road links within the AQMA, recorded concentrations below 35 µg/m^3.

Table 5-7 - Project Specific NO_2 Diffusion Tube Monitoring Survey – 2019 (µg/m^3)

Location	Description	Grid reference (m)	Annualisation factor	Adjusted annual mean concentration
D1	St George's Street - CMS Co-location	394766, 222871	1.03	35.3
D2	A40 - GCHQ	391718, 222000	0.95	34.7
D3	A4019 - West of M5 J10	389856, 226028	1.03	19.7
D4	Withybridge Gardens	390688, 225434	1.03	22.6
D5	A4019 - Near Homecroft Drive	392184, 224667	1.03	29.9
D6	B4634 - Near to Hayden Lane	390136, 223670	1.03	32.8
D7	B4634 - Near to Pilgrove Way	391789, 224221	1.03	21.3
D8	Withybridge Lane - Withybridge Farm	390460, 224669	1.03	22.5
D9	Lowdilow Lane	391521, 226422	1.03	17.0
D10	Princess Elizabeth Way	392365, 223221	1.03	27.4

Local bias adjustment factor 1.009, based on comparison between CBC CMS1 and site D1

Trend Analysis for Annual Mean NO_2 Monitoring Data

5.1.106. Analysis of trends in annual mean NO_2 has been undertaken using the Finnish Meteorological Institute MAKESENS (v1) spreadsheet using the annual mean time series data for CMS sites operated by TBC and CDC. The analysis identifies if there is a statistically significant trend in monitored annual mean NO_2, informing the selection of suitable long-term trend factors.

5.1.107. The statistical analysis undertaken includes a Sen's slope[17] estimate of the linear trend, residual concentrations[18] , which indicate the variation year on year, and the Mann-Kendall test statistic (S) to indicate the significance of any trend. In order to conduct a Mann-Kendall test, four or more series of data must be available for that site. The Mann-Kendall test statistic is expressed as a whole number. For the null hypothesis of a random

[17] The "Sen Slope" refers to the equation of the linear trend line and gives the rate of change per year.
[18] The difference in the actual monitored concentration compared to the concentration indicated by the trend line

distribution of the data to be rejected, the value of S[19] has to be equal to or greater than an absolute value determined from the number of data points (equivalent to a probability of less than 0.1 or 10%).

5.1.108. Measured concentrations at the four suitable diffusion tube sites operated by CDC and one diffusion tube site operated by TBC are shown in Table 5-8. The statistical analysis indicates that all the sites for which the requisite series of data are available show statistically significant downward trends in annual mean NO_2 concentration.

Table 5-8 - Summary of Annual Mean NO_2 Trend Analysis

Site ID	Local Authority	Site Type	Number of Data Points	Required S Value	S Value	Sen's Slope	Significant	Approximate location of the ARN
3	Cheltenham Borough Council	Roadside	5	4	-8	-1.825	Yes	2.2 km east
15	Cheltenham Borough Council	Roadside	5	5	-10	-1.55	Yes	2.6 km south-east
16	Cheltenham Borough Council	Roadside	5	5	-10	-1.738	Yes	3.1 km north-east
18	Cheltenham Borough Council	Roadside	5	4	-8	-1.125	Yes	3.3 km east
16N	Tewkesbury Borough Council	Urban	5	4	-8	-1.488	Yes	within 200 m of ARN

5.1.109. The MAKESENS analysis shows that the annual mean NO_2 concentrations at the CMS sites are decreasing with a statistically significant trend and the use of the DMRB LA 105 LTTE6 projections would provide a conservative assessment. The DMRB LA 105 LTTE6 gap factors have therefore been selected for use in the air quality assessment to ensure that the assessment is not overly optimistic.

Background Mapping

5.1.110. Estimates of background pollutant concentrations in the UK are available on the DEFRA UK-Air website[1]. The background estimates, which are a combination of measured and modelled data, are available for each 1 km grid square throughout the UK for the years 2019 to 2030. The estimated annual average background concentrations in the area covering the Scheme and a 20 x 20 km grid centred upon Cheltenham Town Centre for the baseline year (2019) and the Scheme opening year (2025) have been reviewed with the maximum and minimum values presented in Table 5-9 for the pollutants NO_2, PM_{10} and $PM_{2.5}$.

5.1.111. Mapped background annual mean concentrations of NO_2 and PM_{10} for the grid squares within the air quality study area for both the air quality model base year of 2019 and the Scheme opening year 2025 were below relevant air quality thresholds (6.8 µg/m^3 to 19.6 µg/m^3 and 12.2 µg/m^3 to 16.2 µg/m^3 in the base year and 5.5 µg/m^3 to 14.8 µg/m^3 and 11.4 µg/m^3 to 15.3 µg/m^3 in the opening year for NO_2 and PM_{10} respectively).

[19] Nielsen, D. M. (Ed.). (2005). Practical handbook of environmental site characterization and ground-water monitoring. CRC press

Table 5-9 - DEFRA mapped background concentrations, 2019 and 2025 (µg/m^3)

Grid Square (x,y)	2019 Background Concentration (µg/m^3)			2025 Background Concentration (µg/m^3)		
	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$
Minimum	6.8	12.2	7.9	5.5	11.4	7.2
Maximum	19.6	16.2	10.1	14.8	15.3	9.3

Compliance with Limit Values

5.1.112. DEFRA's PCM model provides estimates of roadside concentrations of annual mean NO_2 and PM_{10}, which have historically been used in reporting to the EU regarding compliance with the limit values. The air quality study area includes a road – the A40 - identified by DEFRA as exceeding the air quality limit value for annual mean NO_2 concentrations. The latest update of the PCM modelling indicates that the air quality limit value for annual mean NO_2 was exceeded at roadside locations in 2018 on part of the A40. This part of the A40 is PCM census ID 802077985 running from Arle Court Roundabout to the A4013 at Princess Elizabeth Way Roundabout on the western side of Cheltenham. However, the PCM model estimates that there will be compliance by 2019. With regard to PM_{10}, there were no modelled roadside PM_{10} annual mean concentrations exceeding the limit value.

5.1.113. The estimated roadside NO_2 concentrations for the A40 link, PCM census ID 802077985, are as follows:

- 2018 - 40.6 µg/m^3
- 2019 - 38.7 µg/m^3
- 2020 - 36.8 µg/m^3
- 2021 - 34.6 µg/m^3

5.1.114. The estimated roadside PM_{10} concentrations for the A40 link, PCM census ID 802077985, are as follows:

- 2018 – 19.7 µg/m^3
- 2020 – 19.1 µg/m^3
- 2025 – 18.4 µg/m^3
- 2030 – 18.5 µg/m^3

5.7. Assessed Impacts

5.1.115. The Scheme has the potential to affect local air quality, both during construction and once operational.

Construction Phase

Dust Emissions

5.1.116. There is the potential for elevated dust deposition and soiling at properties within 200 m of the construction site boundary as a consequence of the works, if dust raising activities are not effectively controlled and mitigated. The level and distribution of dust emissions would vary according to the duration and location of activity, weather conditions, and the effectiveness of suppression measures. The Scheme has the potential for construction dust to affect approximately 432 human health receptors. There are no designated habitats identified within 200 m of the construction site boundary.

5.1.117. Receptors within 200 m of the construction site boundary for the Scheme within the respective distance bands are shown in Figure 5-2. Table 5-10 summarises the number of properties likely to be affected by construction dust.

Table 5-10 - Approximate Number of Sensitive Receptors Likely to be Affected by Construction Dust

Total number of receptors	Receptor counts in distance bands		
	0-50m	50-100m	100-200m
432	200	134	98

5.1.118. The prevailing winds recorded at Gloucestershire meteorological station are from the south west as shown in the wind rose in A5-1 Figure 1, suggesting the wind is more likely to transport dust raised on site to the north east of the construction works.

5.1.119. The Scheme comprises major motorway junction improvements and is therefore considered to have a “large” dust risk potential. Given that there are sensitive receptors within 50 m of construction activities, the receiving environment is considered to be “high sensitivity”. The overall construction dust risk potential for the Scheme is therefore classed as “high” (DMRB LA 105 Table 2.58a and Table 2.58b).

5.1.120. Appropriate dust control measures can be highly effective for controlling emissions and adverse effects can be greatly reduced or eliminated. There are residential properties with the potential to be affected within 200 m of the construction site boundary, however fugitive dust effects at these properties would be temporary and would be mitigated using measures secured in a Construction Environment Management Plan. A summary of construction dust related mitigation measures is provided in the mitigation section below.

Construction Traffic

5.1.121. An increase in vehicle movements is expected to occur during the construction period, associated with the transport of materials, plan and labour to and from site. At this stage, the numbers of expected vehicle movements are not yet known, however, the construction works are expected to last 18 months i.e. less than two years, therefore, a detailed assessment of the construction traffic has not been undertaken in line with the DMRB LA105 guidance.

Operational Phase

Human Health Impacts

5.1.122. Estimated NO_2 concentrations at 71 selected human health receptors for the opening year are presented in Appendix 5.1 - Table 10. The spatial distribution of the results is illustrated within Figure 5-3.

5.1.123. There is only one receptor, R34, estimated to exceed the annual mean NO_2 AQS objective of 40 µg/m^3 in the opening year of 2025, without the Scheme in place, located in proximity to the Arle Court roundabout on the A40 to the east of M5 J11. The modelled annual mean NO_2 concentration at this receptor in 2025 is 40.3 µg/m^3 without the Scheme, and the modelled change is -2 µg/m^3, a ‘small’ decrease, is due to the decrease in traffic (-5,798 AADT) on the A40 to the east of the M5 junction11 as a direct result of the Scheme. R34 is the only modelled receptor informing the significance of the Scheme and although it does not appear to be residential as it is located within an industrial/ commercial area, the address data identifies the property as both commercial and residential.

5.1.124. Five receptors, R23, R38, R43, R50 and R52 are expected to experience an increase with the Scheme in place, as a result of increases in traffic along the A4019 Tewkesbury Road (where R52, R43 and R23 are located, within 10 m of the Scheme redline boundary) and along Stoke Road to the east and west of the M5 where R50 and R38 are located respectively. Changes in annual mean NO_2 concentrations at these receptors range between 2.1 µg/m^3 and 3.2 µg/m^3 , the latter modelled at receptor R43 expected to have the highest change due to the operational phase of the Scheme. However, none of these receptors exceed the AQS objective in any scenario.

5.1.125. There are 18 further receptors expected to experience an increase in annual mean NO_2 concentrations, ranging between 0.5 and 1.8 µg/m^3, as a result of the traffic redistribution with the proposed Scheme in place, located along Stoke Road to the east and west of the M5, along the A4019 Tewkesbury Road to the east of M5 J10 and along the A38 to the west of the M5 North of Coombe Hill, along the A40 east and west of J11 and isolated properties near to the M5 between J10 and J11. None of these receptors exceed the AQS objectives in any scenario.

5.1.126. Four receptors (R3, R24, R29 and R42, located along the B4634 Old Gloucester Road and the B4063 to the east of the M5, and along the A38 Tewkesbury Road to the West of the M5) are expected to experience a decrease of between 2 and 4 µg/m^3 and 34 receptors are expected to experience a decrease of between 0.4 and 2 µg/m^3 with the Scheme as a result of a decrease in traffic flows within the study area. No exceedance of the air quality thresholds is expected to occur at these receptors in any scenario.

5.1.127. The remaining 10 receptors are estimated to experience a change of less than +/- 0.4 µg/m^3 in annual mean NO_2 concentrations with the Scheme, with modelled annual mean NO_2 concentrations being well below[20] the AQS objective at all receptors except R40, located along Hatherley Lane to the east of M5 J11, which measures an annual mean concentration of 33.8 µg/m^3.

5.1.128. In line with Defra's LAQM.TG16 there are not expected to be any exceedances of the NO_2 1-hour mean AQS objective as there are no receptors with an annual mean concentration above 60 µg/m^3.

5.1.129. The human health receptors informing the significance of effect on air quality are presented in Table 5-11.

5.1.130. DMRB LA 105 Table 2.92N, replicated in Table 5-3, provides guideline bands on the number of properties experiencing worsening and improvement when considering evaluation of significance. For both worsening and improvement of air quality with a 'large' change, the guideline band is 1 to 10 receptors, with a 'medium' change the guideline band is 10 to 30 receptors and with a 'small' change the guideline band is 30 to 60 receptors. There is only one modelled receptor exceeding the AQS objective for annual mean NO_2 with a 'small' change (a 'small' decrease), considered to be representative of fewer than 30 sensitive receptors, meaning that there is not a significant effect on human health due to the Scheme.

Table 5-11 - Significance for Human Health

Magnitude of Change in Annual Average NO_2 (µg/m^3)	Total Receptors with:	
	Worsening of air quality objective already above objective or creation of new exceedance	Improvement of air quality objective already above objective or the removal of an existing exceedance
Large (>4)	0 (0 in total)	0 (0 in total)
Medium (>2)	0 (0 in total)	0 (0 in total)
Small (>0.4)	0 (0 in total)	1 (1 in total)

5.1.131. Modelled annual mean PM_{10} and daily exceedances for all receptors are provided in Appendix 5.1 Table 11. There are no exceedances of the PM_{10} AQS objectives in the base year (2019), therefore, assessment of PM_{10} concentrations in the Scheme opening year (2025) has not been undertaken (as per the DMRB LA 105 (para 2.21.2)).

[20] well below < 75% of the air quality objective

Compliance Risk Assessment

5.1.132. The modelling results for the Scheme do not indicate any areas of exceedance of the air quality annual mean NO_2 limit value across the study area where increases in modelled concentrations are occurring. At this stage, a proportionate approach has been undertaken, which indicates that there is no risk to the reported date of compliance is identified. A full Compliance Risk Assessment will be undertaken for the ES report.

Designated Habitats

5.1.133. Total nitrogen deposition rates have been modelled for ecological receptors within relevant designated habitats. These comprise one veteran tree and seven local wildlife sites. The changes in nitrogen deposition rates for these habitats are provided in Appendix 5.1 - Table 12.

5.1.134. DMRB LA 105 (para 2.97 to 2.102, and Figure 2.98) provides designated habitat screening criteria for determining the need for further consideration of the impacts of nitrogen deposition. The designated habitat screening criteria are considered to be exceeded where total nitrogen deposition rates are greater than the lower level of the relevant lower critical load, and the change in nitrogen deposition rates is greater than 1% of the relevant lower critical load. Where these criteria are exceeded, further consideration was given to the magnitude of the change in nitrogen deposition rates. Where this was greater than 0.4 kg N/ha/yr, then the significance of effect was assessed by a competent expert for biodiversity. Further details on the assessment methodology for designated habitats are provided in Appendix 5.1.

5.1.135. Given the limited information available on features within the designated habitats in the air quality study area, detailed habitat identification was not undertaken prior to screening. Nitrogen deposition rates were therefore assigned on the basis of the habitat type identified from satellite photography, accessed using google earth, of the receptor location. Each receptor representing non-statutory designated habitats was attributed as either “woodland” or “grassland” habitat types (for which there are different NO_2 to nitrogen deposition conversion factors).

5.1.136. The total nitrogen deposition rate with the Scheme is above the lower critical load at all receptors, however, the change in nitrogen deposition rates is less than 1% at all receptor points included in the assessment, and they are all expected to experience a decrease in nitrogen deposition rates with the Scheme in place. The overall significance of effect of the Scheme for ecological receptors is therefore not significant.

5.8. Potential mitigation measures

Construction

Dust Emissions

5.1.137. Construction activities for the Scheme represent a ‘high’ construction dust risk potential. Mitigation measures to control dust during construction will be specified within contract documentation and will be incorporated into the Construction Environmental Management Plan CEMP. The precise measures, suitable for a ‘high’ construction dust risk will depend on the intended construction methods and the degree of dust generation at each site.

5.1.138. Such measures may include but not necessarily be limited to:

- Regular water-spraying and sweeping of unpaved and paved roads to minimise dust and remove mud and debris
- Using wheel washes, shaker bars or rotating bristles for vehicles leaving the site where appropriate to minimise the amount of mud and debris deposited on the roads
- Sheeting vehicles carrying dusty materials to prevent materials being blown from the vehicles whilst travelling

- Enforcing speed limits for vehicles on unmade surfaces to minimise dust entrainment and dispersion
- Ensuring any temporary site roads are no wider than necessary to minimise their surface area
- Damping down of surfaces prior to their being worked, and
- Storing dusty materials away from site boundaries and in appropriate containment (e.g. sheeting, sacks, barrels etc.)

5.1.139. Other best practice incorporated into the CEMP includes:

- Ensuring plant and equipment is maintained in good working order
- Ensuring construction plant is not left running when not in use
- Locating plant away from sensitive receptors (including residential and ecological)
- Securing an adequate water supply on site for the effective suppression of dust

Construction Traffic

5.1.140. No specific mitigation is currently proposed for air quality given that there is unlikely to be a significant adverse effect. The contractor will provide a construction traffic management plan in line with best practice guidance.

Operation

5.1.141. No specific mitigation is required during the operational phase in relation to air quality given that there is not expected to be an overall significant adverse effect.

Designated Habitats Assessment

5.1.142. No specific mitigation is currently proposed for air quality given that there is not expected to be a significant adverse effect.

5.9. Residual impacts

Construction

5.1.143. Residual effects are not expected with adoption of mitigation measures which would be secured within a CEMP.

Operation

5.1.144. The air quality impacts identified in this report are not significant and no mitigation measures have been recommended. This outcome will be evaluated in the EIA assessment and consideration will be given to mitigation measures if appropriate.

5.10. Cumulative effects

5.1.145. Cumulative effects of other known developments occurring within the same timescales as the Scheme, known as Reasonably Foreseeable Future Projects (RFFP's are embedded within the traffic modelling scenarios, as described in the Transport chapter. The air quality assessment of cumulative effects is conducted within the limitations of the traffic data available and forecasting of traffic growth rates.

5.11. NPS compliance

5.1.146. Overall the scheme is consistent with the requirements set out in paragraphs 5.12 and 5.13 of the NPS NN[21] as it would not trigger a significant adverse air quality effect, nor would it affect the UK's reported ability to meet the annual mean NO_2 limit value in the shortest timescale possible. There is not expected to be a compliance risk with regard to the UK's ability to comply with the AQ Directive.

5.12. Assumptions and limitations

5.1.147. Background concentrations and future projections are based on the most recently updated national model outputs prepared by Defra.

5.1.148. Current air quality guidance and tools have been used in the preparation of this air quality assessment.

5.1.149. Assumptions relating to detailed dispersion modelling are discussed in the Air Quality Assessment Methodology, detailed in Appendix 5.1.

5.13. Chapter summary

Baseline

5.1.150. Cheltenham has an AQMA within 1 km of the scheme and the Tewkesbury AQMA is within 200 m of the air quality ARN. Baseline air quality monitoring data indicates that there are no exceedances of the annual mean AQS objective for NO_2 within the study area in 2019 (most recent year representing normal pre-covid traffic conditions). There are no estimated exceedances of the annual mean NO_2 air quality limit value in the Defra PCM model links within the ARN in 2019, although the A40 between Arle Court and Princess Elizabeth Way exceeded the limit value in 2018.

Construction

5.1.151. Any air quality effects due to construction would be temporary and could be suitably minimised by the application of standard and appropriate mitigation measures. The Construction Dust Assessment identifies the site as high risk and suitable mitigation measures are detailed in the potential mitigation measures. With adoption of suitable and proportionate mitigation, there is unlikely to be a significant effect on air quality due to the construction of the Scheme.

Operation

5.1.152. Air quality modelling has indicated that the Scheme is unlikely to have significant adverse effects on human health and designated habitats.

[21] DfT (2014) National Policy Statement for National Networks. [Online] Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387223/npsnn-web.pdf [Accessed September 2021]

The discipline specific chapters of this PEIR have been produced as separate documents.

5. Noise and Vibration

6. Biodiversity

7. Road Drainage and the Water Environment

8. Landscape and Visual

9. Geology and Soils

10. Cultural Heritage

11. Materials and Waste

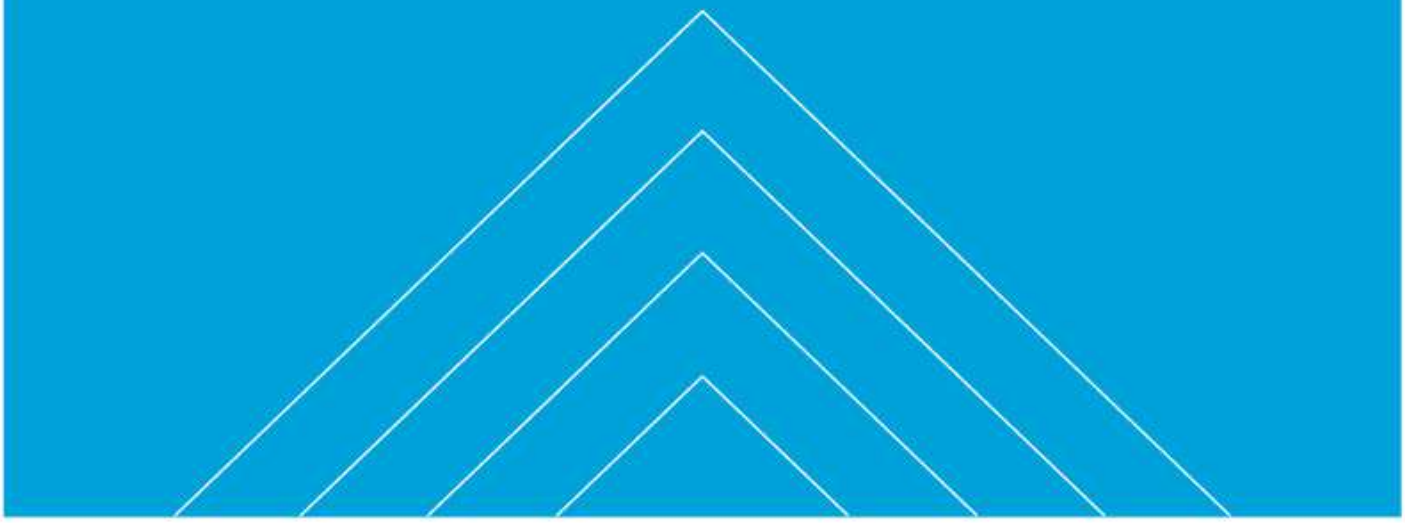
12. Population and Human Health

13. Climate

14. Cumulative Effects Assessment

Appendices to the Air Quality chapter

- Appendix 5.1



Appendix 5.1

A.1. Air Quality Assessment Methodology

Emission Modelling

5.1.153. The emission rates used in the local air quality modelling were derived in accordance with DMRB LA 105 (paragraph 2.29 – 2.38 and Appendix A) on speed banding (based on EFT v10.1). The emission rates for each road links were calculated using the Annual Average Daily Traffic (AADT) flows (in terms of LDV and HDV) obtained from the traffic model and a speed band assigned to each road link. The AADT emissions were used in combination with a time varying 24 hour diurnal traffic profile.

5.1.154. Hourly emissions were calculated for LDV and HDV separately for each road link using the AADT flow, speed and road type and the emission factors from DMRB LA105 for the relevant speed band. Calculated LDV and HDV emissions were then added together to give the total 24hr emission rate for each road link.

5.1.155. The calculated emission factor for each road link were combined with the weekday and weekend 24-hour varying diurnal traffic profile and assigned against the relevant hour of the day in order to provide hour by hour emissions.

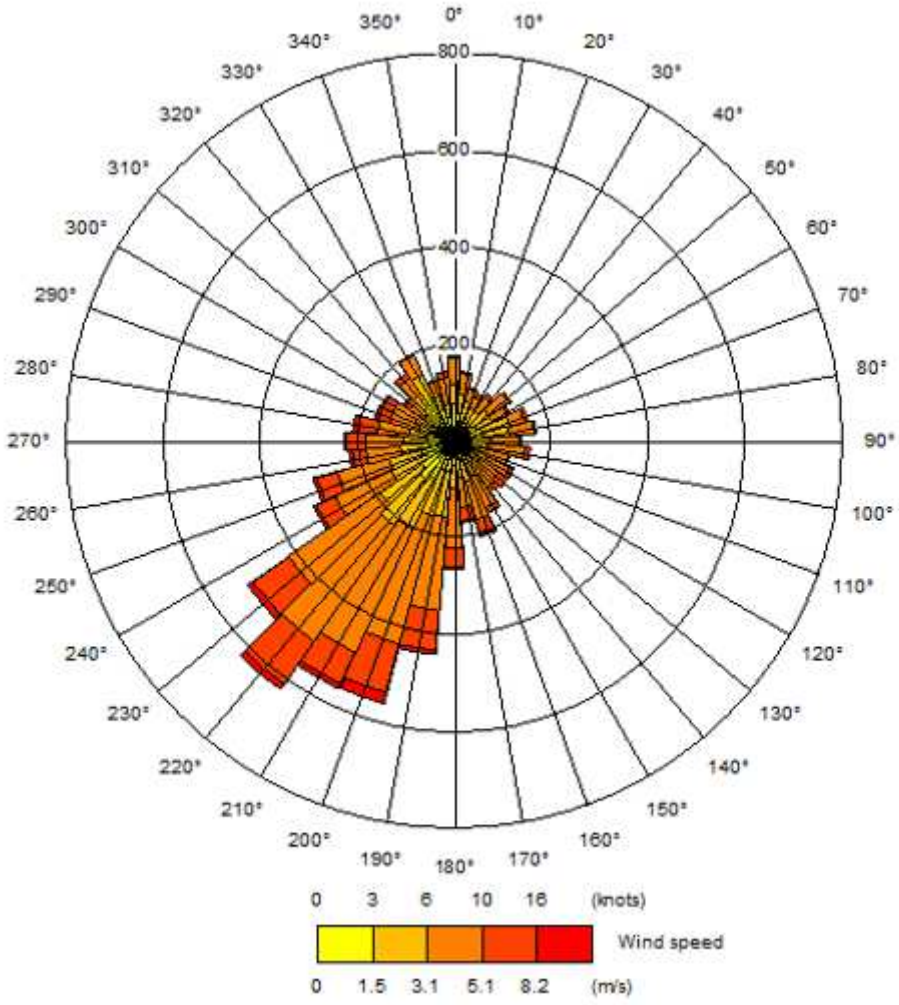
5.1.156. Adjustment of assigned speed band where changes in speed did not justify a change in speed band (speed change less than 5 kph) or where a speed band change was considered not to reflect a valid Scheme impact were applied as part of the ARN calculation process..

Dispersion Model set up

5.1.157. The dispersion model was set up based on the following key inputs and assumptions:

- Road sources were modelled using the ADMS-Roads source representation tool.
- Ordnance Survey Master Map base mapping was used to define the road geometry.
- All dual carriageways and motorway links were represented with a centreline included for each carriageway direction. All other roads are represented with a single centreline.
- Road widths have been measured in GIS from Ordnance Survey Master Map data.

5.1.158. Hourly sequential meteorological data for 2019 for Gloucestershire meteorological station were used. The parameters required by the model included: date, time, wind direction (angle wind blowing from), wind speed (at 10 metres above ground level), surface air temperature (degrees Celsius), and cloud cover (oktas – or eighths of sky covered). The wind rose for Gloucestershire (presented below in Figure A5-1 indicates that the dominant wind direction for 201 was from the south west.



A5-1 Figure 1 Wind Rose Diagram for Gloucestershire, 2019

5.1.159. A latitude of 51.9 degrees was selected. This determines times of sunrise and sunset for each day throughout the year, which in turn affects stability calculations.

5.1.160. Surface roughness coefficients have been defined as 0.5 m (representative of parkland and open suburbia) at both the dispersion site and the meteorological site. The surface roughness is important in the approximation of turbulent conditions within the atmospheric boundary layer and thus in the estimation of pollutant concentrations at receptors.

5.1.161. Minimum Monin-Obukhov length has been defined as 30 m at both the dispersion site and at the meteorological site (representative of cities and large towns). This parameter limits the occurrence of very stable boundary layer conditions (i.e. when the air is still) to a degree that is appropriate to the general land-use. In general, the potential for very stable conditions is lowest in large urban areas where the 'heat island' effect promoting turbulent motion in the boundary layer is strongest.

Modelled Receptors

Human Health

5.1.162. There are 71 human health receptors selected for inclusion for assessment in the air quality study area. All receptors were modelled at a height of 1.5 m above ground to reflect worst case average human exposure. Details of the receptors assessed are presented in Appendix 5.1 - Table 1. The locations of these receptors are shown on the results figures in Figure 5-3.

Appendix 5.1 - Table 1 Discrete Human Health Receptor locations included in the Air Quality Model

Receptor ID	Road Name	X	Y	AQ verification Area	Local Authority
R1	Flat, QUEENS HEAD, TEWKESBURY ROAD, LONGFORD, GL2 9EJ	383822	220735	All other	Tewkesbury
R2	119, TEWKESBURY ROAD, LONGFORD, GL2 9BN	383983	221208	All other	Tewkesbury
R3	118, TEWKESBURY ROAD, LONGFORD, GL2 9BW	383998	221211	All other	Tewkesbury
R4	62, MEADOW LANE, LONGFORD, GL2 9FQ	384897	220663	All other	Tewkesbury
R5	OLD LANE COTTAGE, TEWKESBURY ROAD, NORTON, GL2 9LH	385536	223859	All other	Tewkesbury
R6	15, MELODY WAY, GLOUCESTER, GL2 0XU	386021	220398	All other	Tewkesbury
R7	SANDYCROFT COTTAGE, DANCEY ROAD, CHURCHDOWN, GL3 1HP	386943	220726	All other	Tewkesbury
R8	32A, VERVAIN CLOSE, CHURCHDOWN, GL3 1LT	387156	220991	All other	Tewkesbury
R9	8, BERRYFIELD GLADE, CHURCHDOWN, GL3 2BT	387495	220500	All other	Tewkesbury
R10	77, CHELTENHAM ROAD EAST, CHURCHDOWN, GL3 1JN	387543	221449	All other	Tewkesbury
R11	VERGE, CHELTENHAM ROAD EAST, CHURCHDOWN, GL2 9QF	387949	221967	All other	Tewkesbury
R12	THE OLD POLICE STATION, TEWKESBURY ROAD, COOMBE HILL, GL19 4BA	388816	227028	All other	Tewkesbury
R13	CORNER HOUSE, TEWKESBURY ROAD, COOMBE HILL, GL19 4AZ	388848	227024	All other	Tewkesbury
R14	DEANS WAY, TEWKESBURY ROAD, COOMBE HILL, GL19 4BQ	388892	227321	All other	Tewkesbury
R15	PEAR TREE COTTAGE, GLOUCESTER ROAD, STAVERTON, GL51 0TF	389081	222438	All other	Tewkesbury
R16	89, STAVERTON PARK, STAVERTON, GL51 6TD	389127	222197	All other	Tewkesbury
R17	SALTERS HILL HOUSE, GLOUCESTER ROAD, TEWKESBURY, GL20 7DA	389243	229367	All other	Tewkesbury
R18	FLAT, ODESSA INN, GLOUCESTER ROAD, GL20 7DA	389264	229831	All other	Tewkesbury
R19	HIGHFIELD FARM LODGE, TEWKESBURY ROAD, DEERHURST, GL19 4BP	389301	228768	All other	Tewkesbury

Receptor ID	Road Name	X	Y	AQ verification Area	Local Authority
R20	ELMHURST, OLD GLOUCESTER ROAD, STAVERTON, GL51 0TG	389350	222813	All other	Tewkesbury
R21	WOODBINE COTTAGE, BAMFURLONG LANE, STAVERTON, GL51 6SW	389637	221832	Motorway	Tewkesbury
R22	6, VALLEY COTTAGES, GLOUCESTER ROAD, GL51 0TF	389694	222516	Motorway	Tewkesbury
R23	STANBORO COTTAGE, TEWKESBURY ROAD, ELMSTONE HARDWICKE, GL51 9SY	389879	226036	All other	Tewkesbury
R24	WITHYBRIDGE END, OLD GLOUCESTER ROAD, BODDINGTON, GL51 0TG	390203	223792	All other	Tewkesbury
R25	YORK BARN, BADGEWORTH ROAD, BADGEWORTH, GL51 6RJ	390230	221133	All other	Cheltenham
R26	ELM COTTAGE, OLD GLOUCESTER ROAD, BODDINGTON, GL51 0SW	390309	223848	All other	Tewkesbury
R27	2, BUTLERS COURT COTTAGE, WITHYBRIDGE LANE, GL51 0TH	390462	224714	All other	Tewkesbury
R28	1, BUTLERS COURT COTTAGE, WITHYBRIDGE LANE, GL51 0TH	390465	224718	All other	Tewkesbury
R29	VINE COTTAGE, GLOUCESTER ROAD, STAVERTON, GL51 0SS	390479	222149	All other	Tewkesbury
R30	MILL HOUSE, WITHYBRIDGE LANE, CHELTENHAM, GL51 0TH	390502	224692	All other	Tewkesbury
R31	52, ASHCHURCH ROAD, TEWKESBURY, GL20 8BT	390658	233081	All other	Tewkesbury
R32	6 WESTFIELD COTTAGE, ELMSTONE HARDWICKE, TEWKESBURY, GL51 9TE	390921	227363	All other	Tewkesbury
R33	ELM COTTAGE, SHURDINGTON ROAD, SHURDINGTON, GL51 4UA	390994	217304	All other	Tewkesbury
R34	THE WILLOWS, GLOUCESTER ROAD, CHELTENHAM, GL51 0SX	391108	221787	All other	Cheltenham
R35	8, REDGROVE COTTAGES, HATHERLEY LANE, GL51 6SH	391123	221574	All other	Cheltenham
R36	HARROW FARM, ELMSTONE HARDWICKE, TEWKESBURY, GL51 9TF	391137	227811	All other	Tewkesbury
R37	WILLOW MEAD, FIDDLERS GREEN LANE, CHELTENHAM, GL51 0TD	391155	221953	All other	Cheltenham

Receptor ID	Road Name	X	Y	AQ verification Area	Local Authority
R38	BRAMBLE COTTAGE, ELMSTONE HARDWICKE, TEWKESBURY, GL51 9TF	391163	227809	All other	Tewkesbury
R39	LAY BY, TEWKESBURY ROAD, UCKINGTON, GL51 9SX	391169	225126	All other	Tewkesbury
R40	WHITE LODGE, HATHERLEY LANE, CHELTENHAM, GL51 6SH	391185	221700	All other	Cheltenham
R41	18, MILNE PASTURES, ASHCHURCH, GL20 8SG	391190	233185	All other	Tewkesbury
R42	PILGROVE COTTAGE, OLD GLOUCESTER ROAD, CHELTENHAM, GL51 0SW	391339	224154	All other	Tewkesbury
R43	WESTWALL COTTAGE, TEWKESBURY ROAD, UCKINGTON, GL51 9SX	391360	225014	All other	Tewkesbury
R44	4, NIMBUS HOUSE, GEMINI CLOSE, GL51 0FH	391520	221932	Cheltenham	Cheltenham
R45	4, MULBERRY COURT, CHELTENHAM, GL51 0XA	391599	222731	All other	Cheltenham
R46	GREENWAY LODGE, MAIN ROAD, SHURDINGTON, GL51 4TX	391711	218080	All other	Tewkesbury
R47	5, ASTON COURT, SOTHERBY DRIVE, GL51 0FS	391888	222099	Cheltenham	Cheltenham
R48	14, CORINNE COURT, SOTHERBY DRIVE, GL51 0FW	391926	222171	Cheltenham	Cheltenham
R49	73, MONKSCROFT, CHELTENHAM, GL51 7TU	391993	222144	Cheltenham	Cheltenham
R50	DOVE COTTAGE, STOKE ROAD, STOKE ORCHARD, GL52 7RY	392029	228291	All other	Tewkesbury
R51	4, ANAPA MEWS, CHELTENHAM, GL51 7RB	392209	222813	Cheltenham	Cheltenham
R52	1, MILLWAY, TEWKESBURY ROAD, GL51 9SL	392730	224316	All other	Tewkesbury
R53	THE BUNGALOW, STOKE ROAD, STOKE ORCHARD, GL52 7RU	392980	228063	All other	Tewkesbury
R54	12, PRINCESS ELIZABETH WAY, CHELTENHAM, GL51 7PE	392997	223628	Cheltenham	Cheltenham
R55	254, BROOKLYN ROAD, CHELTENHAM, GL51 8ED	393028	223446	Cheltenham	Cheltenham
R56	25, PROVIDENCE PARK, CHELTENHAM, GL51 7NY	393089	223644	Cheltenham	Cheltenham
R57	CLEEVE STATION HOUSE, STOKE ROAD, STOKE ORCHARD, GL52 7RY	393315	227966	All other	Tewkesbury

Receptor ID	Road Name	X	Y	AQ verification Area	Local Authority
R58	CLEEVE STATION HOUSE, STOKE ROAD, BISHOPS CLEEVE, GL52 7RS	393317	227966	All other	Tewkesbury
R59	LARKFIELD, WYMANS LANE, CHELTENHAM, GL51 9QF	393770	224626	All other	Cheltenham
R60	WINGMORE LODGE, STOKE ORCHARD ROAD, BISHOPS CLEEVE, GL52 7DG	393790	227779	All other	Tewkesbury
R61	MORRIS HILL, SWINDON LANE, CHELTENHAM, GL50 4PE	393901	224649	All other	Cheltenham
R62	71, WYMANS LANE, CHELTENHAM, GL51 9QH	393913	224887	All other	Cheltenham
R63	INGLENOOK, HYDE LANE, SWINDON VILLAGE, GL51 9QN	394091	225039	All other	Cheltenham
R64	36, FARRIERS REACH, BISHOPS CLEEVE, GL52 7UZ	394912	227488	All other	Tewkesbury
R65	101, STOKE ROAD, BISHOPS CLEEVE, GL52 8RP	395135	227605	All other	Tewkesbury
R66	6, FOXMOOR, BISHOPS CLEEVE, GL52 8SS	395266	227468	All other	Tewkesbury
R67	34, MIDDLEHAY COURT, BISHOPS CLEEVE, GL52 8TE	395285	227447	All other	Tewkesbury
R68	106, CHELTENHAM ROAD, BISHOPS CLEEVE, GL52 8LZ	395595	226881	All other	Tewkesbury
R69	WOODHOUSE FARM, BROCKWORTH ROAD, CHURCHDOWN, GL3 4RD	389345	219100	Motorway	Tewkesbury
R70	STAFFHOUSE, BAMFURLONG LANE, STAVERTON, GL51 6SU	389752	221486	Motorway	Tewkesbury
R71	MALVERN HOUSE, SWAN LANE, STOKE ORCHARD, GL52 7RW	391536	228073	Motorway	Tewkesbury

Ecological Receptors

5.1.163. There were eight designated habitats included in the air quality model in the air quality study area. All receptors were modelled at a height of zero metres above ground to reflect a worst case situation of vegetation at ground level exposure. Details of the receptors assessed are presented in Appendix 5.1 - Table 2.

Appendix 5.1 - Table 2 Ecological Receptors Included in the Air Quality Dispersion Model

Receptor ID	Name	X	Y
ECO1	Norton (A38) LWS	386186	224310
ECO2	Pegmore Farm, The Leigh 'Meadow 2' LWS	386651	224927
ECO3	Cotswold Farm, The Leigh LWS	387677	225912
ECO4	Tewkesbury Nature Reserve LWS	390000	232820
ECO5	Tewkesbury Nature Reserve LWS	390107	232741
ECO6	Tewkesbury Railway Line (Disused) LWS	390930	233266
ECO7	Walton Cardiff Ponds LWS	391507	232395
ECO8	Veteran Tree	395732	225894

Model Verification

Verification for NO_2

5.1.164. Model verification was undertaken considering monitoring sites within 200 metres of the roads meeting the DMRB LA 105 traffic screening criteria. From the full network of NO_2 diffusion tubes available, only those representative of selected sensitive receptor locations and with sufficient data capture were considered suitable for the purpose of model verification.

5.1.165. Model verification was undertaken for the 2019 base year considering thee passive monitoring sites within the air quality study area. A total of 13 monitoring sites were considered (5 Local Authority tubes and 8 tubes from the Scheme Specific Survey). Figure 5-1 shows the locations of the diffusion tubes used in verification.

5.1.166. The annual mean NO_2 concentrations for the 2019 base year were verified by means of comparison against available ratified monitoring data. The modelled road NO_x concentrations were adjusted where appropriate, with reference to the methodology set out in Defra's LAQM.TG(16).

5.1.167. Uncertainty in modelled estimates has been considered by calculating root mean square error (RMSE) and fractional bias statistics. An air quality model can be considered to perform reasonably well where 95% of modelled concentrations are within 25% of monitored concentrations in accordance with Defra's Technical Guidance LAQM.TG(16). The RMSE should ideally be within 10% of the relevant air quality criterion (less than 4 $\mu g/m^3$) but is acceptable where it is within 25% of the relevant air quality criterion (i.e. 10 $\mu g/m^3$). The Fractional Bias (FB) has an ideal value of 0 but is acceptable in the range between +2 and -2.

5.1.168. First, unadjusted modelled estimates of total annual mean NO_2 concentrations have been compared against monitored annual means. Out of 13 comparisons, 2 modelled estimates

are within +/- 25% of monitored without adjustment, as given in Appendix 5.1 - Table 3. Substantial and systematic underestimates of more than 25% are indicated for 11 sites.

Appendix 5.1 - Table 3 Comparison of Unadjusted Modelled and Measured NO_2 Concentrations ($\mu g/m^3$)

Site ID	Measured NO_2	Modelled Total NO_2	Modelled – Measured Difference ($\mu g/m^3$)	Ratio (Modelled / Measured)	% Difference
22	33.4	19.3	-14.1	0.6	-42.3%
28	38.2	23.9	-14.4	0.6	-37.6%
29	33.7	19.1	-14.6	0.6	-43.4%
D2	34.7	22.5	-12.2	0.6	-35.0%
D3	19.7	12.3	-7.4	0.6	-37.6%
D4	22.6	14.2	-8.4	0.6	-37.3%
D5	29.9	17.5	-12.5	0.6	-41.7%
D6	32.8	16.9	-15.9	0.5	-48.4%
D7	21.3	12.5	-8.8	0.6	-41.4%
D8	22.5	13.6	-8.9	0.6	-39.5%
D10	27.4	17.0	-10.5	0.6	-38.2%
15N	25.7	27.3	1.6	1.1	6.3%
16N	22.0	24.1	2.1	1.1	9.4%

5.1.169. For unadjusted modelled estimates of NO_2 compared to monitored concentrations, the RMSE is 11.01 $\mu g/m^3$, which is above the target value according to Defra's LAQM.TG(16) (ideal less than 4 $\mu g/m^3$, acceptable less than 10 $\mu g/m^3$). Overall, the unadjusted model tends to underestimate total concentrations of NO_2, as indicated by a high fractional bias value of 0.41.

5.1.170. The second comparison of modelled estimates of road contributed annual mean NOx with the road NOx component derived from monitoring data is presented in Appendix 5.1 - Table 4. Analysis requires the estimation of the monitored road NOx component. This has been undertaken using Defra's NO_2 to NOx calculator (version 8.1, August 2020).

5.1.171. Modelled road NOx concentrations can be adjusted by taking the slope of the linear regression line that has been forced through zero. Due to the model performing differently in the study area and the geographical extent of the latter, the verification was spilt into three zones (as described in Appendix 5.1 - Table 4), resulting in three different adjustment factors for the full study area (13 sites).

5.1.172. The model was split into three verification zones. The factors used to adjust the model results in these areas are shown below in Appendix 5.1 - Table 5

Appendix 5.1 - Table 4 Comparison of Unadjusted Modelled and Measured NOx Concentrations (µg/m3)

Site ID	Zone	Modelled Road NOx	Measured Road NOx	Modelled - Measured	Measured / Modelled	Measured / Modelled % Difference
22	"All Other"	12.6	41.4	-28.8	3.3	-69%
28	"Cheltenham"	20.4	50.8	-30.4	2.5	-60%
29	"Cheltenham"	13.6	43.5	-29.9	3.2	-69%
D2	"Cheltenham"	20.3	45.6	-25.3	2.2	-55%
D3	"All Other"	7.6	21.7	-14.0	2.8	-65%
D4	"All Other"	9.8	26.1	-16.3	2.7	-62%
D5	"All Other"	13.1	38.1	-25.0	2.9	-66%
D6	"All Other"	11.3	43.3	-32.0	3.8	-74%
D7	"All Other"	4.5	21.1	-16.6	4.7	-79%
D8	"All Other"	6.6	23.6	-17.0	3.6	-72%
D10	"Cheltenham"	10.3	31.0	-20.7	3.0	-67%
15N	Motorway	26.0	22.7	3.3	0.9	14%
16N	Motorway	29.0	24.9	4.1	0.9	17%

Appendix 5.1 - Table 5 Model Verification Adjustment Factors

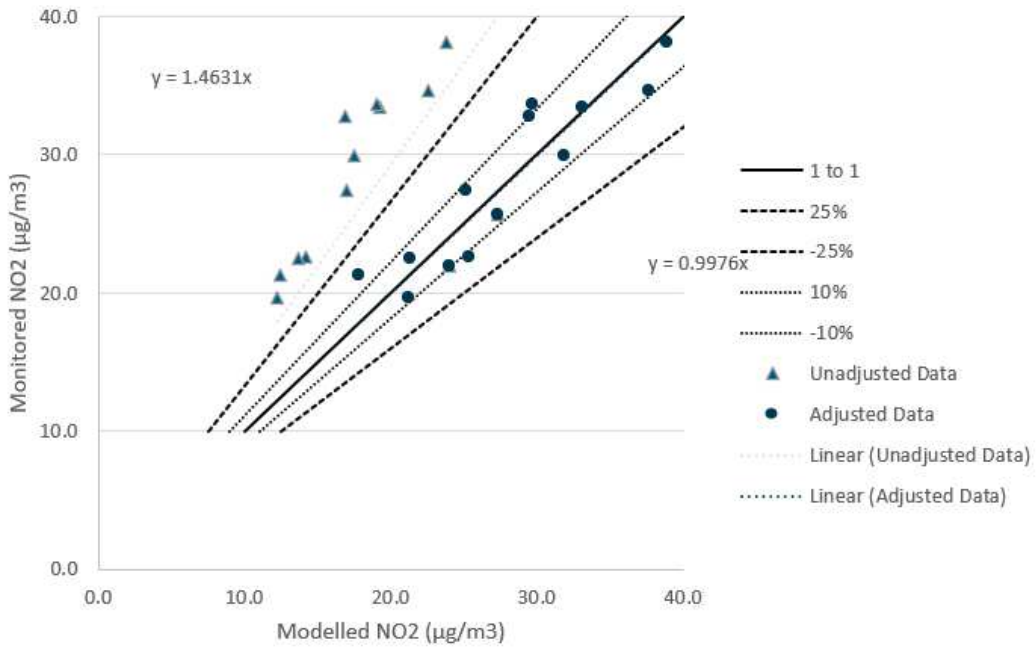
Zone	Zone name	Number of Monitoring Sites	Adjustment Factor
1	"All Other"	7	3.22
2	"Cheltenham"	4	2.57
3	Motorway	2	1.0

5.1.173. The third comparison of the adjusted modelled estimates of total annual mean NO_2 with monitored concentrations is presented in Appendix 5.1 Table 6 and Figure A5-2. All the comparisons are within +/- 25% of the monitored values at the same site. The majority (10 of 13 sites) are within 10% of monitored concentrations. Overall, this suggests that the model is performing well at all locations in accordance with Defra Technical Guidance LAQM.TG(16).

5.1.174. The RMSE for the adjusted modelled NO_2 concentrations compared to monitored concentrations is 2.40 µg/m^3 i.e. below the Defra's target value (4 µg/m^3). Adjustment has therefore improved model performance. Overall, the adjusted model has tended to very slightly underestimate total concentrations of NO_2, as indicated by a fractional bias value of 0.00.

Appendix 5.1 Table 6 Comparison of Adjusted Modelled and Measured NO_2 Concentrations (µg/m^3)

Site ID	Measured NO_2	Modelled Total NO_2	Modelled – Measured Difference (µg/m^3)	Ratio (Modelled / Measured)	% Difference
22	33.4	33.1	-0.3	1.0	-1%
28	38.2	38.9	0.7	1.0	2%
29	33.7	29.7	-4.0	0.9	-12%
D2	34.7	37.6	2.9	1.1	8%
D3	19.7	21.2	1.5	1.1	8%
D4	22.6	25.4	2.8	1.1	12%
D5	29.9	31.9	1.9	1.1	6%
D6	32.8	29.5	-3.3	0.9	-10%
D7	21.3	17.8	-3.5	0.8	-16%
D8	22.5	21.4	-1.2	0.9	-5%
D10	27.4	25.2	-2.2	0.9	-8%
15N	25.7	27.3	1.6	1.1	6%
16N	22.0	24.1	2.1	1.1	9%



A5-2 Comparison of Modelled and Measured NO_2 Concentrations (µg/m^3) before and after adjustment

National Highways DMRB LA105 Gap Analysis

5.1.175. Appendix 5.1 - Table 7 and Appendix 5.1 - Table 8 below provide details of the derivation of the gap factor between the base year 2019 and future year 2025, for human health receptors and designated habitats respectively.

Appendix 5.1 - Table 7 Derivation of GAP Factor in Accordance with National Highways LTTE6 Projection Factors for Human Health

Receptor ID	Base 2019 NO_2	2025 Projected Base NO_2	2025 Projected Base NO_2 / Base 2019 NO_2 (Ratio A)	2025 Long Term Adjustment Factor / 2019 Long Term Adjustment Factor (Ratio B)	Gap Factor (Ratio B / Ratio A)
R1	26.19	16.94	0.6	0.9	1.3
R2	21.9	14.19	0.6	0.9	1.3
R3	25.69	16.37	0.6	0.9	1.4
R4	24.61	15.64	0.6	0.9	1.4
R5	15.43	10.28	0.7	0.9	1.3
R6	24.95	15.82	0.6	0.9	1.4
R7	27	17.45	0.6	0.9	1.3
R8	19.44	13.44	0.7	0.9	1.2
R9	28.24	17.55	0.6	0.9	1.4
R10	28.85	18.42	0.6	0.9	1.3
R11	20.41	13.64	0.7	0.9	1.3
R12	17.32	11.2	0.6	0.9	1.3
R13	21.43	13.54	0.6	0.9	1.4
R14	19.19	12.28	0.6	0.9	1.3
R15	26.92	17.6	0.7	0.9	1.3
R16	18.16	12.72	0.7	0.9	1.2
R17	18.64	11.95	0.6	0.9	1.3
R18	20.35	12.83	0.6	0.9	1.4
R19	16.99	11.03	0.6	0.9	1.3
R20	23.99	15.85	0.7	0.9	1.3
R21	24.54	16.43	0.7	0.9	1.3
R22	28.76	18.08	0.6	0.9	1.4
R23	19.36	12.44	0.6	0.9	1.3
R24	24.65	15.74	0.6	0.9	1.3
R25	21.71	14.36	0.7	0.9	1.3
R26	23.53	15.15	0.6	0.9	1.3
R27	18.4	12.07	0.7	0.9	1.3
R28	18.48	12.11	0.7	0.9	1.3
R29	27.38	17.29	0.6	0.9	1.4

Receptor ID	Base 2019 NO_2	2025 Projected Base NO_2	2025 Projected Base NO_2 / Base 2019 NO_2 (Ratio A)	2025 Long Term Adjustment Factor / 2019 Long Term Adjustment Factor (Ratio B)	Gap Factor (Ratio B / Ratio A)
R30	18.46	12.12	0.7	0.9	1.3
R31	19.95	13.11	0.7	0.9	1.3
R32	15.97	10.58	0.7	0.9	1.3
R33	38.77	24.14	0.6	0.9	1.4
R34	41.52	26	0.6	0.9	1.4
R35	29.01	19.3	0.7	0.9	1.3
R36	18.7	12	0.6	0.9	1.3
R37	31.3	20.7	0.7	0.9	1.3
R38	23.09	14.52	0.6	0.9	1.4
R39	23.85	15.06	0.6	0.9	1.4
R40	36.56	23.54	0.6	0.9	1.3
R41	30.25	20.47	0.7	0.9	1.3
R42	21.75	14.11	0.6	0.9	1.3
R43	24.75	15.58	0.6	0.9	1.4
R44	29.4	19.06	0.6	0.9	1.3
R45	26.13	17.52	0.7	0.9	1.3
R46	29.54	18.69	0.6	0.9	1.4
R47	29.74	18.7	0.6	0.9	1.4
R48	23.24	15.28	0.7	0.9	1.3
R49	27.41	17.5	0.6	0.9	1.3
R50	23.06	14.59	0.6	0.9	1.4
R51	26.16	16.73	0.6	0.9	1.3
R52	27.87	17.78	0.6	0.9	1.4
R53	18.46	12.12	0.7	0.9	1.3
R54	29.62	18.77	0.6	0.9	1.4
R55	21.34	15.31	0.7	0.9	1.2
R56	33.31	21.52	0.6	0.9	1.3
R57	14.73	10.41	0.7	0.9	1.2
R58	14.75	10.42	0.7	0.9	1.2
R59	35.5	23.11	0.7	0.9	1.3
R60	15.55	10.87	0.7	0.9	1.2
R61	29.18	20.38	0.7	0.9	1.2
R62	34.73	22.56	0.6	0.9	1.3
R63	26.72	16.49	0.6	0.9	1.4

Receptor ID	Base 2019 NO_2	2025 Projected Base NO_2	2025 Projected Base NO_2 / Base 2019 NO_2 (Ratio A)	2025 Long Term Adjustment Factor / 2019 Long Term Adjustment Factor (Ratio B)	Gap Factor (Ratio B / Ratio A)
R64	24.76	15.93	0.6	0.9	1.3
R65	22.11	14.52	0.7	0.9	1.3
R66	20.64	13.84	0.7	0.9	1.3
R67	18.22	12.51	0.7	0.9	1.3
R68	20.1	14.53	0.7	0.9	1.2
R69	19.65	12.7	0.6	0.9	1.3
R70	22.85	15.59	0.7	0.9	1.3
R71	14.98	9.92	0.7	0.9	1.3

Appendix 5.1 - Table 8 Derivation of GAP Factor in Accordance with Highways LTTE6 Projection Factors for Road NO_2 at Ecological Receptors

Receptor ID	Base 2019 NO_2	2025 Projected Base NO_2	2025 Projected Base NO_2 / Base 2019 NO_2 (Ratio A)	2025 Long Term Adjustment Factor / 2019 Long Term Adjustment Factor (Ratio B)	Gap Factor (Ratio B / Ratio A)
ECO1	17.8	11.5	0.6	0.9	1.3
ECO2	10.4	7.5	0.7	0.9	1.2
ECO3	23.4	14.6	0.6	0.9	1.4
ECO4	11.5	8.4	0.7	0.9	1.2
ECO5	11.6	8.5	0.7	0.9	1.2
ECO6	13.9	9.8	0.7	0.9	1.2
ECO7	25.5	15.6	0.6	0.9	1.4
ECO8	14.2	10.1	0.7	0.9	1.2

Designated Habitats Assessment Methodology

Background Deposition Rates

5.1.176. Details of designation types, habitat types, lower level of critical loads and background deposition rates used for designated ecological sites included in the air quality assessment are shown in Appendix 5.1 - Table 9.

Appendix 5.1 - Table 9 Background Nitrogen Deposition Rates, Habitat Type and Critical Loads for Nitrogen Sensitive Designated Sites – Local Non Statutory Designations

Site Name	Designation	Habitat Type	Lower Limit of Critical Load (Kg N/ha/yr)	APIS 2017-19 background N-dep rate (max) (kg N/ha/yr)
Norton (A38) LWS	Local Wildlife Site	Neutral Grassland	10.0	21.6
Pegmore Farm, The Leigh 'Meadow 2' LWS	Local Wildlife Site	Neutral Grassland	10.0	21.6
Cotswold Farm, The Leigh LWS	Local Wildlife Site	Broadleaved Mixed and Yew Woodland	10.0	35.1
Tewkesbury Nature Reserve LWS	Local Wildlife Site	Broadleaved Mixed and Yew Woodland	10.0	49.7
Tewkesbury Nature Reserve LWS	Local Wildlife Site	Broadleaved Mixed and Yew Woodland	10.0	49.7
Tewkesbury Railway Line (Disused) LWS	Local Wildlife Site	Neutral Grassland	10.0	26.9
Walton Cardiff Ponds LWS	Local Wildlife Site	Neutral Grassland	10.0	26.9
Veteran Tree	Veteran Tree	Broadleaved Mixed and Yew Woodland	10.0	34.9

5.1.177. Assessment of the impact of the Scheme on sensitive ecological designations has been undertaken in accordance with DMRB LA 105 (paragraph 2.43 - 2.46 and para 2.97 to 2.102).

5.1.178. The assessment has been undertaken based on the following key inputs and assumptions:

- Designated ecological sites with statutory and non-statutory designations within the air quality study area for the Scheme been identified in accordance with DMRB LA 105 (paragraph 2.18 and 2.25).
- Relevant habitat types have been obtained from APIS. Critical loads have been obtained from APIS. Where sites did not contain habitats sensitive to nitrogen deposition, then the site was excluded from further assessment.
- Receptor locations representative of those designated ecological sites with nitrogen sensitive habitats have been included in the air quality dispersion model.
- LTTE6 projection factors have been applied in accordance with DMRB LA 105 (paragraph 2.47 – 2.55) to annual mean road NO_2 at ecological receptors.
- The road NO_2 was converted to dry nutrient nitrogen deposition rates in kg N/ha/year using the conversion rates for “woodland” and “grassland” habitats given in DMRB LA 105 (para 2.44.1). Where habitat information was not available at screening (for the non-statutory designated ecological sites) nitrogen deposition rates were calculated for both “woodland” and “grassland” habitat types and assigned according to the habitat type identified from satellite photography, accessed using google earth, for each receptor location .

- The background nitrogen deposition rate at each designated site has been obtained from the APIS website for the base year of 2019. For the Scheme opening year of no reduction in background nitrogen deposition was calculated on a precautionary basis.
- Background and road nitrogen deposition rates were combined to give a total nitrogen deposition for each ecological receptor location and the change in nitrogen deposition rate with the Scheme was calculated.
- Each ecological receptor location was screened against the DMRB LA 105 designated habitat screening criteria. The screening criteria were considered to be exceeded where total nitrogen deposition is greater than the relevant lower critical load, and the change in nitrogen deposition is greater than 1% of the relevant lower critical load.

5.1.179. Results of the assessment have identified improvements at the designated ecological sites assessed, with reduction in nitrogen deposition rate estimated at all receptors with the Scheme in place, therefore, the screening criteria were not exceeded and further investigation was not required.

Assessment of Impacts

Local Air Quality Results

NO_2 concentrations

Appendix 5.1 - Table 10 Annual Mean NO_2 Results ($\mu g/m^3$) for Discrete Receptors (Including Gap Factor)

Receptor ID	Base 2019 NO_2	2025 DM NO_2	2025 DS NO_2	2025 DS-DM	2025 NO_2 Change Criteria
R1	26.2	23.0	21.5	-1.5	Not significant
R2	21.9	19.3	17.6	-1.7	Not significant
R3	25.7	22.7	20.5	-2.2	Not significant
R4	24.6	22.2	22.5	0.3	Not significant
R5	15.4	13.5	12.3	-1.2	Not significant
R6	25.0	22.3	22.6	0.3	Not significant
R7	27.0	23.6	22.9	-0.7	Not significant
R8	19.4	16.9	16.0	-0.9	Not significant
R9	28.2	27.0	28.1	1.1	Not significant
R10	28.9	24.8	23.4	-1.4	Not significant
R11	20.4	17.5	16.9	-0.6	Not significant
R12	17.3	15.0	14.1	-0.9	Not significant
R13	21.4	18.6	17.7	-0.9	Not significant
R14	19.2	16.6	17.5	0.9	Not significant
R15	26.9	23.5	22.5	-1.0	Not significant
R16	18.2	16.3	15.8	-0.5	Not significant
R17	18.6	16.2	17.1	0.9	Not significant
R18	20.4	18.0	18.6	0.6	Not significant
R19	17.0	14.8	15.3	0.5	Not significant
R20	24.0	21.8	20.8	-1.0	Not significant

Receptor ID	Base 2019 NO_2	2025 DM NO_2	2025 DS NO_2	2025 DS-DM	2025 NO_2 Change Criteria
R21	24.5	22.3	23.4	1.1	Not significant
R22	28.8	26.4	27.9	1.5	Not significant
R23	19.4	17.1	19.7	2.6	Not significant
R24	24.7	22.8	20.5	-2.3	Not significant
R25	21.7	19.6	19.3	-0.3	Not significant
R26	23.5	22.1	21.3	-0.8	Not significant
R27	18.4	16.6	15.6	-1.0	Not significant
R28	18.5	16.7	15.6	-1.1	Not significant
R29	27.4	24.8	22.4	-2.4	Not significant
R30	18.5	16.7	15.4	-1.3	Not significant
R31	20.0	18.7	17.9	-0.8	Not significant
R32	16.0	14.3	15.0	0.7	Not significant
R33	38.8	35.8	35.0	-0.8	Not significant
R34	41.5	40.3	38.3	-2.0	Small decrease
R35	29.0	25.9	26.4	0.5	Not significant
R36	18.7	16.8	17.8	1.0	Not significant
R37	31.3	27.4	26.2	-1.2	Not significant
R38	23.1	20.9	23.3	2.4	Not significant
R39	23.9	21.0	22.7	1.7	Not significant
R40	36.6	33.4	33.8	0.4	Not significant
R41	30.3	26.7	25.9	-0.8	Not significant
R42	21.8	20.4	18.3	-2.1	Not significant
R43	24.8	21.9	25.1	3.2	Not significant
R44	29.4	28.2	27.1	-1.1	Not significant
R45	26.1	22.4	21.5	-0.9	Not significant
R46	29.5	27.2	26.5	-0.7	Not significant
R47	29.7	26.3	25.5	-0.8	Not significant
R48	23.2	20.4	19.8	-0.6	Not significant
R49	27.4	24.9	24.1	-0.8	Not significant
R50	23.1	21.0	23.1	2.1	Not significant
R51	26.2	23.6	22.2	-1.4	Not significant
R52	27.9	26.2	29.3	3.1	Not significant
R53	18.5	16.5	17.9	1.4	Not significant
R54	29.6	26.2	25.0	-1.2	Not significant
R55	21.3	19.0	19.2	0.2	Not significant
R56	33.3	29.4	28.2	-1.2	Not significant
R57	14.7	12.9	13.5	0.6	Not significant

Receptor ID	Base 2019 NO_2	2025 DM NO_2	2025 DS NO_2	2025 DS-DM	2025 NO_2 Change Criteria
R58	14.8	13.0	13.5	0.5	Not significant
R59	35.5	32.0	31.3	-0.7	Not significant
R60	15.6	13.7	14.4	0.7	Not significant
R61	29.2	25.3	25.6	0.3	Not significant
R62	34.7	30.9	29.8	-1.1	Not significant
R63	26.7	23.8	22.8	-1.0	Not significant
R64	24.8	22.6	24.4	1.8	Not significant
R65	22.1	20.4	20.5	0.1	Not significant
R66	20.6	18.5	19.3	0.8	Not significant
R67	18.2	16.1	16.6	0.5	Not significant
R68	20.1	17.6	16.9	-0.7	Not significant
R69	19.7	17.8	18.0	0.2	Not significant
R70	22.9	21.1	21.2	0.1	Not significant
R71	15.0	13.5	13.6	0.1	Not significant

PM_{10} concentrations

Appendix 5.1 Table 11 Annual Mean PM_{10} Results ($\mu g/m^3$) for Discrete Receptors (Including Gap Factor)

Receptor ID	2019 Base PM_{10}	Number of 24hr Mean PM_{10} Exceedances 2018 Base
R1	16.2	0
R2	15.5	0
R3	16.1	0
R4	16.8	1
R5	14.2	0
R6	17.6	1
R7	18.1	1
R8	15.9	0
R9	17.9	1
R10	17.5	1
R11	15.8	0
R12	13.9	0
R13	14.5	0
R14	14.2	0
R15	18.5	2
R16	16.8	1
R17	14.6	0
R18	15.4	0

Receptor ID	2019 Base PM_{10}	Number of 24hr Mean PM_{10} Exceedances 2018 Base
R19	14.5	0
R20	17.5	1
R21	17.3	1
R22	17.9	1
R23	15.6	0
R24	16.0	0
R25	15.8	0
R26	15.9	0
R27	15.5	0
R28	15.5	0
R29	16.5	0
R30	15.5	0
R31	15.0	0
R32	14.2	0
R33	18.9	2
R34	20.4	4
R35	17.4	1
R36	16.5	1
R37	17.9	1
R38	17.2	1
R39	16.2	0
R40	18.9	2
R41	18.5	2
R42	15.7	0
R43	16.3	0
R44	17.4	1
R45	16.5	1
R46	17.3	1
R47	17.0	1
R48	15.8	0
R49	16.6	1
R50	16.1	0
R51	16.9	1
R52	17.1	1
R53	15.8	0
R54	17.5	1
R55	15.9	0

Receptor ID	2019 Base PM_{10}	Number of 24hr Mean PM_{10} Exceedances 2018 Base
R56	17.9	1
R57	16.3	0
R58	16.3	0
R59	17.9	1
R60	16.5	0
R61	17.0	1
R62	18.7	2
R63	16.7	1
R64	16.7	1
R65	16.3	0
R66	15.9	0
R67	15.4	0
R68	14.8	0
R69	16.3	0
R70	17.1	1
R71	16.9	1

Nitrogen Deposition Rates

Appendix 5.1 - Table 12 Estimated Nitrogen Deposition (kg/N/ha/yr) for all Ecological Receptors, National Highways LTTE6 Projection Factors

ID Ref.	Name	Designated Habitat(s)	Lowest Critical Load (kg N/ha/yr)	Background nitrogen deposition (5km average deposition from APIS (kg N/ha/yr)	Change in N deposition (kg N/ha/yr)	Significance of effect
ECO1	Norton (A38)	Neutral Grassland	10	21.6	-0.24	Not Significant
ECO2	Pegmore Farm, The Leigh 'Meadow 2' U LWS	Neutral Grassland	10	21.6	-0.03	Not Significant
ECO3	Cotswold Farm, The Leigh LWS	Broadleaved Mixed and Yew Woodland	10	35.1	-0.78	Not Significant
ECO4	Tewkesbury Nature Reserve U LWS	Broadleaved Mixed and Yew Woodland	10	49.7	-0.17	Not Significant
ECO5	Tewkesbury Nature	Broadleaved Mixed and	10	49.7	-0.26	Not Significant

ID Ref.	Name	Designated Habitat(s)	Lowest Critical Load (kg N/ha/yr)	Background nitrogen deposition (5km average deposition from APIS (kg N/ha/yr)	Change in N deposition (kg N/ha/yr)	Significance of effect
	Reserve U LWS	Yew Woodland				
ECO6	Tewkesbury Railway Line (Disused) LWS	Neutral Grassland	10	26.9	-0.01	Not Significant
ECO7	Walton Cardiff Ponds LWS	Neutral Grassland	10	26.9	-0.03	Not Significant
ECO8	Veteran Tree	Broadleaved Mixed and Yew Woodland	10	34.9	-0.03	Not Significant

ATKINS
Member of the SNC-Lavalin Group

5th Floor, Block 5
Shire Hall
Bearland
Gloucester
GL1 2TH

Tel: +44 (0) 8000 514 514