8. Air Quality

Summary

Road schemes such as the proposed A9 Dualling Pass of Birnam to Tay Crossing have the potential to impact air quality by changing the concentrations of pollutants at sensitive human health and designated habitat locations during construction and/or operation of the proposed scheme.

A Design Manual for Roads and Bridges (DMRB) Stage 3 air quality assessment was conducted based on computer modelling of future road traffic and air quality conditions. The assessment used forecast road traffic data for the base year (2023), peak construction year (2030) and the proposed year of opening (2036), in addition to other parameters, as part of the modelling process, in accordance with DMRB LA 105 'Air Quality'. A construction risk assessment was also undertaken following Institute of Air Quality Management guidance.

The construction of the proposed scheme has the potential to generate dust and particulate matter emissions which, in the absence of appropriate mitigation, may adversely affect nearby sensitive receptors. Such emissions are, however, unlikely to result in significant adverse effects following the implementation of mitigation measures described in this chapter. The assessment of air quality impacts associated with road traffic during construction were screened out, as the changes in total flow and Heavy-Duty Vehicle flows (as an Annual Average Daily Traffic) did not meet the threshold screening values outlined within DMRB LA 105 'Air Quality' and therefore, impacts would be of negligible significance.

The local air quality assessment of road traffic impacts during operation of the proposed scheme focused on the pollutants nitrogen dioxide (NO_2) and particulate matter with a diameter of less than 10µm (PM_{10}) and 2.5µm ($PM_{2.5}$) at 28 worst-case human health receptors. A further 438 ecological receptors were modelled across 38 transects for the consideration of the potential impacts of the proposed scheme on the deposition of nitrogen at designated Ancient Woodland habitats.

The results for the operation phase show that in the proposed year of opening (2036), there would be no exceedances of Air Quality Objectives for NO_2, PM_{10} or $PM_{2.5}$ at any of the modelled worst-case locations resulting in human health impacts with or without the proposed scheme.

Potentially significant effects were identified for nitrogen deposition on Ancient Woodland, and impacts were consequently assessed in Chapter 12 (Biodiversity), which concludes that such effects are considered to be slight and not significant.

8.1 Introduction

8.1.1 This chapter presents the Design Manual for Roads and Bridges (DMRB) Stage 3 Environmental Impact Assessment (EIA) of the potential effects of the proposed scheme on air quality during construction and operation. The assessment was conducted in accordance with DMRB LA 105 'Air Quality' (National Highways et al., 2024) and Institute of Air Quality Management (IAQM) guidance on the assessment of dust from demolition and construction (IAQM, 2024), which require the following:

- Review and assessment of existing air quality conditions within the defined study.
- Assessment of construction impacts (dust generation and emissions from construction vehicles).
- Road traffic impacts during construction.
- Assessment of all vehicle emissions on local air quality once the proposed scheme becomes operational (modelling impacts on air quality at representative sensitive receptor locations).

8.1.2 The chapter is supported by the following appendices and figures:

- Appendix A8.1: Air Quality Methodology.
- Appendix A8.2: Air Quality Results.
- Appendix A8.3: Construction Risk Assessment.
- Figure 8.1: Modelled Human Health Receptors.
- Figure 8.2: Modelled Ecological Receptors.
- Figure 8.3: Baseline Conditions.
- Figure 8.4: Construction Dust Risk Assessment.
- Figure 8.5: Operational Human Health Assessment Results.
- Figure 8.6: Operational Ecological Assessment Results.

8.1.3 Air quality is measured in relation to the concentrations of certain pollutants in the air, taking account of the effects of these pollutants on sensitive receptor locations. Nitrogen oxides (NO_X) (which refers to nitric oxide (NO) and nitrogen dioxide (NO_2)) and particulate matter (PM; including PM_{10} and $PM_{2.5}$) are all pollutants arising from vehicle traffic emissions that have been considered in the local air quality assessment for the proposed scheme. In rural areas, vehicle emissions represent the main sources of air pollutants, including along the A9. Changes to road alignments and junctions can affect air quality as they can alter the volume and speed of traffic at particular locations and the distribution of traffic more widely across the local road network.

8.1.4 NO_2 is a colourless, odourless gas which has been shown to have adverse health effects, including cardio-pulmonary effects. Combustion in air forms mainly NO and some NO_2 (collectively termed nitrogen oxides; NO_X) from the combination of atmospheric nitrogen and oxygen.

8.1.5 For PM_{10} and $PM_{2.5}$, the numbers denote the size of particulate matter in the air with an average aerodynamic diameter of less than 10µm and 2.5µm respectively, which allows them to settle deep within the lungs causing a range of adverse health effects including cardiovascular and respiratory illnesses. Primary PM is formed from the incomplete combustion of fuel (e.g. soot from diesel exhausts), sea-salt and wind-blown dust. Secondary PM is formed in the atmosphere from other pollutants such as ammonia, NO_X and sulphur dioxides. PM has a residence time of several days in the atmosphere, so pollution events can also occur in the UK when polluted air is blown in from the continent.

8.1.6 As well as the impact on local air quality at human exposure locations, air quality can affect the natural environment. Concentrations of pollutants in the air and the deposition of 'nutrient' nitrogen (N) can have direct and indirect adverse effects on plants, lichens and habitats. The pollutant of most concern for sensitive vegetation near roads is NO_X (UK Centre for Ecology and Hydrology (2024)). Increases in concentrations of NO_X also directly increase levels of N deposition. N can also be formed from ammonia (NH_3), which is a product of the emissions control systems in vehicles (used to reduce emissions of NO_X) rather than combustion within the vehicle engine, and it is consequently not included in the Department for Food and Rural Affairs (Defra) Emission Factor Toolkit (EFT) (Defra et al., 2024). An additional calculation of N deposition associated with road traffic emissions of ammonia is required to understand the full impact of N deposition at sensitive designated habitats. This is discussed in Section 8.2 (Approach and Methods).

Legislative and Policy Framework

8.1.7 While some UK legislation on air quality and pollution prevention is applicable to Scotland, the Scottish Government is responsible for developing most of the domestic policies and legislation to address air quality and reduce associated impacts on human health in Scotland, which are summarised in this section.

Legislation and Strategies

8.1.8 The key air quality legislation and associated strategies relevant to this assessment are summarised in Table 8.1 below.

Table 8.1: Relevant Air Quality Legislation and Strategies

Legislation / Strategy	Description and Relevance to the Proposed scheme
Environment Protection Act 1990; amended by the Pollution Prevention and Control Act 1999. (UK Government, 1990 & 1999)	Part III provides statutory nuisance provisions for dust.
Environment Act 1995, Part IV (UK Government, 1995)	Introduced a system of Local Air Quality Management (LAQM) in the UK. This requires local authorities to review and assess air quality within their boundaries regularly and systematically against Air Quality Objectives (AQOs), appraise development and transport plans against these

Legislation / Strategy	Description and Relevance to the Proposed scheme
	assessments and make plans to meet the AQOs where these are exceeded. Where relevant, an air quality assessment should demonstrate the potential interaction with the LAQM process being undertaken by local authorities.
The Air Quality (Scotland) Regulations 2000, and The Air Quality (Scotland) Amendment Regulations 2002 (Scottish Government, 2000 & 2002)	Legislates for the AQOs for pollutants set out in the 2000 Air Quality Strategy, which was revised in 2007 (Defra, 2007). AQOs exist for a variety of pollutants including NO_X, NO_2, PM_{10} and $PM_{2.5}$. These are established for both the protection of human health and the protection of vegetation and ecosystems.
The National Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland (Defra, 2007).	Updates the 2000 Air Quality Strategy, and sets out how local air quality is managed, through the application of AQOs based on the above Air Quality (Scotland) Regulations 2000 and 2002 Amendments.
Directive 2008/50/EC on ambient air quality and cleaner air for Europe (European Commission, 2008).	Consolidates previous European Directives on ambient Air Quality. These Directives form the basis for UK air quality legislation and were transposed into UK law via The Air Quality Standards (Scotland) Regulations 2010. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007) (AQS; Defra et al. 2007) is consistent with The Air Quality Standards (Scotland) Regulations 2010 (Scottish Government, 2010).
The Air Quality Standards (Scotland) Regulations 2010 (Scottish Government, 2010).	Transposes the formalised Limit Values (LVs) set out in the European Union (EU) Ambient Air Quality Directive 2008/50/EC (European Commission, 2008) to UK law.
Cleaner Air for Scotland (CAFS) (Scottish Government, 2015).	A national strategy setting out the Scottish Government's proposals for delivering further improvements to air quality for compliance with EU air quality legislation. Commits to aligning the AQOs in relation to PM with the World Health Organisation (WHO) recommendations.
The Air Quality (Scotland) Amendment Regulations 2016 (Scottish Government, 2016).	Updates the annual mean $PM_{2.5}$ AQOs from the Air Quality (Scotland) Regulations 2000.
The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 (UK Government, 2020).	Made amendments to environmental laws to ensure continued effectiveness after the end of the implementation period. Amendments to directly applicable retained EU law. Regulations 2,3 and 4 make changes to secondary legislation that implemented EU environmental laws relating to air quality and endangered species. Regulations 5 and 6 make minor changes to Regulations made under 8(1) of the EU (Withdrawal) Act 2018, relating to air quality and chemicals. It also includes

Legislation / Strategy	Description and Relevance to the Proposed scheme
	an amended LV for particulate matter ($PM_{2.5}$) of 20µg/m^3 (excluding Scotland).
The Environment Strategy for Scotland: visions and outcomes (Scottish Government, 2020).	This provides the framework and policy priorities for Scotland.
Cleaner Air for Scotland 2 (CAFS2) (Scottish Government, 2021).	CAFS2 supersedes CAFS and sets out actions to improve air quality and how these will be delivered based upon the 2020 Environment Strategy for Scotland.

8.1.9 EU Directive 2008/50/EC Ambient Air Quality and Cleaner Air for Europe (European Commission, 2008) was published to consolidate previous European Directives on ambient air quality. The Directive forms the basis for UK air quality legislation and was transposed to UK law via The Air Quality Standards (Scotland) Regulations 2010 (Scottish Government, 2010). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007) (AQS; Defra et al. 2007) is consistent with The Air Quality Standards (Scotland) Regulations 2010 (Scottish Government, 2010).

8.1.10 In 2016, Scotland became the first country in Europe to adopt the 2005 WHO recommended annual mean guideline value for $PM_{2.5}$ of 10µg/m^3 and so currently, the Scottish Air Quality Objectives (AQOs) for particulate matter are 18µg/m^3 and 10µg/m^3 for PM_{10} and $PM_{2.5}$, respectively.

8.1.11 Prior to Brexit, the UK Government was responsible to the European Commission (EC) for ensuring that it complied with the provisions of the EU Directive. Although this is no longer the case, the Air Quality Standards (Scotland) Regulations 2010 remain in force and compliance with the Limit Values (LVs) within these regulations is still required.

National Air Quality Standards

8.1.12 The AQOs applicable to Local Air Quality Management (LAQM) in Scotland are set out in The Air Quality (Scotland) Regulations 2000 and its associated amendments (The Air Quality (Scotland) Amendment Regulations 2002; and 2016), whilst LVs are set out in The Air Quality Standards (Scotland) Regulations 2010. AQOs are health-based standards set at a level to provide protection to the whole population. The pollutants relevant to this assessment are NO_X, NO_2, PM_{10} and $PM_{2.5}$. The relevant AQOs / LVs for these pollutants are presented in Table 8.2. The AQS also provides for a non-statutory objective for NO_X. This is currently not assessed by Scottish local authorities.

8.1.13 Pollutants such as benzene and 1,3-butadiene, for which AQOs have been set, are associated with the use of fuels for road transport (petrol). Other pollutants are also potentially associated with emissions from diesel combustion. However, based on review and assessment of air quality across the UK, DMRB LA 105 specifies that there is no potential risk

of exceedance of the AQOs or significant impacts for any pollutants other than NO_2 and PM owing to a road scheme.

Table 8.2: Relevant Air Quality Limit Values and National Air Quality Objectives

Pollutant	Concentration	Averaging Period
NO_2	40µg/m^3	Annual mean
	200µg/m^3 (not to be exceeded more than 18 times/yr)	1-hour mean
PM_{10}	18µg/m^3	Annual mean
	50µg/m^3 (not to be exceeded more than 7 times/yr)	24-hour mean
$PM_{2.5}$	10µg/m^3	Annual mean

8.1.14 There are no assessment methods available that can produce robust predictions of short-term concentrations from road traffic. Therefore, compliance with the short-term AQOs/LVs is assessed by following the guidance presented in LAQM Technical Guidance (Defra, 2022) (hereafter referred to as LAQM TG(22)), which provides a relationship between the annual mean concentration and the number of periods per year where the short-term AQO is likely to be exceeded. These relationships have been derived from examination of monitoring data across the UK.

8.1.15 The responsibilities of local authorities with respect to meeting AQOs are not the same as the responsibilities of the UK government for meeting legally binding air quality LVs. Local authorities do have statutory duties for LAQM, however, they are not obliged to ensure AQOs are met, but rather that they are worked towards in the shortest practical time. Under Part IV of the Environment Act 1995, the UK Government introduced LAQM, which placed duties on local authorities to undertake periodic reviews of air quality in their areas to assess present and likely future air quality against the AQOs. Where these AQOs are not likely to be met, the local authority must designate an Air Quality Management Area (AQMA) and produce an action plan for improvement in air quality.

8.1.16 It is important to recognise the difference between the LVs (for which compliance is determined at a national level by government) and AQOs (for which compliance is determined at a local level by local authorities under the LAQM regime). Whilst the LVs and AQOs for a pollutant may be set at the same concentration value (e.g. 40µg/m^3, as an NO_2 annual mean) the means of determining compliance are fundamentally different, and they must be considered separately.

8.1.17 Compliance with air quality LVs is determined via the national monitoring network and national model (the Pollution Climate Mapping (PCM) model). There are important differences between this, and the monitoring/modelling carried out by local authorities to determine compliance with AQOs. Some of these differences are summarised in Table 8.3.

Table 8.3: Comparison Between National and Local Compliance Approaches

Exposure Type	National Compliance	Local Compliance
Relevant exposure	LVs apply everywhere there is public access, within 15m of the running lane/kerbside. However, paths running perpendicular to the road are excluded.	Annual mean AQOs only apply at locations where public exposure is relevant to the averaging period, e.g. at residential building façades.
Treatment of junctions	Monitoring is not carried out within 25m of a junction and the same constraint is applied to the modelling.	Junctions are specifically considered in both monitoring and modelling.
Microscale	Excludes micro-environments and focuses on locations representative of 100m lengths of roads.	Focuses on 'hot-spot' locations (e.g. residential properties near to busy road junctions) where exposure to air pollution is likely to be highest.
Roadside	Modelled concentrations apply to a distance of 4m from kerbside of the national road network. Local roads are excluded from the model.	Focus is on concentrations at the building façade, whatever distance from the kerb and alongside any road.
Monitoring	Restricted to monitoring stations in the national network, operated to meet the Data Quality Objectives of the Directive.	Principally based on local authority monitoring, including both automatic and passive diffusion samplers.

8.1.18 Because of these differences, there are many locations across the UK where the national compliance with the LVs, and local compliance with the AQOs, are not in agreement. They are treated separately in this assessment, which is consistent with the advice in the relevant Planning Advice Notes (PANs), discussed below, produced by the Scottish Government (which provide further guidance on specific topics) and with DMRB LA 105 'Air Quality' guidance.

National Policy

8.1.19 National Planning Framework 4 (NPF4) 2023 was adopted in February 2023 (Scottish Government, 2023). The Framework outlines the Scottish Ministers' policies and proposals for development and land-use in Scotland and details the long-term spatial strategy, spatial principles, priority actions and National Developments up to 2045. The following policy is related to air quality in the context of the proposed scheme:

- Health and Safety - Policy 23d "*Development proposals that are likely to have significant adverse effects on air quality will not be supported. Development proposals will consider opportunities to improve air quality and reduce exposure to poor air quality. An air quality assessment may be required where the nature of the proposal or the air quality in the location suggest significant effects are likely".*

8.1.20 PAN 51 summarises the statutory responsibilities of the environmental protection bodies (Scottish Executive, 2006). Its purpose is to support the existing policy on the role of the planning system in relation to the environmental protection regimes.

Dust Nuisance

8.1.21 One of the main concerns regarding the air quality impact during construction is the potential of impacts from fugitive dust. There are no nationally recognised criteria defining levels of dust that can cause an annoyance.

8.1.22 Fugitive dust effects can be controlled under the Statutory Nuisance provisions of Part III of the Environmental Protection Act 1990. Industry developed best practice techniques and fugitive dust control mitigation measures are outlined by the IAQM guidance (IAQM, 2024), which has been used in this assessment.

Local Policy and Guidance

8.1.23 Perth & Kinross Council (PKC) manage local air quality through the implementation of Local plans, policies through partnerships and initiatives. These include:

- Perth & Kinross Air Quality Action Plan (AQAP) (PKC, 2009).
- Perth & Kinross Local Development Plan 2 (LDP2) (PKC, 2019).
- Supplementary Guidance: Air Quality and Planning (PKC, 2020).

8.1.24 The AQAP for Perth City (PKC, 2009) is currently being updated and is under final review before going out to public consultation and, at the time of writing, had not been published. The AQAP for Perth City relates to the Air Quality Management Area (AQMA) in Perth City and, as such, is not relevant to the proposed scheme as the study area for the assessment of air quality for this EIA does not extend into the Perth AQMA.

8.1.25 Policies within the LDP2 relevant to air quality include Policy 57: Air Quality, which includes the prevention of new pollution hotspots and worsening of air quality as a result of planning decisions. This air quality assessment has considered the potential for any new air pollution hot spots and/or worsening of air quality as a result of the proposed scheme.

8.1.26 The Supplementary Guidance (PKC, 2020) produced by PKC supports the LDP and provides guidance for all parties regarding how air quality will be considered when determining planning applications. The Supplementary Guidance uses criteria consistent with the Environmental Protection UK (EPUK) and IAQM Land-Use Planning & Development Control: Planning for Air Quality (EPUK/IAQM, 2017) criteria, to determine when an air quality impact assessment is likely to be required. It also aligns with the IAQM guidance on the assessment of dust from demolition and construction (IAQM, 2024). This air quality impact assessment is compliant with the Supplementary Guidance for the assessment of construction dust impacts, however, DMRB LA 105 screening criteria was applied for the road transport emissions assessment. This criterion is more appropriate for large road projects (such as the proposed scheme) than the EPUK/IAQM guidance.

8.2 Approach and Methods

Scoping and Consultation

8.2.1 Consultation via electronic mailed correspondence with PKC (25 January 2024) regarding site locations for a nitrogen dioxide diffusion tube survey and the DMRB Stage 3 assessment approach was undertaken. The diffusion tube monitoring undertaken is discussed further in Section 8.3 (Baseline Conditions).

8.2.2 Further detail on scoping and consultation is provided in Chapter 7 (Consultation and Scoping).

General Approach

8.2.3 The assessment has considered air quality primarily in accordance with DMRB LA 105 (formerly DMRB HA 207/07). Aspects of the approach to the assessment have also been informed by the Defra LAQM technical guidance (hereafter referred to as LAQM TG(22)) (Defra, 2022) and other guidance as discussed further below.

8.2.4 This assessment conforms to the standard practice of EIA, whereby a baseline is established, and then a future situation with the proposed scheme in place (DS) is compared with the situation without the proposed scheme in place (DM) and this informs the determination of significant effects from the proposed scheme. For the purposes of the assessment, the proposed year of opening has been modelled as 2036.

8.2.5 The construction dust risk assessment has followed the IAQM Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2024). The methodology is specific to construction and includes mitigation measures to minimise impacts from dust and site equipment.

Simple or Detailed Assessment

8.2.6 For the assessment of road scheme impacts on air quality, DMRB LA 105 sets out two levels of assessment: 'simple' and 'detailed'. A simple assessment is considered appropriate if air quality is not expected to be a fundamental issue in the decision-making process, with detailed assessment intended to be applied where the potential exists for exceedances of air quality thresholds or for the proposed scheme to cause significant effects.

8.2.7 To determine the appropriate assessment, DMRB LA 105 provides matrices tables. These consider the project risk potential to impact on traffic (Table 2.11a) (high or low) and the sensitivity of the receiving environment (Table 2.11b) (low, medium or high).

8.2.8 The proposed scheme does not meet the criteria defined as 'high' risk for traffic impact, which are identified as:

- a large smart motorway project;
- a bypass; or

- a major motorway junction improvement.

8.2.9 The proposed scheme is also between low and medium categories with regards to the receiving environment sensitivity, which are as indicated. The proposed scheme has:

- no AQMAs or EU LV exceedances within the study area (low);
- monitored annual mean NO_2 concentrations <36µg/m^3 (low); and
- sensitive receptors within 50m of roads triggering traffic change criteria (medium).

8.2.10 The outcome of the Stage 2 A9 Dualling Programme: Pass of Birnam to Tay Crossing Environmental Impact Assessment (EIA) for the proposed route options (Transport Scotland, 2022) predicted no significant effects at human health locations and the potential for significant effects on Ancient Woodland habitats (sites designated on the Ancient Woodland Inventory; NatureScot, 2000) owing to changes to air quality.

8.2.11 Having accounted for the nature of the scheme, (which generally involves online widening of an existing road with junction improvements) and subsequent low traffic impact risk, accompanied with the low to medium receiving environment sensitivity, a DMRB simple assessment was considered appropriate. A simple assessment is also consistent with the approach taken for other A9 dualling sections.

Study Area

Construction Dust Assessment

8.2.12 Potential air quality impacts as a result of construction activities were considered within 250m of the proposed scheme boundary, and 50m from the haul route roadsides up to 250m from the construction site exit. Sensitive receptors were banded at the following distances from dust-raising activities for construction (distances from the site boundary), in accordance with IAQM guidance, and as shown on Figure 8.4 (Construction Dust Risk Assessment):

- 0 to 20m;
- 21 to 50m;
- 51 to 100m; and
- 101 to 250m.

Road Traffic Assessment

8.2.13 The study area for air quality impacts from road transport was defined following the screening process outlined in DMRB LA 105, which identifies the 'Affected Road Network' (ARN) based on changes between the DM and DS scenarios where:

- the horizontal road alignment changes by 5m or more;
- the daily traffic flows change by more than 1,000 annual average daily traffic (AADT);
- the daily Heavy-Duty Vehicle (HDV) flows change by more than 200 AADT; and/or

- a change in speed band.

8.2.14 The 'speed band' referenced above refers to a range of categories for which outputs from the traffic model are grouped to describe their emissions based on speed and road type, as defined in DMRB LA 105. There is a National Highways tool for simple assessments that uses speed banded traffic data to calculate the air quality receptor concentrations (version 9.0, available on request from National Highways (National Highways, 2024a)). However, this simple assessment tool is not appropriate for this assessment as it does not include an output for $PM_{2.5}$. $PM_{2.5}$ needs to be included for air quality assessments in Scotland due to the AQOs in Scotland, as listed in Table 8.1. Another tool from National Highways (National Highways, 2024c) can be used with speed banded traffic data to calculate emissions only, including $PM_{2.5}$ (as opposed to concentrations). However, the speed banded emission factors are consistent with the English vehicle fleet mixes, as opposed to Scottish. Speed bands were not therefore requested from the traffic modellers, and as a result were not available for use in this assessment. This issue was discussed with Transport Scotland in accordance with SNAA. Therefore, the following supplemental criteria, taken from the previous DMRB air quality guidance HA 207/07 (Highways Agency et al., 2007)), were used to identify road links in the ARN where changes in vehicle speed may have the potential to result in significant air quality impacts:

- daily average speeds change by 10kph or more; and/or
- peak hour speed change by 20kph or more.

8.2.15 The study area (defined as receptors within 200m of the ARN) is presented in Figure 8.1 (Modelled Human Health Receptors). All roads within 200m of the modelled receptors were also included to allow the impact of other roads to be accounted for. The extent of the study area was limited to 500m from either end of the proposed scheme. This was consistent with the approach applied to the assessment of this and other sections of the A9 Dualling Programme at DMRB Stage 2 and Stage 3.

Sensitive Receptors

8.2.16 Sensitive receptors for the protection of human health were identified at worst-case locations of relevant exposure (in accordance with LAQM TG(22) (Defra, 2022)) and modelled for the road traffic assessment. Receptors were located within 200m of the ARN. These receptor locations represent areas likely to experience the maximum potential air quality impacts of the proposed scheme or experience the largest changes in pollutant concentrations as a result of the proposed scheme (i.e. they represent worst-case locations).

8.2.17 In accordance with DMRB LA 105, designated habitats within 200m of the ARN were also considered. Designated habitat locations contain features which may be sensitive to air pollutants, either directly (i.e. on the primary habitat designated) or indirectly (i.e. on the habitat associated with a non-habitat designation, e.g. birds), and which could be adversely affected by the effect of air pollution on vegetation. Designated habitats, as defined within DMRB LA 105, include Ramsar sites, Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSIs), Local Nature Reserves (LNRs),

Local Wildlife Sites (LWSs) which includes Sites of Biological Importance (SBIs), Nature Improvement Areas (NIAs), Ancient Woodlands and veteran trees.

8.2.18 Designated habitat locations were identified within 200m of the ARN. For each habitat, transect lines were drawn perpendicular to the road and receptors points placed at 10m intervals along the transect line, from the habitat boundary nearest the road, up to 200m from the nearest ARN road edge, for inclusion in modelling.

Construction Dust Assessment

8.2.19 Major construction projects can give rise to increased long-term and short-term PM_{10} concentrations. There is also the potential for dust soiling effects at receptors within 250m of construction sites and/or 50m from the edge of proposed haulage roads (up to 250m along the haulage roads from the site entrance(s)). These dust soiling effects, which are separate from potential adverse effects on health, can arise through annoyance caused by the soiling of windows, cars, washing and other property.

8.2.20 Very high levels of dust deposition can also affect plants and ecosystems, by covering their leaf surfaces or changing the chemical composition and texture of the soil. According to the IAQM guidance (IAQM, 2024), the maximum distance at which dust effects are likely to be experienced at ecological receptors is 50m from the source and/or 50m from the edge of proposed haulage roads (up to 250m along the haulage roads from the site entrance(s)).

8.2.21 Potential construction phase impacts resulting from the generation and dispersion of suspended particles (PM and dust) have been assessed following the approach outlined within the IAQM guidance, which provides a qualitative risk-based appraisal and considers the proposed scheme in relation to sensitive locations, the planned construction process and local site characteristics to determine a risk of dust impact and subsequent recommendations to minimise the potential for significant effects. The full methodology and assessment results are provided within Appendix A8.3 (Construction Risk Assessment) and the sensitive receptors considered for assessment are shown in Figure 8.4 (Construction Dust Risk Assessment). A summary of the methodology is provided in Table 8.4. For clarity, trackout is the transport of dust and dirt from the construction site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. This arises when HDVs leave the construction site with dusty materials, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on-site.

Table 8.4: Summary of IAQM Construction Dust Assessment Methodology

Step	Methodology Summary
1	Screen the need for a detailed assessment.
2a	Determine the potential dust emission magnitude - small, medium and large-scale risk, for each site activity – demolition, earthworks, construction and trackout.
2b	Define the sensitivity of the area – low, medium or high which includes specific sensitivities of receptors based on proximity and numbers of those receptors and the local background PM_{10} (pertinent to human health effects).
2c	Define the risk of impacts, based on the dust risk and area sensitivity conclusions from Step 2a and 2b (without mitigation).
3	Site specific mitigation (if required).
4	Determination of significant residual effects.

8.2.22 The construction dust risk assessment has been undertaken using construction data provided by the project design team. The assessment area was divided into four A9 Zones (North, Central, Dunkeld & Birnam Station and South) as shown in Figure 8.4.

8.2.23 The level of dust measures and controls required differ in relation to the level of risk for potential for dust nuisance. The mitigation measures required are generally suitable for inclusion in a Construction Environmental Management Plan, which would normally be agreed with the respective local authority prior to commencement of activity on the site. Mitigation measures and controls for the proposed scheme are detailed further in Section 8.5 (Mitigation).

Construction Traffic Assessment

8.2.24 DMRB LA 105 states that if "*construction activities are less than 2 years it is unlikely that the construction activities would constitute a significant air quality effect … given the short-term duration of the construction activities as opposed to the long-term operation of the project*". The construction period is approximately 3 years 7 months (43 months) duration (refer to Chapter 6: The Proposed Scheme), albeit the maximum duration per A9 Zone (i.e. North, Central, Dunkeld & Birnam Station and South, as shown in Figure 8.4 and discussed in paragraph 8.2.22) is approximately 1.8 years (96 weeks). Construction traffic was therefore screened in line with the DMRB LA 105 scoping criteria, discussed under Study Area.

8.2.25 The total construction traffic two-way vehicle movements over a duration of 3 years 7 months years were factored to derive AADT for each of the four A9 Zones. Whilst there is the possibility of equipment and staff moving between the four A9 Zones, it is assumed that each Zone will be managed independently, with localised satellite compounds offering welfare, offices, storage facilities etc.

8.2.26 Screening of the construction traffic indicated that it was unlikely that construction activities would result in significant changes in air quality as a result of changes in traffic conditions on the local road network or haul routes. The largest estimated construction HDV traffic flow (as an AADT) was 125 and the largest total daily flow of all vehicles (as an AADT) was 295. Both of these maximum construction traffic flows occurred in the North Zone, where 50% of all construction vehicle movements are expected to occur. These maximum values were below the DMRB LA 105 screening thresholds and as such, likely changes to local air quality would be negligible. Given the North Zone is below the DMRB threshold, this also means that Central, South and Dunkeld and Birnam Stations Zones will also be below the DMRB thresholds. The requirement to assess construction road traffic was therefore, **scoped out.** The construction traffic flows are presented in Appendix A8.1 (Air Quality Methodology).

Diversionary routes

8.2.27 To keep the existing A9 operational during construction of the proposed scheme, there are planned diversionary routes, moving existing A9 traffic off one side of the carriageway, to enable construction activities to take place. The maximum duration for a diversion is approximately 96 weeks. Given the duration of diversionary routes are for less than 2 years further assessment of air quality impacts is **scoped out** in accordance with DMRB LA 105. The proposed diversionary routes are shown in Appendix A of the Constructability & Phasing Report (Jacobs UK, 2025).

Background Concentrations

8.2.28 Background concentrations are necessary to account for non-modelled contributions to derive the total pollutant concentration. The Scottish Air Quality website (Scottish Air Quality, 2024) provides empirically derived national background maps, as part of the Scottish Air Quality Database project, which provide estimates of background pollutant concentrations on a 1km x 1km grid square resolution. Data for 2023 NO_X, NO_2 and PM_{10} have been obtained for the Perth & Kinross area.

8.2.29 Scotland specific maps for $PM_{2.5}$ were not available from the Scottish Air Quality website. Therefore, the ratio between the Defra $PM_{2.5}$ and Defra PM_{10} (Defra, 2020a) concentrations were calculated for each mapped data point across the study area. These ratios were applied to the corresponding mapped data points for the Scotland specific PM_{10} backgrounds to calculate estimated Scottish Air Quality background $PM_{2.5}$ concentrations. Mapped background NO_X concentrations were also adjusted by comparing with monitored concentrations, as discussed in Appendix A8.1 (Air Quality Methodology).

8.2.30 The 'in-grid square' contributions from road sources have been removed (i.e. the contribution to backgrounds from road sources within the 1km grid square to avoid double counting of the modelled roads) from the annual mean NO_X, PM_{10} and $PM_{2.5}$ background concentration estimates. The background annual mean NO_2 estimates have been corrected using the Defra Sector Removal Tool (Version v8.0) (Defra, 2020b) using the updated background NO_X. All tools used during modelling were appropriate at the time of assessment (during the summer of 2024).

Traffic Data

8.2.31 Traffic data (as road links) were provided for a base year of 2025 and the opening year 2036. The base year 2025 was used as a proxy for 2023 (which was agreed as a suitable proxy with the traffic modellers) within the air quality assessment to allow for model verification against monitoring data, as discussed below. The Traffic Reliability Area (TRA) covered the extent of the proposed scheme and other key roads and is shown in Figure 8.3 (Baseline Conditions). The traffic data included:

- vehicles per day (as an AADT);
- percentage HDV (as an AADT); and
- daily average vehicle speed, in kph.

Air Quality Modelling

8.2.32 As the simple assessment tool discussed in paragraph 8.2.14 could not be used, traffic data were used in conjunction with the Defra Emissions Factor Toolkit (EFT) version 12.0.1 (selecting Scotland as a region for fleet mix purposes) to calculate emissions for all road links within the study area. These calculated emissions rates were, along with distances to receptors, then used with dispersion equations described in Annex C of the DMRB HA 207/07 (Highways Agency, 2007) to provide a road traffic contribution at each receptor for the base year (2023) and the with and without proposed scheme in the opening year 2036.

8.2.33 The road contributions were adjusted by a project specific verification factor, derived from the comparison of modelled and monitored concentrations as discussed in Appendix A8.1 (Air Quality Methodology), and combined with background concentrations to calculate the total NO_X, PM_{10} and $PM_{2.5}$ concentrations at relevant receptors for the scenarios assessed.

8.2.34 Modelled road NO_X contributions were combined with background NO_2 concentrations to provide an estimate of annual mean NO_2 concentrations using Defra's NO_X to NO_2 Calculator v8.1 (Defra, 2020c), which is compatible with the fleet mix within EFT v12.0.1. The 'All other urban UK traffic' traffic mix was selected, and the local authority set to 'Perth & Kinross'.

8.2.35 To account for future years under prediction of NO_2, DMRB LA 105 discusses use of a gap factor to adjust model predictions to better reflect measured long-term trends of NO_X and NO_2. This methodology was applied to this assessment. This method is explained in further detail in Appendix A8.1 (Air Quality Methodology).

8.2.36 The change in DM and DS road NO_2 concentrations (verification and Long Term Trends (LTT) adjusted) were converted to the dry nutrient nitrogen (N) deposition (kgN/ha/yr) using the following conversion rates, as recommended by DMRB LA 105:

- Grassland and similar habitats: 1µg/m^3 of NO_2 = 0.14 kgN/ha/yr
- Forests and similar habitats: 1µg/m^3 of NO_2 = 0.29 kgN/ha/yr

8.2.37 In addition, the National Highways draft Ammonia N deposition tool (National Highways, 2024b) was used to calculate the ammonia (NH_3) component.

8.2.38 The total N deposition for each transect point was then calculated by adding the road-based N deposition components, derived from NO_2 and NH_3, to the relevant baseline N deposition rates. Baseline nitrogen (N) deposition rates and Critical Loads (CL) for the confirmed nitrogen-sensitive habitats were obtained from Air Pollution Information System website (APIS) (UK Centre for Ecology and Hydrology, 2024a). CLs are defined on the APIS website as "*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge* (UK Centre for Ecology and Hydrology, 2025)."

Impact Magnitude and Significance

Human Health Receptors

8.2.39 The significance of an environmental impact is a function of the sensitivity of the receptor and the scale or magnitude of the impact. The approach taken to assess the likely significance of predicted impacts at human health receptors is set out in the following sections. It is noted that only the receptors predicted to exceed an AQO in the DM or DS scenario are considered in the assessment of significance.

8.2.40 DMRB LA 105 indicates that a conclusion of no likely significant air quality effect for human health should be recorded where the following apply:

- Outcomes of the air quality modelling for human health indicate that all concentrations are less than the relevant air quality thresholds.
- All modelled changes in concentrations are 'imperceptible' i.e. less than 1% of the air quality threshold (e.g. 0.4µg/m^3 or less for annual mean NO_2).

8.2.41 The magnitude of change criteria based on DMRB LA 105 were applied to the modelling results based on the change in annual mean concentration between the DM and DS for the proposed year of opening (2036). Whilst the methodology in DMRB LA 105 does not specifically include an assessment of $PM_{2.5}$, PM has been assessed using the respective percentage ranges for the determination of 'magnitude' as NO_2 (as indicated in Table 8.5).

Table 8.5: Air Quality Annual Mean Magnitude of Change Criteria (µg/m^3)

Magnitude	Magnitude of Change NO_2 (AQO: 40µg/m^3)	Magnitude of Change PM_{10} (AQO: 18µg/m^3)	Magnitude of Change $PM_{2.5}$ (AQO: 10µg/m^3)
Imperceptible (<1% +/- of AQO)	<0.4	<0.18	<0.1
Small (1-5% +/- of AQO)	0.4 – 2	0.18 – 0.9	0.1 – 0.5
Medium (5-10% +/- of AQO)	2 – 4	0.9 – 1.8	0.5 – 1
Large (>10% +/- of AQO)	>4	>1.8	>1

8.2.42 Where changes are greater than 1% (i.e. not imperceptible) of the AQOs, a receptor is assigned to one of the six categories in Table 8.6 if also exceeding the relevant AQO. Where

the assessment predicted that modelled concentrations at all assessed sensitive receptors were less than the AQOs or where any changes above the AQOs had a magnitude of change of imperceptible, it was concluded that the impact of the proposed scheme was not significant.

8.2.43 Table 2.92N of DMRB LA 105 provides guidance on the number of receptors in each magnitude of change category that could constitute a significant effect, as reproduced in Table 8.6.

8.2.44 It should be noted that these are guideline values, based on the considered opinion of National Highways, in consultation with Transport Scotland, and are intended to help provide consistency across highways scheme assessments.

Table 8.6: Guideline to the Number of Receptors Constituting a Significant Effect

Magnitude of Change in Annual Mean Pollutant Concentration	Number of Receptors with worsening of an AQO already above the objective or the creation of a new exceedance	Number of Receptors with improvement of an AQO already above the objective or the removal of an existing exceedance
Large (>10% of AQO)	1 to 10	1 to 10
Medium (>5% of AQO)	10 to 30	10 to 30
Small (>1% of AQO)	30 to 60	30 to 60

8.2.45 The number of receptors in each guideline band have been used to inform professional judgement of the likely significance of the effects of the proposed scheme on human health. In order to inform this judgement, DMRB LA 105 suggests the following:

- Where the total number of receptors are less than the lower guideline band for all the six magnitude of change categories, the project is unlikely to trigger a significant air quality effect for human health. The impacts of a scheme can still be deemed significant, however, if the number of receptors affected are below the lower guideline band, for example where there are changes in concentrations in the small magnitude of change category, but the changes are approaching the medium magnitude of change criteria (e.g. 1.8 / 1.9µg/m^3).
- Where the total number of receptors are greater than the upper guideline band in any of the magnitude categories, the project is likely to result in a significant air quality effect.
- Where the number of properties resides between the lower and upper guideline bands for any of the magnitude of change criteria in Table 8.6, then the following criteria should be considered when assessing significance:
  - The absolute concentration at each receptor i.e. is the modelled concentration 40 or 60µg/m^3.
  - How many receptors there are in each of the magnitude of change criteria i.e. does the project create more worsening than improvements.
  - The magnitude of change in concentration at each receptor e.g. 0.6 vs 1.8µg/m^3.

8.2.46 Consideration of whether the proposed scheme detracted from or supported measures set out in relevant local authority Air Quality Action Plans (AQAPs) was considered as part of the overall significance. However, as there were no AQMAs in proximity to the proposed scheme, this aspect was also scoped out from consideration.

Designated Habitats

8.2.47 Where the predicted change in N deposition was >1% of the minimum CL (as defined in 8.2.38); the deposition rate change was greater than 0.4 kgN/ha/yr; and the total N deposition was above the minimum CL, the results were classed as potential significant. Chapter 12 (Biodiversity) provides an assessment of whether the changes in nitrogen deposition are likely to trigger a significant air quality effect on designated sites.

8.2.48 Potential impacts on designated sites in relation to PM are not required to be assessed under DMRB LA 105.

Compliance Risk Assessment

8.2.49 Defra provide projections for concentrations of NO_2 for a selection of road links across the UK in a process known as Pollution Climatic Mapping (PCM); a model assessment for the development of the UK Plan for tackling roadside NO_2 concentrations and determining compliance with air quality LVs. Any ARN road links that are part of the PCM network have to be assessed in terms of their impact on the LVs.

8.2.50 The 2020 projection dataset (2018 reference year) (Defra, 2020d) was obtained for this assessment and all PCM links meeting the following criteria were assessed:

- correspond with the ARN; and
- contain qualifying features (e.g. where there is public access or sensitive receptors) within 15m of the running lane.

8.2.51 No road links were identified in the PCM model that correspond to road links within the ARN. Therefore, no LV compliance has been undertaken and it was scoped out.

Cumulative Effects

8.2.52 Potentially significant cumulative effects resulting from the construction and operation of the proposed scheme, and those of the proposed scheme in combination with other reasonably foreseeable developments, are assessed in Chapter 21 (Assessment of Cumulative Effects).

Limitations to Assessment

8.2.53 As with any computer model that seeks to predict future conditions, there is uncertainty in the predictions made. Elements of impact prediction such as the specific concentration of a given pollutant at a given property, or whether an exceedance of AQOs or LVs would or would not occur at a specific location, are not precise and are always subject to a margin of error. However, the assessment process is based on reasonable, robust and representative

methodologies, taking advice from published guidance. Furthermore, model outputs have been verified against local monitoring data, as shown in Appendix A8.1 (Air Quality Methodology) and following adjustment are shown to be acceptable.

8.2.54 Identification of sensitive receptors was based on OS AddressBase Plus data. In some cases, there may be properties, such as those recently built, that were not present within this data source. Every reasonable endeavour was made to identify and consider all such properties within the study area during the DMRB Stage 3 assessment.

8.2.55 It is assumed the traffic model is robust and fit for purpose. Any limitations relating to traffic data are not discussed here. However, the simple assessment approach and application of AADT traffic flows does smooth out any changes occurring during peak hours, which may influence emission rates from traffic, particularly if congestion is an issue. On the basis the existing A9 does not experience significant congestion or hot spot pollution episodes, more detailed traffic data were not required.

8.2.56 The construction dust risk assessment was undertaken using data available at the time of the assessment. The CPO boundary includes land take areas, which may or may not be utilised for construction purposes, therefore the assessment is a worst-case approach and assumes construction activities could be undertaken at the proposed scheme construction site boundary.

8.3 Baseline Conditions

8.3.1 Baseline conditions have been determined by considering information and data from the following sources provided below:

- 2023 Air Quality Annual Progress Report (APR) (PKC, 2024b).
- Detailed Assessment of Revocation of Crieff AQMA (PKC, 2024c).
- A9 Dualling Pass of Birnam to Tay Crossing air quality monitoring survey (Jacobs UK, 2024).
- Scottish Air Quality background maps (Scottish Air Quality, 2024).
- Defra background maps for $PM_{2.5}$ calculation (Defra, 2020a).
- Ecology site baseline data and critical loads (UK Centre for Ecology and Hydrology, 2024).
- Ecology site open data (NatureScot, 2024).
- Ordnance Survey AddressBase Plus and mapping data (Transport Scotland, 2025).

Local Authority Reports

8.3.2 Under Part IV of the Environment Act 1995, which established the LAQM regime, all local authorities are required to undertake a regular review of air quality in their area of jurisdiction. The local authority must designate an AQMA where ambient concentrations of pollutants exceed or are predicted to exceed the relevant air quality thresholds. The proposed scheme is within the administrative boundaries of PKC. Therefore, the most recent PKC Air Quality Annual Progress Report (PKC, 2024b) was reviewed. This describes recent air

quality conditions within the PKC administrative area, including monitoring and the status of AQMAs.

8.3.3 PKC has declared two AQMAs encompassing the whole of Perth City and the high street corridor through Crieff:

- Perth AQMA was declared in 2006 for exceedances of annual mean AQOs for NO_2 and 24hr mean PM_{10} and an AQAP was prepared in 2009. The existing plan has been re-aligned to meet Scottish Government policy published in 2023 and continues to be progressed. A draft Perth Air Quality Action Plan (PAQAP) (PKC, 2024d) was published November 2024 for public consultation. Results from this will be used to finalise the PAQAP and following committee approval, will come into effect. Results are expected February 14th 2025.
- Crieff AQMA (Perth AQMA No. 2) was declared in 2014, also for exceedances of annual mean NO_2 and 24hr mean PM_{10} AQOs. An AQAP for the Crieff AQMA was approved mid-2019. In 2024 PKC published detailed modelling in support of the proposed revocation of Crieff AQMA (PKC, 2024c). The report by SWECO UK Limited (on behalf of PKC) concluded the revocation of the AQMA should be considered. The 'Perth and Kinross Air Quality Management Area (No.2) Revocation Order' (PKC, 2024e) came into effect on 1st December 2024.

8.3.4 The Perth and Crieff AQMAs lie approximately 13km and 26km, respectively, outside of the air quality study area and, therefore, are unlikely to be influenced by changes to traffic as a result of the proposed scheme. It is also considered that the proposed scheme would not affect the implementation of the Perth AQAP. The AQMAs and AQAP are, therefore, not considered further in this assessment.

Air Quality Monitoring

Local Authority

8.3.5 PKC undertook continuous monitoring at four locations during 2023 for NO_2, PM_{10} and $PM_{2.5}$. The Council also operates a network of 76 passive NO_2 diffusion tubes across the local authority area, covering Perth City centre, wider Perth area, Crieff, Auchterarder and Blairgowrie. Although PKC uses a variety of automatic and non-automatic air quality monitoring methods within their administrative area, no monitoring locations were identified within the air quality study area and as such none of the locations where monitoring is undertaken were considered in the assessment of the proposed scheme.

Proposed Scheme NO_2 Diffusion Tube Monitoring

8.3.6 A six-month passive NO_2 diffusion tube survey was undertaken by Jacobs UK Ltd between February 2024 and August 2024 to augment available baseline data for use in this assessment and inform the model verification process (Jacobs UK, 2024).

8.3.7 The 13 monitoring locations were agreed with PKC as discussed in Section 8.2 (Scoping and Consultation); these comprised roadside locations representative of sensitive receptors or

locations close to the expected ARN for model verification purposes. The locations of the monitoring sites are presented in Figure 8.3 (Baseline Conditions).

8.3.8 Monitored monthly concentrations were annualised and adjusted to the base year (2023) and bias adjusted in accordance with LAQM TG(22) guidance (Defra, 2022) for comparison against modelled baseline predicted NO_2 concentrations in model verification. The short to long term adjustment (annualisation) of monitoring data and verification process is outlined in full within Appendix A8.1 (Air Quality Methodology) and resultant monitored concentrations detailed below in Table 8.7.

Table 8.7: Proposed Scheme NO_2 Diffusion Tube Monitoring

Site ID	Location Description	Location X	Location Y	Annualised and Bias Adjusted 2023 NO_2 Concentration (µg/m^3)
A9_01	On Lamp Post, Atholl Street	302649	742820	9.4
A9_02	On Birnam Local Services sign, A923	302683	742201	8.5
A9_03	On signpost Layby 19, A9	300328	743014	15.4
A9_04	On signpost Layby 22, A9	300441	745767	15.9
A9_05	On Lamp Post near Dunkeld train station, A9	303074	741709	15.9
A9_06	On signpost Layby 16, A9	304478	740407	22.3
A9_07	On Lamp Post, Perth Road	302946	742074	8.3
A9_08	On Lamp Post, Perth Road	303558	741505	7.8
A9_09	On signpost Layby 21, A9	300414	745245	19.2
A9_10	On signpost Layby 13, A9	305909	739423	13.6
A9_11	On signpost Layby 14, A9	305763	739459	18.0
A9_12	On Parking directions sign, Bridge St	302661	742630	12.4
A9_13	On Quad Trek sign, A923	302609	742907	5.5

8.3.9 As shown in Table 8.7, monitored annualised and bias-adjusted NO_2 concentrations at all proposed scheme NO_2 diffusion tube locations were well within the NO_2 AQO (40µg/m^3) in the base year (2023).

Mapped Background Pollutant Concentrations

8.3.10 A summary of the minimum and maximum sector removed background concentrations across the air quality study area are provided in Table 8.8. The data indicates that background concentrations for all pollutants within the air quality study area are well within the relevant AQOs. The 2030 mapped backgrounds, the latest year available, were used for the proposed year of opening (2036).

Table 8.8: Mapped Background Annual Mean Pollutant Concentrations Ranges in the Air Quality Study Area (µg/m³)

Pollutant	AQO (µg/m³)	Mapped Background Annual Mean Concentration Range (µg/m³) 2023	Mapped Background Annual Mean Concentration Range (µg/m³) 2030
NO_X	30	2.4 – 3.1	2.1 – 2.6
NO_2	40	2.0 – 2.5	1.7 – 2.4
PM_{10}	18	6.6 – 7.7	6.4 – 7.5
$PM_{2.5}$	10	4.2 – 4.5	4.1 – 4.4

Sensitive Receptors

Human Health Receptors

8.3.11 Locations sensitive to air quality include residential properties and buildings used by the young, elderly and other susceptible populations, such as schools and hospitals. Sensitive human receptors were identified within 200m of the ARN. A number of residential properties outside of this remit were included where potential impacts from other discipline related impacts (e.g. noise) may result in combined effects which is consistent with the approach applied during the modelling at DMRB Stage 2. A total of 28 locations were modelled in the road assessment (as shown in Table 8.9). Receptors R17 and R29 will be demolished as part of the proposed scheme, therefore, these receptors do not have pollutant concentrations in the proposed year of opening (2036) DS scenario and as such, have been excluded from the assessment of potential impacts. The locations of the modelled human health receptors are shown in Figure 8.1 (Modelled Human Health Receptors) and further detail presented in Table 8.9. Their location corresponds with the closest building façade to the ARN source.

Table 8.9: Modelled Sensitive Human Health Receptors

Receptor ID	Location X	Location Y	Location Description
R01	306633	739027	Murthly
R02	305662	739546	Birnam
R03	304506	740207	Birnam
R04	303814	741290	Birnam
R05	303633	741290	Birnam
R06	303834	741363	Birnam
R07	303580	741468	Birnam
R08	303041	741615	Birnam
R09	303082	741736	Birnam
R10	303263	741770	Birnam
R11	302986	741827	Birnam

Receptor ID	Location X	Location Y	Location Description
R12	302855	741925	Birnam
R13	302989	742061	Birnam
R14	302365	741748	Birnam
R15	302634	741910	Birnam
R16	302745	742005	Birnam
R18	302713	742138	Birnam
R19	302534	742169	Little Dunkeld
R20	302605	742168	Little Dunkeld
R21	302616	742275	Little Dunkeld
R22	302666	742272	Little Dunkeld
R23	302685	742271	Little Dunkeld
R24	302663	742579	Dunkeld
R25	302656	742722	Dunkeld
R26	302561	742947	Dunkeld
R27	301570	742270	Inver
R28	301627	742272	Inver
R30	300608	744873	Dunkeld

Designated Habitats

8.3.12 A summary of the identified sensitive ecological receptors within 200m of the ARN are presented in Table 8.10. These ecological receptors were modelled as 11 Ancient or Veteran tree sites and 38 transects representing 27 different areas of Ancient Woodland (as shown on Figure 8.2 (Modelled Ecological Receptors)). The closest point of each transect to the ARN, where designated habitats sensitive to nitrogen impacts are understood to be present, is presented in Table 8.10 and denoted as the transect name followed by "_0". Full results at each modelled ecological transect point are provided in Appendix A8.2 (Air Quality Results). The priority habitats were assigned as either Broadleaved deciduous woodland or Coniferous woodland habitats, following advice from the project ecologists. No other designated habitats were identified. It is worth noting, the River Tay (Special Area of Conservation) was not considered in this assessment and is discussed within Chapter 12 (Biodiversity).

8.3.13 Critical Loads can vary according to the habitat type. The CLs applied to the Broadleaved deciduous and Coniferous woodlands were agreed with the project ecologist for each ecological transect and veteran or ancient tree. Only the minimum CL is presented in Table 8.10, as it is the most stringent value against which to assess the proposed scheme impacts. Background N deposition rates for the grid square associated with the transect boundary or ancient or veteran tree location (denoted by ATI or BT) are presented in Table 8.10.

Table 8.10: Designated Habitats, Background N Deposition Rates and Critical Loads (CL)

Receptor ID	Location X	Location Y	Habitat Designation	Priority Habitat	Existing N deposition (kgN/ha/yr)	Minimum CL (kgN/ha/yr)
ATI_1	303629	741298	Ancient Tree	Broadleaved deciduous woodland	13.92	10
ATI_2	303240	741711	Veteran Tree	Broadleaved deciduous woodland	13.92	10
ATI_3	301946	742438	Veteran Tree	Broadleaved deciduous woodland	13.81	10
ATI_4	301456	742479	Veteran Tree	Broadleaved deciduous woodland	13.81	10
ATI_5	301192	742437	Ancient Tree	Broadleaved deciduous woodland	13.81	10
BT_1	300461	744077	Veteran Tree	Broadleaved deciduous woodland	13.51	10
BT_2	300465	744069	Veteran Tree	Broadleaved deciduous woodland	13.51	10
BT_3	301323	742410	Veteran Tree	Broadleaved deciduous woodland	13.81	10
BT_4	301681	742315	Veteran Tree	Coniferous woodland	13.81	3
BT_5	301865	742322	Veteran Tree	Broadleaved deciduous woodland	13.81	10
BT_6	301968	742343	Veteran Tree	Broadleaved deciduous woodland	13.81	10
ECO_A_0	305807	739400	Ancient Woodland	Coniferous woodland	14.12	3
ECO_C_0	305909	739473	Ancient Woodland	Coniferous woodland	14.12	3
ECO_D_0	304972	739723	Ancient Woodland	Coniferous woodland	14.05	3
ECO_E_0	305023	739741	Ancient Woodland	Coniferous woodland	14.12	3

Receptor ID	Location X	Location Y	Habitat Designation	Priority Habitat	Existing N deposition (kgN/ha/yr)	Minimum CL (kgN/ha/yr)
ECO_F_0	304596	740246	Ancient Woodland	Coniferous woodland	14.06	3
ECO_G_0	303993	740685	Ancient Woodland	Coniferous woodland	13.95	3
ECO_H_0	304124	740876	Ancient Woodland	Coniferous woodland	14.06	3
ECO_I_0	303536	741391	Ancient Woodland	Broadleaved deciduous woodland	13.92	10
ECO_J_0	302892	741750	Ancient Woodland	Coniferous woodland	13.77	3
ECO_K_0	302473	742032	Ancient Woodland	Broadleaved deciduous woodland	13.69	10
ECO_L_0	301235	742204	Ancient Woodland	Broadleaved deciduous woodland	13.81	10
ECO_M_0	301072	742390	Ancient Woodland	Coniferous woodland	13.81	3
ECO_N_0	300897	742322	Ancient Woodland	Coniferous woodland	13.93	3
ECO_O_0	300473	742724	Ancient Woodland	Broadleaved deciduous woodland	13.93	10
ECO_P_0	300229	743145	Ancient Woodland	Coniferous woodland	13.72	3
ECO_Q_0	300407	743164	Ancient Woodland	Broadleaved deciduous woodland	13.72	10
ECO_R_0	300446	743661	Ancient Woodland	Coniferous woodland	13.72	3
ECO_S_0	300328	743678	Ancient Woodland	Coniferous woodland	13.72	3
ECO_T_0	300262	743919	Ancient Woodland	Coniferous woodland	13.72	3
ECO_U_0	300612	744497	Ancient Woodland	Coniferous woodland	13.51	3
ECO_V_0	305865	739554	Ancient Woodland	Broadleaved deciduous woodland	14.12	10
ECO_W_0	305644	739630	Ancient	Coniferous	14.12	3

Receptor ID	Location X	Location Y	Habitat Designation	Priority Habitat	Existing N deposition (kgN/ha/yr)	Minimum CL (kgN/ha/yr)
			Woodland	woodland		
ECO_X_0	304459	740266	Ancient Woodland	Coniferous woodland	14.06	3
ECO_Y_0	303714	741262	Ancient Woodland	Broadleaved deciduous woodland	13.92	10
ECO_Z_0	303490	741571	Ancient Woodland	Broadleaved deciduous woodland	13.92	10
ECO_AA_0	302058	742449	Ancient Woodland	Coniferous woodland	13.69	3
ECO_AB_0	301754	742397	Ancient Woodland	Coniferous woodland	13.81	3
ECO_AC_0	301695	742412	Ancient Woodland	Coniferous woodland	13.81	3
ECO_AD_0	301427	742472	Ancient Woodland	Coniferous woodland	13.81	3
ECO_AE_0	301005	742529	Ancient Woodland	Coniferous woodland	13.81	3
ECO_AF_0	300955	742512	Ancient Woodland	Coniferous woodland	13.93	3
ECO_AG_0	300470	742319	Ancient Woodland	Coniferous woodland	13.93	3
ECO_AH_0	300493	742495	Ancient Woodland	Coniferous woodland	13.93	3
ECO_AI_0	300488	743016	Ancient Woodland	Coniferous woodland	13.72	3
ECO_AJ_0	300071	742987	Ancient Woodland	Coniferous woodland	13.93	3
ECO_AK_0	300017	743249	Ancient Woodland	Coniferous woodland	13.72	3
ECO_AL_0	300012	743348	Ancient Woodland	Coniferous woodland	13.72	3
ECO_AM_0	300147	743776	Ancient Woodland	Coniferous woodland	13.72	3

Baseline Modelling Results

8.3.14 A base model has been run for the purpose of model verification and to inform the long-term trends process. The results are presented in Appendix A8.2 (Air Quality Results) and Table 8.12 for human health receptors, and Table 8.13 for sensitive designated habitats. No

exceedances of the respective NO_2, PM_{10} and $PM_{2.5}$ AQOs were predicted at human health receptor locations in the base year (2023). However, it is noted that N deposition CLs were exceeded at all modelled Ancient Woodland locations, which is not uncommon and is a result of high background N deposition rates.

Future Baseline

8.3.15 In accordance with DMRB LA 105, the future year without the proposed scheme (DM 2036) is considered as part of the assessment process. The results are presented in Appendix A8.2 (Air Quality Results) and Table 8.12 for human health receptors, and Table 8.13 for sensitive designated habitats. No exceedances of the NO_2, PM_{10} and $PM_{2.5}$ AQOs were predicted at human health receptor locations in the proposed year of opening DM scenario (2036). However, it is noted that N deposition CLs were exceeded at all modelled Ancient Woodland locations. In comparison to the baseline modelling results discussed in paragraph 8.3.14, pollutant concentrations are shown to reduce with time due to reduced emissions per vehicle from engine emission improvements, such as from more electrified vehicles in the fleet mix.

8.4 Potential Impacts and Effects

8.4.1 The potential impacts reported in this Section (Potential Impacts and Effects) are assessed in line with the approach set out in Section 8.2 (Approach and Methods) and detailed further in Appendix A8.1 (Air Quality Methodology) and Appendix A8.3 (Construction Risk Assessment).

Construction Phase

Construction Dust Risk Assessment

8.4.2 An assessment of air quality impacts arising from construction activities has been undertaken in accordance with IAQM methodology (IAQM, 2024). There is potential for dust soiling effects during the construction phase of the proposed scheme at sensitive receptors within the distance bands outlined in the IAQM guidance and displayed on Figure 8.4 (Construction Dust Risk Assessment). Full details of the construction dust risk assessment are discussed in Appendix A8.3 (Construction Risk Assessment).

8.4.3 A summary of the overall dust risk from construction activities for each impact and per Zone of the construction of the proposed scheme is presented in Table 8.11.

Table 8.11: Summary of Dust Risk at Human Health and Ecological Receptors

Zones	Potential Impact	Risk of Dust Impacts Demolition	Risk of Dust Impacts Earthworks	Risk of Dust Impacts Construction	Risk of Dust Impacts Trackout
North	Dust Soiling	Negligible	Low	Low	Low
	Human Health	Negligible	Low	Low	Low
	Ecological	Negligible	Low	Low	Low
Central	Dust Soiling	Medium	High	Medium	High
	Human Health	Negligible	Low	Low	Low
	Ecological	Negligible	Low	Low	Low
Dunkeld & Birnam Station	Dust Soiling	Medium	Medium	Medium	Medium
	Human Health	Negligible	Low	Low	Low
	Ecological	Negligible	Low	Low	Low
South	Dust Soiling	Medium	High	Medium	High
	Human Health	Negligible	Low	Low	Low
	Ecological	Negligible	Low	Low	Low

8.4.4 The assessment indicated a Negligible to Low risk of dust impacts per Zone on Human Health (PM_{10} concentrations) and on ecological receptors, and also Negligible to Low risk of dust soiling impacts within the North Zone. However, Medium to High risk of dust soiling was identified across the Central and South Zones. Dunkeld & Birnam Station was classed as Medium risk for dust soiling. The highest dust risk should be applied to each Zone. However, as Dunkeld & Birnam Station is adjacent to the Central Zone with common receptor locations assessed, the highest risk identified for both Central and Dunkeld & Birnam Station should be applied to Dunkeld & Birnam Station Zone. On this basis mitigation measures for the Central, Dunkeld & Birnam Station and South Zones should represent a high risk site, while mitigation measures for the North Zone should represent a low risk site. However, in some cases it was agreed with Transport Scotland to apply high risk site measures across all Zones as a precautionary approach.

8.4.5 Appropriate mitigation measures and operating with best practice techniques would reduce dust risks at all Zones to **not significant**.

8.4.6 It is also concluded that taking account of the low background concentrations and standard best practice techniques and mitigation measures in place, it is unlikely that emissions from Non-Road Mobile Machinery (NRMM) and plant would lead to **adverse impacts** (such as an exceedance of AQOs) at sensitive offsite receptors.

8.4.7 The environmental management plan will include a requirement for the use of best practice techniques and mitigation measures to minimise the risk of potential impacts and these will include compliance with appropriate NRMM standards, the fitting of abatement plant where feasible (i.e. diesel particulate filters); no idling of engines; use of mains power and

avoidance of the use of diesel/petrol power where possible; and surface type related speed restrictions on haul routes (e.g. 15mph on surfaced roads, 10mph on unsurfaced roads).

Assessment of Potential Air Quality Impacts from Construction Traffic

8.4.8 Construction related road traffic has been scoped out as discussed in paragraph 8.2.26 and therefore air quality effects are considered to be **not significant**.

Operational Local Air Quality

8.4.9 There is potential for the proposed scheme to adversely influence (i.e. increase) pollutant concentrations at sensitive human health receptors and at designated habitat locations.

8.4.10 In accordance with DMRB LA 105, a local air quality simple assessment was undertaken. The following text outlines the impacts of the operational phase of the proposed scheme upon local air quality. The results presented are based on the values predicted using the Gap Analysis methodology detailed in Appendix A8.1 (Air Quality Methodology), and Long-Term Trends (LTTE6) for NO_2. This approach is outlined within DMRB LA 105 and is considered to provide a more conservative assessment of impacts in proposed year of opening than the LAQM TG(22) methodology as it generally multiples up the impact (i.e. increases).

Human Health Receptors

8.4.11 Predicted annual mean pollutant concentrations, the change in concentration (DS – DM) and magnitude of change descriptors are presented in Table 8.12 for the base year (2023) and proposed year of opening (2036) DM and DS scenarios. Note that all modelled NO_2, PM_{10} and $PM_{2.5}$ results have been quoted to 1 decimal place. However, the change in concentration values (DS – DM) have been calculated and magnitude of change categories assigned prior to rounding of the modelled values.

8.4.12 The modelled change in NO_2 concentration at each human health receptor is shown in Figure 8.5 (Operational Human Health Assessment Results), with each receptor labelled by the modelled DS NO_2 concentration.

8.4.13 The scheme will require the demolition of receptors R17 and R29. Therefore, these receptors do not have pollutant concentrations in the proposed year of opening (2036) DS scenario and as such have been excluded from the assessment of potential impacts.

Table 8.12: Predicted Annual Mean Modelled NO_2, PM_{10} and $PM_{2.5}$ Concentrations at Sensitive Human Health Receptors (µg/m³)

Receptor ID	NO_2 Base 2023	NO_2 DM 2036	NO_2 DS 2036	NO_2 change (DS-DM) 2036	Magnitude of NO_2 change 2036	PM_{10} Base 2023	PM_{10} DM 2036	PM_{10} DS 2036	PM_{10} change (DS-DM) 2036	Magnitude of PM_{10} change 2036	$PM_{2.5}$ Base 2023	$PM_{2.5}$ DM 2036	$PM_{2.5}$ DS 2036	$PM_{2.5}$ change (DS-DM) 2036	Magnitude of $PM_{2.5}$ change 2036
R01	6.5	6.2	6.8	0.6	Small	8.2	8.0	8.1	0.0	Imperceptible	4.9	4.8	4.8	0.0	Imperceptible
R02	4.7	4.5	4.8	0.4	Imperceptible	8.1	7.9	7.9	0.0	Imperceptible	4.8	4.6	4.6	0.0	Imperceptible
R03	4.6	4.4	6.0	1.6	Small	8.0	7.8	8.2	0.3	Small	4.8	4.7	4.9	0.2	Small
R04	9.8	9.5	10.8	1.3	Small	8.8	8.7	8.4	-0.3	Small	5.4	5.3	5.2	-0.1	Small
R05	4.8	4.6	5.1	0.5	Small	7.7	7.5	7.5	0.0	Imperceptible	4.8	4.6	4.6	0.0	Imperceptible
R06	5.6	5.3	5.6	0.3	Imperceptible	8.0	7.8	7.8	0.0	Imperceptible	4.9	4.8	4.8	0.0	Imperceptible
R07	10.4	10.1	12.0	1.9	Small	9.0	8.9	8.7	-0.1	Imperceptible	5.5	5.4	5.4	0.0	Imperceptible
R08	3.9	3.7	4.0	0.3	Imperceptible	7.4	7.3	7.3	0.1	Imperceptible	4.7	4.5	4.5	0.0	Imperceptible
R09	13.6	13.4	14.3	0.9	Small	9.3	9.3	8.8	-0.5	Small	5.8	5.6	5.4	-0.2	Small
R10	4.7	4.3	4.5	0.2	Imperceptible	7.7	7.5	7.6	0.1	Imperceptible	4.8	4.6	4.7	0.0	Imperceptible
R11	9.5	9.2	9.7	0.5	Small	8.3	8.2	7.9	-0.3	Small	5.1	5.0	4.9	-0.1	Small
R12	9.1	8.8	8.7	-0.1	Imperceptible	8.3	8.3	7.8	-0.5	Small	5.2	5.0	4.8	-0.2	Small
R13	4.5	4.1	4.3	0.1	Imperceptible	7.8	7.5	7.6	0.1	Imperceptible	4.8	4.6	4.7	0.0	Imperceptible
R14	3.5	3.3	3.3	0.0	Imperceptible	7.2	7.0	7.0	0.0	Imperceptible	4.5	4.3	4.3	0.0	Imperceptible
R15	5.2	5.0	5.1	0.1	Imperceptible	7.5	7.4	7.5	0.1	Imperceptible	4.7	4.5	4.6	0.1	Imperceptible
R16	10.0	9.8	8.9	-0.9	Small	8.8	8.8	8.4	-0.3	Small	5.5	5.3	5.1	-0.2	Small
R18	8.1	7.7	8.0	0.4	Imperceptible	8.7	8.4	8.7	0.2	Small	5.3	5.1	5.2	0.1	Small
R19	7.7	7.4	9.6	2.2	Medium	8.5	8.3	9.2	0.9	Medium	5.2	5.0	5.5	0.5	Small

Receptor ID	NO_2 Base 2023	NO_2 DM 2036	NO_2 DS 2036	NO_2 change (DS-DM) 2036	Magnitude of NO_2 change 2036	PM_{10} Base 2023	PM_{10} DM 2036	PM_{10} DS 2036	PM_{10} change (DS-DM) 2036	Magnitude of PM_{10} change 2036	$PM_{2.5}$ Base 2023	$PM_{2.5}$ DM 2036	$PM_{2.5}$ DS 2036	$PM_{2.5}$ change (DS-DM) 2036	Magnitude of $PM_{2.5}$ change 2036
R20	8.7	8.3	8.8	0.5	Small	8.7	8.5	8.8	0.2	Small	5.3	5.2	5.3	0.1	Small
R21	4.6	4.3	4.3	0.0	Imperceptible	7.7	7.5	7.6	0.0	Imperceptible	4.8	4.6	4.6	0.0	Imperceptible
R22	9.2	8.7	8.7	0.0	Imperceptible	8.8	8.6	8.7	0.1	Imperceptible	5.4	5.2	5.2	0.1	Imperceptible
R23	9.8	9.2	9.2	0.0	Imperceptible	9.0	8.7	8.8	0.1	Imperceptible	5.4	5.2	5.3	0.1	Imperceptible
R24	11.8	11.2	11.5	0.4	Imperceptible	9.1	8.8	8.9	0.1	Imperceptible	5.5	5.3	5.3	0.0	Imperceptible
R25	7.6	7.1	7.2	0.1	Imperceptible	8.2	8.0	8.0	0.0	Imperceptible	5.0	4.8	4.8	0.0	Imperceptible
R26	4.7	4.3	4.2	-0.1	Imperceptible	7.8	7.6	7.5	-0.1	Imperceptible	4.8	4.6	4.6	0.0	Imperceptible
R27	13.6	13.4	13.1	-0.3	Imperceptible	9.5	9.5	8.4	-1.2	Medium	5.9	5.8	5.2	-0.6	Medium
R28	13.5	13.4	13.9	0.6	Small	9.5	9.5	8.5	-0.9	Medium	5.9	5.8	5.3	-0.5	Small
R30	2.8	2.6	2.7	0.1	Imperceptible	7.1	7.0	6.9	0.0	Imperceptible	4.5	4.3	4.3	0.0	Imperceptible

8.4.14 As shown in Table 8.12, no exceedances of the annual mean NO_2 AQO (40µg/m^3) were predicted at any of the human health receptors in any scenario assessed. The maximum predicted NO_2 concentration (14.3µg/m^3) in the DS scenario was predicted to occur at receptor R09, located along Station Road in close proximity to the proposed A9 southbound carriageway. An increase in concentration of +0.9µg/m^3 was predicted to occur at this location, which equates to a 'small' magnitude of change, due to an increase in volume of traffic along the A9 as a result of the proposed scheme despite the slight alignment of traffic away from the receptor in this location.

8.4.15 The largest predicted increase in NO_2 concentration was modelled to occur at receptor R19 (+2.2µg/m^3) which equates to a 'medium' magnitude of change. The increase is attributed to the proposed Dunkeld junction improvement aligning traffic closer to the Craigvinean Surgery receptor modelled at this location. The annual mean NO_2 concentration with the proposed scheme (DS 2036) (9.6µg/m^3) at this location, however, was modelled to be well below the relevant AQO (40µg/m^3).

8.4.16 The largest decrease in NO_2 concentration was modelled to occur at receptor R16 (-0.9µg/m^3) which equates to a 'small' magnitude of change in NO_2. This receptor is located on King Duncan's Place adjacent to the A9 mainline and as such this reduction in modelled concentrations is due to the alignment of the A9 carriageway further away from this location as a result of the proposed scheme.

8.4.17 The predicted changes in NO_2 concentrations as a result of the proposed scheme at receptors modelled along Perth Road, and through Dunkeld and Birnam, were all considered as 'negligible' and of 'imperceptible' magnitudes.

8.4.18 As shown in Table 8.12, no exceedances of the annual mean PM_{10} AQO (18µg/m^3) were predicted to occur in all scenarios at any of the modelled human health receptors.

8.4.19 The maximum predicted PM_{10} concentration as a result of the proposed scheme (9.2µg/m^3) was predicted to occur at receptor R19. The change in PM_{10} concentrations at this receptor was modelled to be +0.9µg/m^3 which equates to a 'medium' magnitude of change and was the largest predicted increase across all modelled human health receptors.

8.4.20 The largest reduction in PM_{10} (i.e. a beneficial change) was predicted to occur at receptor R27 (-1.2µg/m^3) which is of a 'medium' magnitude of change. This receptor is located in Inver and is positioned in close proximity to the A9 northbound and as such the significant reduction in PM_{10} modelled to occur at this location is a result of the alignment of the A9 carriageway positioned further away as a result of the proposed scheme.

8.4.21 As shown in Table 8.12, no exceedances of the annual mean $PM_{2.5}$ AQO (10µg/m^3) were predicted to occur in all scenarios at any of the modelled human health receptors.

8.4.22 The maximum predicted $PM_{2.5}$ concentration, as with the maximum predicted PM_{10} concentration, as a result of the proposed scheme (5.5µg/m^3) was predicted to occur at receptor R19. The change in $PM_{2.5}$ concentration at this receptor was modelled to be

+0.5µg/m^3 which equates to 'small' magnitude of change, which was also the largest predicted increase across all modelled human health receptors.

8.4.23 The largest reduction in $PM_{2.5}$, as with the largest reduction in PM_{10}, was predicted to occur at receptor R27 (-0.6µg/m^3) which also is of a 'medium' magnitude of change.

Significance

8.4.24 The predicted pollutant concentrations at all assessed receptors, as a result of the proposed scheme, were modelled to be well below (<75%) the respective AQOs. Therefore, in accordance with the DMRB LA 105 significance criteria detailed in Section 8.2 (Approach and Methods), the air quality effect of the proposed scheme for human health is considered to be **not significant**.

Designated Sites

8.4.25 Nutrient nitrogen deposition calculations were undertaken, in line with DMRB LA 105 for all modelled ecological receptors. Figure 8.2 (Modelled Ecological Receptors) shows the locations of the 407 ecological receptors modelled across 38 transects and 11 additional ecological receptors positioned at the locations of sensitive veteran/ancient trees modelled as part of the ecological assessment.

8.4.26 A summary of the N-deposition assessment is presented in Table 8.13 with the determination of potential significant effects displayed in Figure 8.6 (Operational Ecological Assessment Results).

8.4.27 The results in Table 8.13 show that total deposition rates are predicted to be above the minimum CL with both a predicted change in nitrogen deposition of more than 1% of the minimum CL and of more than 0.4 kgN/ha/year, as a result of the proposed scheme, at 27 of the modelled designated sites (8 veteran/ancient trees and 19 Ancient Woodland transects). The extent of impact (i.e. distance back from the habitat boundary and away from the road source) is also indicated (in the last column). Further discussion on these ecological receptors and their potential to be adversely affected by changes in N deposition, is provided in Chapter 12 (Biodiversity). The ecological receptor ID represents the point location or habitat boundary location where the maximum potential for impacts resulting from changes in air quality are predicted.

Table 8.13: Summary of Designated Habitat Sites with Potentially Significant Effects

Receptor ID	Habitat Designation	Habitat	Distance to Nearest A9 ARN Road Link (DS 2036) (m)	Total Deposition (kgN/ha/yr) Base 2023	Total Deposition (kgN/ha/yr) DM 2036	Total Deposition (kgN/ha/yr) DS 2036	Change (kgN/ha/yr) (DS-DM) 2036	Minimum CL (kgN/ha/yr)	(DS-DM)/ CL (%)	Transect Extent Potentially Impacted (m)
ATI_1	Ancient Tree	BDW	69	16.9	15.5	16.4	0.9	10	9.2	-
ATI_5	Veteran Tree	BDW	113	14.5	14.2	14.6	0.4	10	4.3	-
BT_1	Veteran Tree	BDW	59	18.0	16.0	16.8	0.8	10	7.7	-
BT_2	Veteran Tree	BDW	53	18.7	16.4	17.3	0.9	10	9.1	-
BT_3	Veteran Tree	BDW	91	14.9	14.3	15.2	0.9	10	8.6	-
BT_4	Veteran Tree	CW	11	25.0	20.4	26.3	5.9	3	196.5	-
BT_5	Veteran Tree	BDW	34	21.1	18.0	20.2	2.2	10	22.2	-
BT_6	Veteran Tree	BDW	71	17.0	15.5	16.3	0.8	10	7.9	-
ECO_A_0	Ancient Woodland	CW	37	21.8	18.5	20.3	1.8	3	58.7	60
ECO_C_0	Ancient Woodland	CW	29	23.2	19.4	21.0	1.6	3	52.7	60
ECO_D_0	Ancient Woodland	CW	18	25.8	21.1	24.4	3.4	3	111.9	90
ECO_E_0	Ancient Woodland	CW	16	26.1	21.3	25.0	3.7	3	123.6	80

Receptor ID	Habitat Designation	Habitat	Distance to Nearest A9 ARN Road Link (DS 2036) (m)	Total Deposition (kgN/ha/yr) Base 2023	Total Deposition (kgN/ha/yr) DM 2036	Total Deposition (kgN/ha/yr) DS 2036	Change (kgN/ha/yr) (DS-DM) 2036	Minimum CL (kgN/ha/yr)	(DS-DM)/ CL (%)	Transect Extent Potentially Impacted (m)
ECO_H_0	Ancient Woodland	CW	5	21.4	18.3	21.3	3.0	3	100.9	60
ECO_I_0	Ancient Woodland	BDW	42	19.9	17.3	19.1	1.8	10	18.1	60
ECO_J_0	Ancient Woodland	CW	64	16.8	15.4	16.5	1.1	3	36.7	40
ECO_K_0	Ancient Woodland	BDW	32	18.8	16.5	19.8	3.3	10	33.5	40
ECO_M_0	Ancient Woodland	CW	61	17.1	15.5	16.8	1.3	3	42.2	50
ECO_N_0	Ancient Woodland	CW	8	31.7	24.9	26.3	1.4	3	47.5	60
ECO_P_0	Ancient Woodland	CW	22	15.2	14.5	17.1	2.6	3	88.2	70
ECO_R_0	Ancient Woodland	CW	18	23.2	19.4	23.7	4.3	3	144.4	100
ECO_U_0	Ancient Woodland	CW	50	17.7	15.8	17.4	1.6	3	53.5	50

Receptor ID	Habitat Designation	Habitat	Distance to Nearest A9 ARN Road Link (DS 2036) (m)	Total Deposition (kgN/ha/yr) Base 2023	Total Deposition (kgN/ha/yr) DM 2036	Total Deposition (kgN/ha/yr) DS 2036	Change (kgN/ha/yr) (DS-DM) 2036	Minimum CL (kgN/ha/yr)	(DS-DM)/ CL (%)	Transect Extent Potentially Impacted (m)
ECO_X_0	Ancient Woodland	CW	58	16.3	15.2	17.6	2.3	3	77.6	80
ECO_Y_0	Ancient Woodland	BDW	41	19.4	17.0	18.9	1.9	10	19.4	70
ECO_Z_0	Ancient Woodland	BDW	86	16.9	15.5	16.1	0.7	10	6.7	20
ECO_AB_0	Ancient Woodland	CW	97	15.2	14.5	15.1	0.5	3	18.1	20
ECO_AC_0	Ancient Woodland	CW	109	14.8	14.3	14.8	0.4	3	14.5	10
ECO_AH_0	Ancient Woodland	CW	28	20.2	17.5	20.8	3.3	3	110.4	90

Significance

8.4.28 In accordance with the DMRB LA 105, the air quality results were assessed by the project ecologist and are discussed further in Chapter 12 (Biodiversity). The conclusions provided in Chapter 12 (Biodiversity) indicate that the level of impact at all sites was assessed as minor and the significance of effect as slight (non-significant). The changes in N deposition as a result of the proposed scheme are therefore not considered to lead to a significant effect to air quality.

8.5 Mitigation

8.5.1 This Section (Mitigation), references overarching standard mitigation measures applicable across A9 dualling projects ('SMC' mitigation item references), and also project-specific essential mitigation measures ('P02' mitigation item references). Those that specifically relate to air quality are assigned an 'AQ' reference.

Standard Mitigation

Construction

Dust Deposition

8.5.2 The application of control measures for dust arising during construction can be very effective. These are based on reducing dust generation at source. To reduce the potential for dust emissions, a range of Standard Mitigation commitments will be adopted and are presented in Table 8.14. Measures not covered by the Standard Mitigation Commitments are included in Table 8.15 as project specific mitigation. All mitigation measures should be agreed with the Perth & Kinross Council as well as Transport Scotland (TS).

Table 8.14: Standard Mitigation Air Quality

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose / Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
SMC-AQ1	Throughout proposed scheme	Construction	Main Contractor	In relation to minimising fugitive dust emissions from earthworks, material storage and concrete batching the following mitigation items will be implemented: ▪ stockpiles and mounds will be at a suitable angle of repose to prevent material slippage, will be enclosed or securely sheeted, and/or kept damped as necessary during dry weather; ▪ the surfaces of any long-term stockpiles which give rise to a risk of dust or air pollution will be covered with appropriate sheeting or will be treated to stabilise the surfaces; ▪ mixing of large quantities of concrete will be carried out only in enclosed or shielded areas; ▪ all handling areas will be maintained in a dust free state as far as is practicable with sprinklers and hoses used to prevent dust escaping from the site boundaries; and ▪ procedures will be established so that the site is regularly inspected for spillage of dusty or potentially dusty materials and any such spillage would be dealt with promptly where necessary to prevent dust nuisance.	To reduce fugitive dust emissions from earthworks, material storage and concrete batching.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
SMC-AQ2	Throughout proposed scheme	Construction	Main Contractor	In relation to minimising dust from vehicle movements within the site the following mitigation items will be implemented: ▪ the Contractor will employ appropriate measures, such as covering materials deliveries or loads entering and leaving the construction site by a fixed cover or sheeting appropriately fixed and suitable for the purposes of preventing materials and dust spillage; ▪ where unsurfaced routes are identified as creating dust emissions during periods of dry weather, surfaces will be regularly dampened down using water bowsers; and ▪ appropriate speed limits will be established and enforced over all unmade surfaces.	To reduce dust from vehicle movements.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.

Assessment of Potential Air Quality Impacts from Construction Traffic

8.5.3 No significant effect on local air quality is predicted as a result of additional construction related traffic on the road network or because of the proposed diversion routes (moving existing traffic closer to sensitive receptors). No mitigation measures beyond standard mitigation commitments are therefore proposed.

Operation

Local Air Quality – Human Receptors

8.5.4 No significant effects on local air quality at human health receptors have been identified. Therefore, no mitigation is required.

Local Air Quality – Designated Habitats

8.5.5 Mitigation relating to ecological sites and veteran trees is discussed in Chapter 12 (Biodiversity). No mitigation or compensation measures are required as no significant effects have been identified.

Project Specific Mitigation

Construction

8.5.6 Project specific mitigation measures are those identified as being required to reduce the potential for significant effects of dust emissions in the vicinity of the proposed scheme and which are not covered by the Standard Mitigation commitments.

8.5.7 The Construction Dust Risk Assessment conclusions discussed in Section 8.4 (Potential Impacts and Effects) of Chapter 8 (Air Quality), identify that mitigation measures for a high-risk site should be implemented at Central, Dunkeld & Birnam Station and South Zones and a low-risk site at the North Zone, owing to the low presence of sensitive Receptors. Table 8.15 outlines the mitigation measures required in addition to the project wide Standard Mitigation commitments. They are taken from IAQM guidance (IAQM, 2024) and are suitable to mitigate dust emissions generated by the proposed scheme. Measures deemed 'Highly recommended' within IAQM guidance are included only. The contractor will decide whether to include those measures deemed 'desirable' as set out in IAQM (IAQM, 2024) and outlined in full in Appendix A8.3 (Construction Risk Assessment). All mitigation measure will be agreed with Perth & Kinross Council as well as Transport Scotland (TS).

Table 8.15: Project Specific Mitigation Air Quality

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose / Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
P02-AQ1	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone. **Desirable for North Zone.	Construction	Main Contractor	In relation to Communications, the following items will be implemented: ▪ Develop and implement a stakeholder communications plan that includes community engagement before work commences on site. ▪ Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager. ▪ Display the head or regional office contact information. ▪ Develop and implement a Dust Management Plan (DMP) which may include measures to control other emissions, approved by the Local Authority. The level of detail will depend on the risk and should include as a minimum the highly recommended measures. The desirable measures should be included as appropriate for the site in question**.	To manage any uncontrolled dust impacts on and off-site.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ2	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone.	Construction	Main Contractor	In relation to Site Management, the following items will be implemented: ▪ Record all dust and air quality complaints, identify cause(s), and take appropriate measures to reduce emissions in a timely manner, and record the measures taken. ▪ Make the complaints log available to the local authority when asked. ▪ Record any exceptional incidents that cause dust/air emissions, either onsite or offsite, and the action taken to resolve the situation in the logbook. Review measures accordingly. ▪ Hold regular liaison meetings with other high risk construction sites within 250m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes*.	To ensure dust emissions are minimised and the controls implemented are managed.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ3	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) **Desirable for North Zone.	Construction	Main Contractor	In relation to Monitoring, the following items will be implemented: ▪ Undertake daily on/off site inspections, at nearby receptors (including roads) to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary should be undertaken, with cleaning to be provided if necessary, and make the complaints log available to the local authority when asked**. ▪ Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked. ▪ Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy	To reduce the risk of dust impacts off-site.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose / Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
				conditions.			
P02-AQ4	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) **Desirable for North Zone.	Construction	Main Contractor	In relation to preparing and maintaining the site, the following items will be implemented: ▪ Plan site layout so that machinery and dust/odour causing activities are located away from receptors, as far as is possible. ▪ Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site. ▪ Fully enclose specific operations where there is a high potential for dust production and the site is active for an extensive period**. ▪ Avoid site runoff of water or mud. ▪ Remove materials that have potential to produce dust from site as soon as possible, unless being re-used on-site. If they are being re-used on-site, cover, seed or fence stockpiles to prevent wind whipping.	To reduce dust impacts on and off site.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ5	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone.	Construction	Main Contractor	In relation to operating vehicle/machinery and sustainable travel, the following items will be implemented: ▪ Ensure all vehicles switch off engines when stationary - no idling vehicles. ▪ Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable. ▪ Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials*. ▪ Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).	To minimise emissions to air from construction related vehicles.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ6	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200)	Construction	Main Contractor	In relation to operations, the following items will be implemented: ▪ Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems. ▪ Use enclosed chutes and conveyors and covered skips. ▪ Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	To minimise emissions to air.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose / Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
P02-AQ7	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200)	Construction	Main Contractor	In relation to waste management, the following items will be implemented: ▪ Avoid bonfires and burning of waste materials.	To minimise emissions to air.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ8	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200)	Construction - Demolition	Main Contractor	In relation to demolition, the following items will be implemented: ▪ Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust). ▪ Ensure effective water suppression is used during demolition operations. Handheld sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground. ▪ Avoid explosive blasting, using appropriate manual or mechanical alternatives. ▪ Bag and remove any biological debris or damp down such material before demolition.	To reduce and control emissions of dust during demolition activities.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ9	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone.	Construction - Earthworks	Main Contractor	In relation to earthworks, the following items will be implemented: ▪ Re-vegetate earthworks and exposed areas / soil stockpiles to stabilize surfaces as soon as practicable*. ▪ Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable*. ▪ Only remove the cover in small areas during work and not all at once *.	To reduce dust emissions during earthworks activities.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.
P02-AQ10	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone. **Desirable for North Zone.	Construction	Main Contractor	In relation to construction, the following items will be implemented: ▪ Avoid scabbling (roughening of concrete surfaces) if possible**. ▪ Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emissions control systems to prevent escape of material and overfilling during delivery*.	To reduce dust emissions during construction activities.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose / Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
P02-AQ11	North Zone (ch5700-8400), Central Zone (ch3500- 5700, Dunkeld & Birnam Station Zone (ch3200-3500), South Zone (ch576-3200) *Not required- North Zone. ** Desirable for North Zone.	Construction	Main Contractor	In relation to trackout, the following items will be implemented: ▪ Avoid dry sweeping of large areas**. ▪ Record all inspections of haul routes and any subsequent action in a site log book**. ▪ Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned*. ▪ Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits*. ▪ Access gates to be located at least 10m from receptors where possible*.	To reduce potential for dust from public roads.	Perth & Kinross Council	Via supervision requirements outlined in Contract Documents.

8.6 Residual Effects

8.6.1 This section presents the residual effects that remain following the implementation of mitigation measures as discussed in Section 8.5 (Mitigation).

Construction

Dust Deposition Impacts

8.6.2 With the implementation of appropriate dust management measures discussed in Section 8.5, as outlined in Table 8.14 and Table 8.15, dust risks from construction should be reduced and are considered **not significant**.

Construction Traffic Impacts

8.6.3 Traffic emissions from construction traffic during the construction phase are not predicted to have a significant residual impact on air quality.

Operation

Local Air Quality - Human Receptors

8.6.4 The proposed scheme is predicted to lead to increases and decreases in annual mean NO_2, PM_{10} and $PM_{2.5}$ pollutant concentrations at human health receptor locations within the study area. None of these increases exceed the annual mean AQOs for these pollutants in either the DM or DS scenarios. Mitigation measures are therefore not required, and no significant residual impacts are predicted.

Local Air Quality – Designated Habitats

8.6.5 Reference is made to Chapter 12 (Biodiversity).

8.7 Compliance Against Plans and Policy

8.7.1 DMRB LA 104 'Environmental Assessment and Monitoring' states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant overseeing organisation.

8.7.2 Appendix 3.1 (Assessment of Policy Compliance) provides the results of a topic specific review of national and local policy documents which are of relevance to the assessment undertaken and reported in this chapter in accordance with DMRB guidance. The compliance assessment undertaken in Appendix 3.1 focuses principally on the long-term effects of the proposed scheme rather than the short term, temporary effects from construction.

8.7.3 National policy objectives (and best practice guidance) of relevance to this assessment are provided in the National Planning Framework 4 (Scottish Government 2023) (in particular Policy 23, Health and Safety) and Planning Advice Note 51 (Scottish Executive 2006). The

Perth and Kinross Local Development Plan 2 (Perth and Kinross Council 2019) Policy 57 (Air Quality) and Air Quality and Planning Supplementary Guidance (Perth and Kinross Council 2020) have also been considered.

Summary of Policy Compliance

8.7.4 Overall, the design and assessment of the proposed Scheme has had regard to, and is compliant with, policy objectives aimed at assessing and mitigating effects on air quality during both the construction and operational phases.

8.8 Statement of Significance

Construction

8.8.1 The proposed scheme has the potential to give rise to construction phase air quality impacts, including those associated with construction dust and construction traffic. The effects of road traffic emissions on sensitive receptors are assessed to be **not significant**.

8.8.2 Following IAQM guidance, the risk of dust impacts has been determined for sensitive receptors within 250m of proposed construction activities. It is recommended that the highest level of risk per Zone is used for mitigation purposes, however, as Dunkeld & Birnam Station is adjacent to the Central Zone with common Receptors across both Zones, this should have the highest risk out of both Central and Dunkeld & Birnam Station applied. Therefore, mitigation for all Zones other than the North should have High risk mitigation, while the North Zone should have low risk mitigation. The Standard mitigation to be applied across the proposed scheme is presented in Table 8.14 and additional project specific mitigation is presented in Table 8.15. With the implementation of identified mitigation measures and application of best practice techniques, the impact of construction activities is reduced to **not significant**.

8.8.3 As there are no roads within the study area that need to be assessed for compliance against Scottish Government statutory air quality Limit Values (LV), it is considered that the construction phase and proposed scheme in operation will not lead to any non-compliance with the LVs and is **not significant**.

Operation

8.8.4 The assessment of operational traffic effects on human health receptors concluded that the proposed scheme would not lead to any exceedances of the AQOs at modelled (worst case) human receptor locations. Consequently, in accordance with DMRB LA 105 criteria on significance, the effect of the proposed scheme on air quality at human health receptors is considered to be **not significant**.

8.8.5 Changes in nitrogen deposition have the potential to impact sensitive habitats within designated habitat locations. The project ecologist concluded that, whilst changes in N deposition would cause minor adverse impacts, these are assessed to be **not significant**.

8.9 References

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