Air Quality Assessment: Harrogate Road, New Line Junction Improvement Scheme

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Experts in air quality
management & assessment

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Executive Summary

The potential air quality impacts associated with the construction and improvements to the Harrogate Road, New Line Junction Improvement Scheme in Greengates, Bradford have been assessed.

Existing conditions within the study area show concentrations are above the annual mean nitrogen dioxide objective at two receptor locations, indicating air quality in some locations at the junction is poor.

The construction works will give rise to a *Medium* Risk of dust impacts. It will therefore be necessary to apply a package of mitigation measures to minimise dust emissions. With these mitigation measures in place, the overall impacts during construction will be „not significant".

The proposed Junction Improvement Scheme will affect air quality at existing properties along the local road network, due to the road-realignment, predicted increases in traffic and changes in speed. Changes in pollutant concentrations at sensitive locations resulting from the proposed works will have impacts ranging from *negligible* to *substantial beneficial* at different locations for nitrogen dioxide. All impacts on PM_{10} and $PM_{2.5}$ concentrations will be *negligible.* Concentrations will remain below the air quality objectives at all of the receptors.

Overall, the construction air quality impacts of the scheme are judged to be „not significant" and the operational impacts, which are beneficial, are considered to be „significant".

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1 Introduction

1.1 This report describes the potential air quality impacts associated with improvement works to the junction of the A658 Harrogate Road and A657 New Line, in Greengates, Bradford. The proposed junction improvement scheme comprises road widening works, the introduction of cycle lanes, a new link road („P-Loop" Junction) and new access to the Farmfoods retail premises. The planning application specifically relates to the proposed „P-Loop" Junction and Farmfoods access, with car parking, which forms part of the overall A658 Harrogate Road / A657 New Line Junction Improvement Scheme.

1.2 The operational impacts have been assessed for the junction improvement scheme as a whole, as the impacts of the P-Loop and Farmfoods access are dependent on the rest of the scheme.

1.3 The assessment has been carried out by Air Quality Consultants Ltd on behalf of City of Bradford Metropolitan District Council (MDC).

1.4 The junction improvements may lead to a change in traffic flows at the junction, changes in vehicle speed and realignment of roads closer to existing residential properties. The main air pollutants of concern related to traffic emissions are nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$).

1.5 There is also the potential for the construction activities to impact upon the surrounding area. The main pollutants of concern related to construction activities are dust and PM_{10}. The assessment of construction dust impacts have been undertaken for the application sites only, as this is to which the air quality assessment relates; rather than the entire junction improvement works.

1.6 This report describes existing local air quality conditions (2016), and the predicted air quality in the future assuming that the proposed development does, or does not proceed. The assessment of traffic-related impacts focuses on 2021, which is the anticipated year of opening. The assessment of construction dust impacts focuses on the anticipated duration of the works.

1.7 This report has been prepared taking into account all relevant local and national guidance and regulations, and follows a methodology agreed with City of Bradford MDC.

2 Policy Context and Assessment Criteria

Air Quality Strategy

2.1 The Air Quality Strategy (Defra, 2007) published by the Department for Environment, Food, and Rural Affairs (Defra) and Devolved Administrations, provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an Air Quality Management Area (AQMA), and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

Planning Policy

National Policies

2.2 The National Planning Policy Framework (NPPF) (2012) sets out planning policy for England in one place. It places a general presumption in favour of sustainable development, stressing the importance of local development plans, and states that the planning system should perform an environmental role to minimise pollution. One of the twelve core planning principles notes that planning should *"contribute to…reducing pollution"*. To prevent unacceptable risks from air pollution, planning decisions should ensure that new development is appropriate for its location. The NPPF states that the *"effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account"*.

2.3 More specifically the NPPF makes clear that:

"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan".

2.4 The NPPF is now supported by Planning Practice Guidance (PPG) (DCLG, 2017), which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states that *"Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with EU Limit Values"* and *"It is important that the potential impact of new development on air quality is taken into account … where the national assessment indicates that relevant limits have been exceeded or are near the limit"*. The role of the local authorities is covered by the LAQM regime, with the PPG stating that local authority Air Quality Action Plans "*identify measures that will be introduced in pursuit of the objectives*". In addition, the PPG makes clear that *"Odour and dust can also be a planning concern, for example, because of the effect on local amenity"*.

2.5 The PPG states that:

"Whether or not air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to generate air quality impact in an area where air quality is known to be poor. They could also arise where the development is likely to adversely impact upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife)".

2.6 The PPG sets out the information that may be required in an air quality assessment, making clear that *"Assessments should be proportional to the nature and scale of development proposed and the level of concern about air quality"*. It also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear that *"Mitigation options where necessary, will depend on the proposed development and should be proportionate to the likely impact".*

Local Transport Plan

2.7 One of the aims of the West Yorkshire Local Transport Plan (City of Bradford MDC, 2011) is to improve air quality by reducing the demand for car travel, and a modal shift in transport.

Local Policies

2.8 The current planning policy for City of Bradford MDC is the Replacement Unitary Development Plan (RUDP) (City of Bradford MDC, 2005) . „Saved" Policy P1 relates to air quality and states:

"development will not be permitted where it is likely to have an unacceptable effect on air quality. In determining whether or not an unacceptable effect will result, particular consideration will be given to the following issues:

(1) the likelihood of emissions which are likely to have a significantly unacceptable effect on the amenity of the local area;

(2) where there is the significant risk that public health may be adversely affected;

(3) where there is a significant possibility that any proposed development will lead to a breach of national air quality objectives. An air quality impact assessment may be required before determining applications with a potential to significantly contribute to air pollution".

2.9 The Council has produced a Core Strategy as part of its Development Plan which is currently awaiting adoption (City of Bradford MDC, 2014). It contains a number of emerging polices relating to air quality; the principal policy being draft EN8 Environmental Protection which states;

"In order to protect public health and the environment the Council will require that:

Proposals which are likely to cause pollution or are likely to result in exposure to sources of pollution (including noise, odour and light pollution) or risks to safety, will only be permitted if measures can be implemented to minimise pollution and risk to a level that provides a high standard of protection for health, environmental quality and amenity. The following issues require particular attention:

A. Air Quality In liaison with partner organisations, the Council will take a proactive approach to maintaining and improving air quality within the District in line with both National Air Quality Standards, the European Union limit values and the principles of best practice. Through a range of actions, it will seek to secure a reduction in emissions from sources which contribute to poor air quality. Development proposals that have the potential to adversely impact on air quality will be required to incorporate measures to mitigate or offset their emissions and impacts, in accordance with the Low Emission Strategy for Bradford and associated guidance documents. In areas where air quality is a matter of concern, development proposals will be required to deliver a positive impact on air quality in the district. Development proposals must not exacerbate air quality beyond acceptable levels; either through poor design or as a consequence of site selection".

Bradford Air Quality Strategy

2.10 The Bradford Air Quality Strategy aims to provide a framework to improve and maintain air quality within the district. The strategy defines „strategic action areas" to improve air quality including development control, transport and public sector procurement.

Air Quality Action Plans

National Air Quality Plans

2.11 Defra has produced an Air Quality Plan to tackle roadside nitrogen dioxide concentrations in the UK (Defra, 2017a). Alongside a package of national measures, the Plan requires those Local Authorities that are predicted to have exceedances of the limit values beyond 2020 to produce local action plans by March 2018. These plans must have measures to achieve the statutory limit values within the shortest possible time. There is currently no practical way to take account of the effects of the national Plan in the modelling undertaken for this assessment; however, consideration has been given to whether there is currently, or is likely to be in the future, a limit value exceedance in the vicinity of the proposed development. This assessment has principally been carried out in relation to the air quality objectives, rather than the EU limit values that are the focus of the Air Quality Plan.

Local Air Quality Action Plan and Low Emission Strategy

2.12 City of Bradford MDC has declared four AQMAs for exceedances of annual mean nitrogen dioxide objectives. The Council has developed an Air Quality Action Plan (City of Bradford MDC, 2009), which sets out measures to improve air quality within its area, such as the reduction in freight emissions, travel planning, and production of an air quality strategy. One the aims of the action plan is for the development of a Low Emissions Strategy (LES) to reduce vehicle emissions. The subsequent LES (City of Bradford MDC, 2013) evaluates a number of topics to encourage emission reductions including, transport planning, improvements to the Council‟s own vehicle fleet, bus and freight emissions, as well as using planning and development control to reduce emissions, as well as considering the feasibility of a low emission zone.

Assessment Criteria

Health Criteria

2.13 The Government has established a set of air quality standards and objectives to protect human health. The „standards‟ are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The „objectives‟ set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations, 2000, Statutory Instrument 928 (2000) and the Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002).

2.14 The objectives for nitrogen dioxide and PM_{10} were to have been achieved by 2005 and 2004 respectively, and continue to apply in all future years thereafter. The $PM_{2.5}$ objective is to be achieved by 2020. Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded at roadside locations where the annual mean concentration is below 60 $\mu g/m^3$ (Defra, 2016b). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level. Measurements have also shown that the 24-hour PM_{10} objective could be exceeded at roadside locations where the annual mean concentration is above 32 $\mu g/m^3$ (Defra, 2016b). The predicted annual mean PM_{10} concentrations are thus used as a proxy to determine the likelihood of an exceedence of the 24-hour mean PM_{10}

objective. Where predicted annual mean concentrations are below 32 µg/m^3 it is unlikely that the 24-hour mean objective will be exceeded.

2.15 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2016b). The annual mean objectives for nitrogen dioxide and PM_{10} are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 24-hour objective for PM_{10} is considered to apply at the same locations as the annual mean objective, as well as in gardens of residential properties and at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets.

2.16 The European Union has also set limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$. The limit values for nitrogen dioxide are the same numerical concentrations as the UK objectives, but achievement of these values is a national obligation rather than a local one (Directive 2008/50/EC of the European Parliament and of the Council, 2008). In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded.

2.17 The relevant air quality criteria for this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide, PM_{10} and $PM_{2.5}$

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour Mean	200 µg/m^3 not to be exceeded more than 18 times a year
	Annual Mean	40 µg/m^3
Fine Particles (PM_{10})	24-hour Mean	50 µg/m^3 not to be exceeded more than 35 times a year
	Annual Mean	40 µg/m^3 [a]
Fine Particles ($PM_{2.5}$) [b]	Annual Mean	25 µg/m^3

[a] A proxy value of 32 µg/m^3 as an annual mean is used in this assessment to assess the likelihood of the 24-hour mean PM_{10} objective being exceeded. Measurements have shown that, above this concentration, exceedances of the 24-hour mean PM_{10} objective are possible (Defra, 2016b).

[b] The $PM_{2.5}$ objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it.

Construction Dust Criteria

2.18 There are no formal assessment criteria for dust. In the absence of formal criteria, the approach developed by the Institute of Air Quality Management (IAQM)[1] (2016), has been used. Full details of this approach are provided in Appendix A1.

Descriptors for Air Quality Impacts and Assessment of Significance

Construction Dust Significance

2.19 Guidance from IAQM (2016) is that, with appropriate mitigation in place, the impacts of construction dust will be „not significant‟. The assessment thus focuses on determining the appropriate level of mitigation so as to ensure that impacts will normally be „not significant‟.

Operational Significance

2.20 There is no official guidance in the UK in relation to development control on how to describe air quality impacts, nor how to assess their significance. The approach developed jointly by Environmental Protection UK (EPUK) and the IAQM (Moorcroft and Barrowcliffe et al, 2017) has therefore been used. This includes defining descriptors of the impacts at individual receptors, which take account of the percentage change in concentrations relative to the relevant air quality objective, rounded to the nearest whole number, and the absolute concentration relative to the objective. The overall significance of the air quality impacts is determined using professional judgement, taking account of the impact descriptors. Full details of the EPUK/IAQM approach are provided in Appendix A2. The approach includes elements of professional judgement, and the experience of the consultants preparing the report is set out in Appendix A2.1.

[1] The IAQM is the professional body for air quality practitioners in the UK.

3 Assessment Approach

Consultation

3.1 The assessment methodology has been discussed and agreed by email between Sally Jones (Pollution Control Officer at City of Bradford MDC) and Lucy Hodgins (Air Quality Consultants) on 16th December 2016.

Existing Conditions

3.2 Information on existing air quality has been obtained by collating the results of monitoring carried out specifically for the proposed development by the local authority. Background concentrations have been defined using the national pollution maps published by (Defra, 2017b). These cover the whole country on a 1x1 km grid

3.3 Exceedances of the annual mean EU limit value for nitrogen dioxide in the study area have been identified using the maps of roadside concentrations published by Defra (2017d) as part of its 2017 Air Quality Plan for the baseline year 2015 and for the future years 2017 to 2030.These are the maps used by the UK Government, together with the results from national AURN monitoring sites that operate to EU data quality standards, to report exceedances of the limit value to the EU. The national maps of roadside PM_{10} and $PM_{2.5}$ concentrations, which are available for the years 2009 to 2015, show no exceedances of the limit values anywhere in the UK in 2015.

Construction Impacts

3.4 The construction dust assessment considers the potential for impacts within 350 m of the site boundaries; or within 50 m of roads used by construction vehicles. The assessment methodology is that provided by IAQM (2016). This follows a sequence of steps. Step 1 is a basic screening stage, to determine whether the more detailed assessment provided in Step 2 is required. Step 2a determines the potential for dust to be raised from on-site works and by vehicles leaving the site. Step 2b defines the sensitivity of the area to any dust that may be raised. Step 2c combines the information from Steps 2a and 2b to determine the risk of dust impacts without appropriate mitigation. Step 3 uses this information to determine the appropriate level of mitigation required to ensure that there should be no significant impacts. Appendix A1 explains the approach in more detail.

Road Traffic Impacts

Sensitive Locations

3.5 Concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been predicted at a number of locations close to the proposed Junction Improvement Scheme works. Receptors have been identified to represent worst-case exposure within these locations, being located on the façades of the properties closest to the sources.

3.6 Fourteen existing residential properties have been identified as receptors for the assessment. These locations are described in Table 2 and shown in Figure 1, below. In addition, concentrations have been modelled at the diffusion tube monitoring sites located within the study area, in order to verify the modelled results (see Appendix A4 for verification method).

Table 2: Description of Receptor Locations

Receptor	Description
Receptor 1	91 New Line [b]
Receptor 2	919 Harrogate Road [c]
Receptor 3	142 New Line [a]
Receptor 4	885 Harrogate Road [a]
Receptor 5	Flats above Italian Restaurant [d]
Receptor 6	159 New Line [a]
Receptor 7	830 Harrogate Road [a]
Receptor 8	138 New Line [a]
Receptor 9	830 Harrogate Road [a]
Receptor 10	85 New Line [a]
Receptor 11	933 Harrogate Road [a]
Receptor 12	14 Stockhill Road [a]
Receptor 13	Greengates Primary School [a]
Receptor 14	917 Harrogate Road [c]

[a] Receptors modelled at a height of 1.5 m and 4.5 m

[b] Receptors modelled at heights of 1.5 m, 4.5 m and 7.5 m

[c] Receptors modelled at a height of 3.4 m

[d] Receptor modelled at a height of 4.5 m

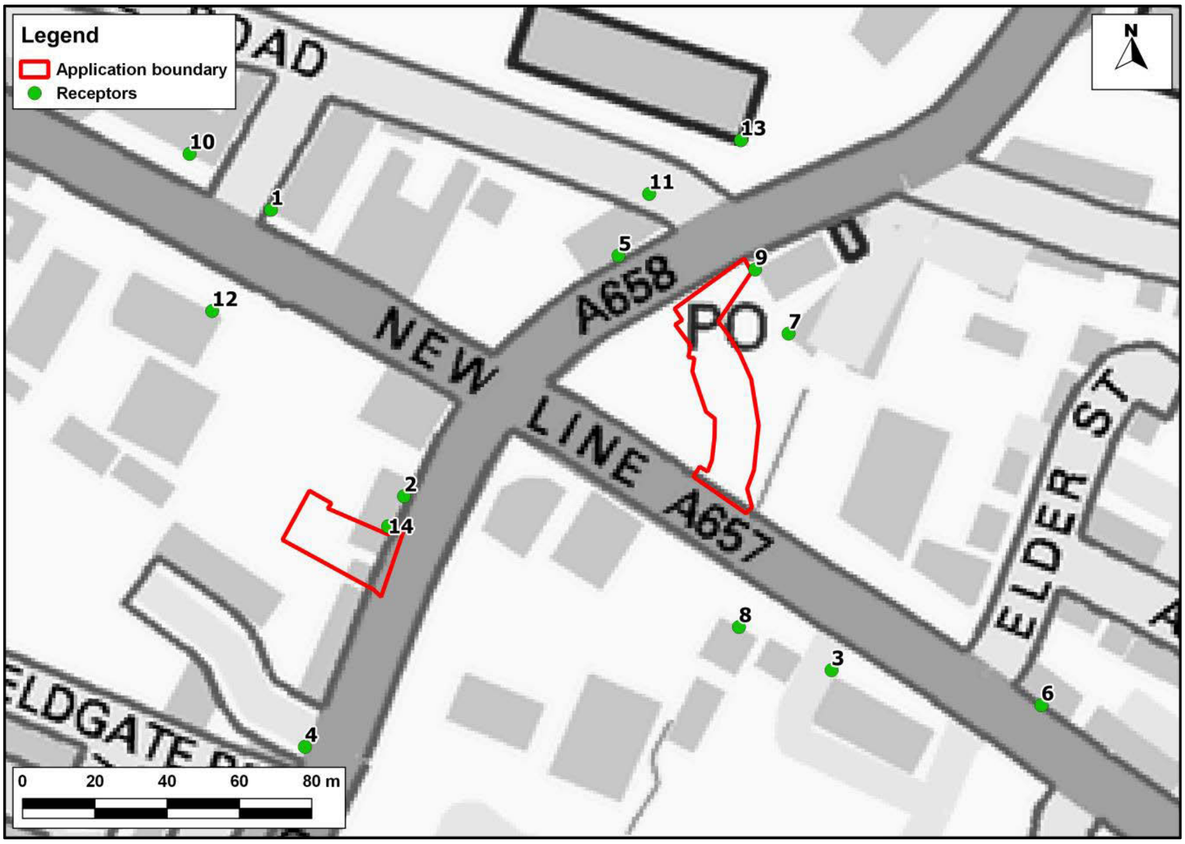

Figure 1: Receptor Locations

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Assessment Scenarios

3.7 Predictions of nitrogen dioxide, PM_{10} and $PM_{2.5}$ concentrations have been carried out for a base year (2016), and the proposed year of opening (2021). For 2021, predictions have been made assuming both that the entire Junction Improvement Scheme (including the aspects for which the planning application is sought, as well as other associated aspects of the scheme) does proceed (With Scheme), and does not proceed (Without Scheme). In addition to the set of „official" predictions, a sensitivity test has been carried out for nitrogen dioxide that involves assuming much higher nitrogen oxides emissions from certain vehicles than have been predicted by Defra, using AQC"s Calculator Using Realistic Emissions for Diesels (CURED V2A) tool (AQC, 2016a). This is to address the potential under-performance of emissions control technology on modern diesel vehicles (AQC, 2016b).

Modelling Methodology

3.8 Concentrations have been predicted using the ADMS-Roads dispersion model. Details of the model inputs, assumptions and the verification are provided in Appendix A4, together with the method used to derive current and future year background concentrations. Where assumptions have been made, a realistic worst-case approach has been adopted.

Traffic Data

3.9 Traffic data for the assessment have been provided by Fore Consulting Limited. Further details of the traffic data used and the uncertainties associated with these are described in paragraph 3.16 and Appendix A4.

Uncertainty in Road Traffic Modelling Predictions

3.10 There are many components that contribute to the uncertainty of modelling predictions. The road traffic emissions dispersion model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms.

3.11 An important stage in the process is model verification, which involves comparing the model output with measured concentrations (see Appendix A4). Because the model has been verified and adjusted, there can be reasonable confidence in the prediction of current year (2016) concentrations.

3.12 Predicting pollutant concentrations in a future year will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections provided by Department for Transport (DfT) and Defra as to what will happen to traffic volumes, background pollutant concentrations and vehicle emissions.

3.13 Historically, across the country large reductions in nitrogen oxides emissions have been projected, which has led to significant reductions in nitrogen dioxide concentrations from one year to the next being predicted. Over time, it was found that trends in measured concentrations did not reflect the rapid reductions that Defra and DfT had predicted (Carslaw et al., 2011). This was evident across the UK, although the effect appeared to be greatest in inner London; there was also considerable inter-site variation. Emission projections over the 6 to 8 years prior to 2009 suggested that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25%, whereas monitoring data showed that concentrations remained relatively stable, or even showed a slight increase. Analysis of more recent data for 23 roadside sites in London covering the period 2003 to 2012 showed a weak downward trend of around 5% over the ten years (Carslaw and Rhys-Tyler, 2013), but this still falls short of the improvements that had been predicted at the start of this period. Similar analyses have not been carried out within Bradford but trends are likely to have been similar, since these are nation-wide phenomena.

3.14 The reason for the disparity between the expected concentrations and those measured relates to the on-road performance of modern diesel vehicles. New vehicles registered in the UK have had to meet progressively tighter European type approval emissions categories, referred to as "Euro" standards. While the nitrogen oxides emissions from newer vehicles should be lower than those from equivalent older vehicles, the on-road performance of some modern diesel vehicles has often been no better than that of earlier models. This has been compounded by an increasing proportion of nitrogen dioxide in the nitrogen oxides emissions, i.e. primary nitrogen dioxide, which has a significant effect on roadside concentrations (Carslaw et al., 2011) (Carslaw and Rhys-Tyler, 2013).

3.15 A detailed analysis of emissions from modern diesel vehicles has been carried out (AQC, 2016b). This shows that, where previous standards had limited on-road success, the „Euro VI‟ and „Euro 6‟ standards that new vehicles have had to comply with from 2013/16[2] are delivering real on-road improvements. A detailed comparison of the predictions in Defra‟s latest Emission Factor Toolkit (EFT) v7.0 against the results from on-road emissions tests has shown that Defra‟s latest predictions still have the potential to under-predict emissions from some vehicles, albeit by less than has historically been the case (AQC, 2016b). In order to account for this potential under-prediction, a sensitivity test has been carried out in which the emissions from Euro IV, Euro V, Euro VI, and Euro 6 vehicles have been uplifted as described in Paragraph A4.10 in Appendix A4, using AQC‟s CURED (V2A) tool (AQC, 2016a). The results from this sensitivity test are likely to over-predict emissions from vehicles in the future (AQC, 2016b) and thus provide a reasonable worst-case upper-bound to the assessment.

3.16 Traffic data for the assessment have been provided by Fore Consulting Ltd; derived from its Aimsum model developed for these junction improvement works. Annual Average Daily Traffic (AADT) flows are based on the model runs for weekday peak hour periods and Saturday peak periods, which have been factored assuming a constant relationship between peak hour traffic and AADT. It has been assumed that peak hour modelled speeds are the same as annual average speeds.

2 Euro VI refers to heavy duty vehicles, while Euro 6 refers to light duty vehicles. The timings for meeting the standards vary with vehicle type and whether the vehicle is a new model or existing model.

4 Site Description and Baseline Conditions

4.1 The proposed Junction Improvement Scheme works, including the „P-Loop Junction" and relocated Farmfoods access and new parking, are located approximately 4.5 km north-east of Bradford city centre, within Greengates, at the junction of the A658 and A657. The junction is located towards the outskirts of the city, with a number of commercial units and residential properties within the immediate vicinity of the junction.

Air Quality Review and Assessment

4.2 City of Bradford MDC has investigated air quality within its area as part of its responsibilities under the LAQM regime. It has declared four AQMAs for exceedances of the annual mean nitrogen dioxide objective. None of these are close to the application site boundaries.

4.3 In terms of PM_{10}, City of Bradford MDC has concluded that there are no exceedances of the objectives. It is therefore reasonable to assume that existing PM_{10} levels will not exceed the objectives within the study area.

Local Air Quality Monitoring

4.4 City of Bradford MDC is undertaking diffusion tube monitoring within the vicinity of the junction improvements. Monitoring commenced in March 2016 using diffusion tubes supplied and analysed by West Yorkshire Analytical Services Laboratory (WYAS) using the 50% Triethanolamine in acetone method. No further monitoring is undertaken by the Council in close proximity to the application site. Results for the period March to December 2016 have been annualised and bias adjusted and summarised in Table 3 and shown in Appendix A5. Monitoring locations are shown in Figure 2.

Table 3: Summary of Relevant Nitrogen Dioxide (NO_2) Measurements (μg/m^3) [a]

Site No.[b]	Site Name	Average (2016)[c]	Annualised	Bias Adjusted (Factor 0.75)
HR1	Harrogate Rd	51.6	55.5	**41.6**
HR2	New Line (former school)	54.5	58.7	**44.0**
HR3	Stockhill Rd (school)	37.9	40.2	30.1
HR4	Harrogate Rd	68.3	73.5	**55.1**
HR5	New Line (ped crossing)	50.7	50.0	37.5
Objective		40		

[a] Exceedances of the objectives are shown in bold

[b] Using City of Bradford MDC nomenclature.

[c] Weighted average based on exposure period

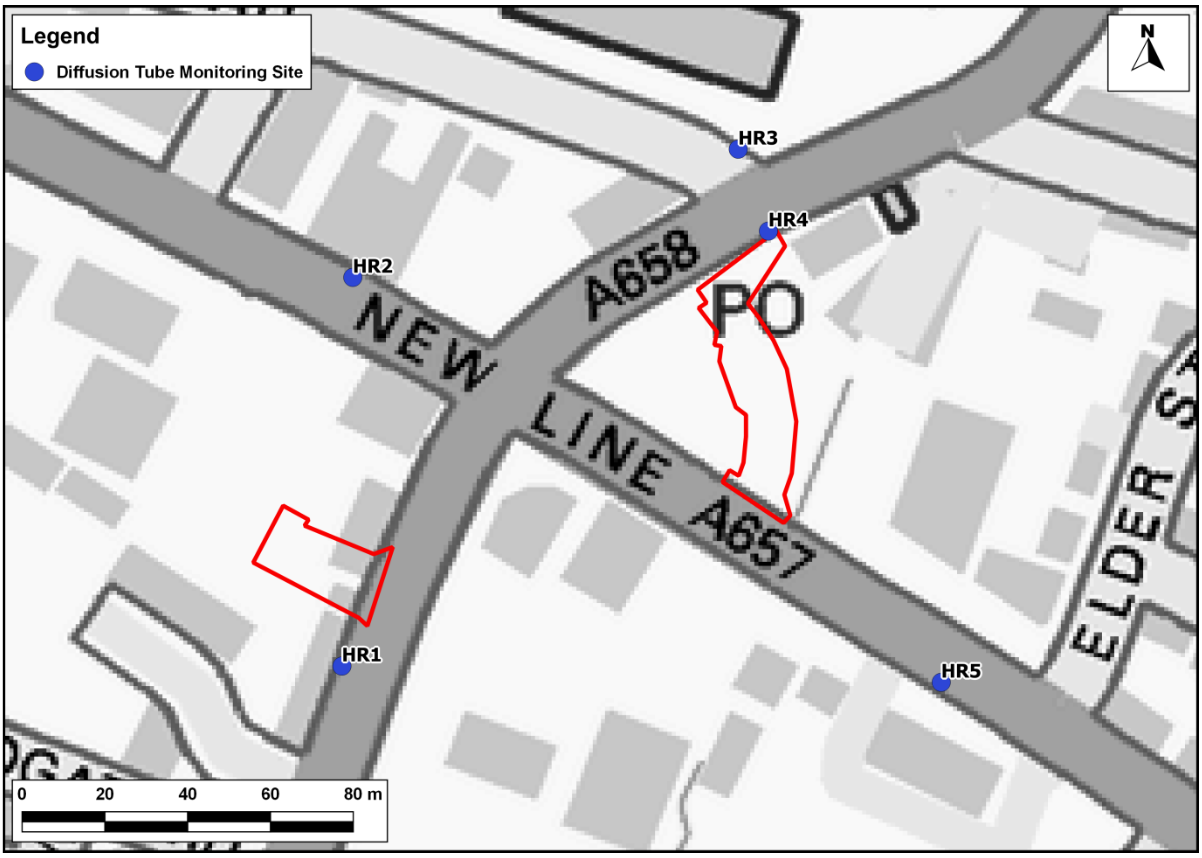

Figure 2: Diffusion Tube Monitoring Locations

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Exceedances of EU Limit Value

4.5 There are no AURN monitoring sites within 1 km of the application sites, with which to identify exceedances of the annual mean nitrogen dioxide limit value. Defra‟s roadside annual mean nitrogen dioxide concentrations (Defra, 2017d), used to report exceedances of the limit value to the EU and which have been updated to support the 2017 Air Quality Plan, do not identify any exceedances within the study area in 2015. As such, there is considered to be no risk of a limit value exceedance in the vicinity of the proposed development by the time that it is operational.

Background Concentrations

4.6 In addition to the locally measured concentrations, estimated background concentrations in the study area have been determined for 2016 and the opening year 2021 using Defra‟s background maps (Defra, 2017a). The background concentrations are set out in Table 4 and have been derived as described in Appendix A4. The background concentrations are all well below the objectives.

Table 4: Estimated Annual Mean Background Pollutant Concentrations in 2016 and 2021 ($\mu g/m^3$)

Year	NO_2	PM_{10}	$PM_{2.5}$
2016	19.2-20.8	13.5-14.0	9.7-10.1
2021 [a]	15.6-17.1	13.1-13.6	9.3-9.7
2021 Worst-case Sensitivity Test [b]	*16.6-18.1*	*N/A*	*N/A*
Objectives	**40**	**40**	**25** [c]

N/A = not applicable. The range of values is for the different 1x1 km grid squares covering the study area.

[a] In line with Defra"s forecasts.

[b] Assuming higher emissions from modern diesel vehicles as described in Appendix A4.

[c] The $PM_{2.5}$ objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it.

Baseline Dispersion Model Results

4.7 Baseline concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been modelled at each of the existing receptor locations (see Figure 1 and Table 2 for receptor locations). The results, which cover both the existing (2016) and future year (2021) baseline (Without Scheme), are set out in Table 5 and Table 6. The predictions for nitrogen dioxide include a sensitivity test, which accounts for the potential under-performance of emissions control technology on modern diesel vehicles. In addition, the modelled road components of nitrogen oxides, PM_{10} and $PM_{2.5}$ have been increased from those predicted by the model based on a comparison with local measurements (see Appendix A4 for the verification methodology).

Table 5: Modelled Annual Mean Baseline Concentrations of Nitrogen Dioxide (µg/m^3) at Existing Receptors

Receptor	2016 [a]	2021 Without Scheme [a]	*Worst-case Sensitivity Test* [b,c]	
			2016	*2021 Without Scheme*
Receptor 1	36.4	28.8	*36.5*	*32.5*
Receptor 2	33.1	24.8	*33.1*	*28.0*
Receptor 3	31.9	24.2	*31.9*	*27.3*
Receptor 4	39.0	30.4	*38.9*	*34.6*
Receptor 5	32.2	24.2	*32.2*	*27.3*
Receptor 6	**40.9**	30.7	***41.1***	*35.1*
Receptor 7	32.4	24.5	*32.5*	*27.6*
Receptor 8	31.5	23.9	*31.5*	*26.9*
Receptor 9	**45.7**	34.1	***45.8***	*39.0*
Receptor 10	33.5	27.4	*33.7*	*30.8*
Receptor 11	36.8	27.4	*36.8*	*31.1*
Receptor 12	30.6	24.1	*30.7*	*26.8*
Receptor 13	31.6	24.0	*31.7*	*27.0*
Receptor 14	32.5	24.6	*32.5*	*27.7*
Objective	**40**			

[a] In line with Defra"s forecasts.

[b] Assuming higher emissions from modern diesel vehicles as described in Paragraph A4.10 in Appendix A4.

[c] The methodology for the sensitivity test uses different traffic emissions and required a separate verification (see Appendix A4), which leads to slightly different 2016 values.

Table 6: Modelled Annual Mean Baseline Concentrations of PM_{10} and $PM_{2.5}$ at Existing Receptors (µg/m^3)

Receptor	PM_{10} [a]		$PM_{2.5}$	
	2016	2021 Without Scheme	2016	2021 Without Scheme
Receptor 1	16.9	16.4	11.8	11.3
Receptor 2	15.8	15.3	11.1	10.6
Receptor 3	15.7	15.2	11.1	10.6
Receptor 4	17.1	16.5	11.9	11.3
Receptor 5	15.7	15.2	11.0	10.5
Receptor 6	17.8	17.3	12.3	11.7
Receptor 7	15.7	15.2	11.1	10.6
Receptor 8	15.5	15.1	11.0	10.5
Receptor 9	18.3	17.8	12.7	12.0
Receptor 10	16.4	15.9	11.5	11.0
Receptor 11	16.3	15.8	11.4	10.9
Receptor 12	15.7	15.3	11.1	10.6
Receptor 13	15.6	15.1	11.0	10.5
Receptor 14	15.7	15.2	11.1	10.6
Objective / Criterion	32 [a]		25 [b]	

[a] While the annual mean PM_{10} objective is 40 µg/m^3, 32 µg/m^3 is the annual mean concentration above which an exceedence of the 24-hour mean PM_{10} objective is possible, as outlined in LAQM.TG16 (Defra, 2016b). A value of 32 µg/m^3 is thus used as a proxy to determine the likelihood of exceedence of the 24-hour mean PM_{10} objective, as recommended in EPUK & IAQM guidance (Moorcroft and Barrowcliffe et al, 2017).

[b] The $PM_{2.5}$ objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it.

Baseline

4.8 The predicted annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ are below the objective at the majority of receptors in 2016 and 2021. Predicted nitrogen dioxide concentrations at Receptors 6 and 9 in 2016 are above the objective. The annual mean PM_{10} concentrations are below 32 µg/m^3 and it is, therefore, unlikely that the 24-hour mean PM_{10} objective will be exceeded.

4.9 The junction has not been identified by the Council within its Review and Assessment reports as an area exceeding the air quality objective, as monitoring only commenced in 2016. Measurements made by the Council at the junction (albeit that monitoring sites are not at locations of relevant exposure) suggests concentrations are above the level of the objective in the study area and the model results are broadly consistent with these measurements.

4.10 The results from the upper-bound sensitivity test are not materially different from those derived using the „official" predictions.

5 Construction Phase Impact Assessment

5.1 The construction works will give rise to a risk of dust impacts during demolition, earthworks and construction, as well as from trackout of dust and dirt by vehicles onto the public highway. Step 1 of the assessment procedure is to screen the need for a detailed assessment. There are receptors within the distances set out in the guidance (see Appendix A1), thus a detailed assessment is required. The following section sets out Step 2 of the assessment procedure. The assessment of construction dust impacts considers the planning application only and not the entire Junction Improvement Scheme works.

Potential Dust Emission Magnitude

Demolition

5.2 There will be a requirement to demolish brick buildings within the site area. Demolition will be undertaken in advance of the main construction works. The buildings to be demolished are made of natural stone, with slate roofs and will be taken down by hand, with some machine assistance. This will reduce the potential for dust emissions. Based on the example definitions set out in Table A1.1 in Appendix A1 and conservative assumptions, the dust emission class for demolition is considered to be *medium.*

Earthworks

5.3 The characteristics of the soil at the development site have been defined using the British Geological Survey‟s UK Soil Observatory website (British Geological Survey, 2017), as set out in Table 7. Overall, it is considered that, when dry, this soil has the potential to be moderately dusty.

Table 7: Summary of Soil Characteristics

Category	Record
Soil Layer Thickness	Deep
Soil Parent Material Grain Size	Mixed (Argillaceous [a] – Rudaceous [b])
European Soil Bureau Description	Glacial Till
Soil Group	Medium to Light (Silty) to Heavy
Soil Texture	Clayey Loam [d] to Silty Loam

[a] grain size < 0.06 mm.

[b] grain size > 2.0 mm.

[d] a loam is composed mostly of sand and silt.

5.4 The application area covers approximately 1,300 m^2 and most of this will be subject to earthworks, involving excavation and levelling of the area. The earthworks will last around two months and will involve the movement of material with a maximum of four earth moving vehicles. Dust will arise mainly from vehicles travelling over unpaved ground and from the handling of dusty materials (such as dry soil). The construction of the road base and surfacing will take place over a one year period, and will include piling and construction of a concrete wall for the re-located Farmfoods access. Based on the example definitions set out in Table A1.1 in Appendix A1, the dust emission class for earthworks is considered to be *medium*.

Construction

5.5 There is considered to be limited construction associated with the „P-Loop Junction‟ and Farmfoods access and parking. The construction and road re-alignment is considered to be more relevant to earthworks, and therefore considered in paragraph 5.3.

Trackout

5.6 The number of vehicles associated with the construction work, which may track out dust and dirt is likely to be a maximum of 10 per day. The majority of these will not have travelled over unpaved surfaces, but at a maximum the unpaved road length would be approximately 25 m. Based on the example definitions set out in Table A1.1 in Appendix A1, the dust emission class for trackout is considered to be *small*.

5.7 Table 8 summarises the dust emission magnitude for the proposed development.

Table 8: Summary of Dust Emission Magnitude

Source	Dust Emission Magnitude
Demolition	Medium
Earthworks	Medium
Construction	N/A
Trackout	Small

Sensitivity of the Area

5.8 This assessment step combines the sensitivity of individual receptors to dust effects with the number of receptors in the area and their proximity to the site. It also considers additional site-specific factors such as topography and screening, and in the case of sensitivity to human health effects, baseline PM_{10} concentrations.

Sensitivity of the Area to Effects from Dust Soiling

5.9 The IAQM guidance explains that residential properties are „high‟ sensitivity receptors to dust soiling, while the commercial properties are „medium‟ sensitivity receptors (Table A1.2 in Appendix A1). There are more than 10 properties within 20 m of the planning application boundary. Using the matrix set out in Table A1.3 in Appendix A1, the area surrounding the onsite works is of „high" sensitivity to dust soiling.

5.10 Table 8 shows that the dust emission magnitude for trackout is *small* and Table A1.3 in Appendix A1 thus explains that there is a risk of material being tracked 50 m from the site. It has been assumed that vehicles leaving the application sites could travel in any direction. There are more than 10 properties within 20m of the road along which material could be tracked, and Table A1.3 in Appendix A1 thus indicates that the area is of „high" sensitivity to dust soiling due to trackout.

Sensitivity of the Area to any Human Health Effects

5.11 Residential properties are also classified as being of „high" sensitivity to human health effects. The matrix in Table A1.4 in Appendix A1 requires information on the baseline annual mean PM_{10} concentration in the area. The maximum predicted baseline PM_{10} concentration for those receptors within 20m of the application boundary is 16.5 µg/m^3 (Table 12), and this value has been used. Using the matrix in Table A1.4 in Appendix A1, the area surrounding the onsite works and alongside roads which the material may be tracked is of „low" sensitivity to human health effects.

Summary of the Area Sensitivity

5.12 Table 9 summarises the sensitivity of the area around the proposed construction works.

Table 9: Summary of the Area Sensitivity

Effects Associated With:	Sensitivity of the Surrounding Area	
	On-site Works	Trackout
Dust Soiling	High Sensitivity	High Sensitivity
Human Health	Low Sensitivity	Low Sensitivity

Risk and Significance

5.13 The dust emission magnitudes in Table 8 have been combined with the sensitivities of the area in Table 9 using the matrix in Table A1.6 in Appendix A1, in order to assign a risk category to each activity. The resulting risk categories for the four construction activities, without mitigation, are set out in Table 10. These risk categories have been used to determine the appropriate level of mitigation as set out in Section 6 (step 3 of the assessment procedure).

Table 10: Summary of Risk of Impacts Without Mitigation

Source	Dust Soiling	Human Health
Demolition	Medium Risk	Low Risk
Earthworks	Medium Risk	Negligible Risk
Construction	N/A	N/A
Trackout	Low Risk	Negligible Risk

5.14 The IAQM guidance does not provide a method for assessing the significance of effects before mitigation, and advises that pre-mitigation significance should not be determined. With appropriate mitigation in place, the IAQM guidance is clear that the residual effect will normally be „not significant" (IAQM, 2016).

6 Operational Phase Impact Assessment

6.1 Predicted annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ in 2021 for existing receptors are set out in Table 11, Table 12 and Table 13 for both the "Without Scheme" and "With Scheme" scenarios. The "With Scheme" scenario includes the impacts of the entire Junction Improvement Scheme and not just those aspects covered by the planning application. These tables also describe the impacts at each receptor using the impact descriptors given in Appendix A2. For nitrogen dioxide, results are presented for two scenarios so as to include a worst-case sensitivity test.

Table 11: Predicted Impacts on Annual Mean Nitrogen Dioxide Concentrations in 2021 (µg/m^3)

Receptor	Without Scheme [a]	With Scheme [a]	% Change [a,b]	Impact Descriptor [b]	*Worst-case Sensitivity Test [c]*			
					Without Scheme	*With Scheme*	*% Change [c]*	*Impact Descriptor*
Receptor 1	28.8	26.5	-6	Slight Beneficial	32.5	29.8	-7	Moderate Beneficial
Receptor 2	24.8	24.5	-1	Negligible	28.0	27.5	-1	Negligible
Receptor 3	24.2	25.1	2	Negligible	27.3	28.3	3	Negligible
Receptor 4	30.4	27.8	-7	Moderate Beneficial	34.6	31.2	-8	Moderate Beneficial
Receptor 5	24.2	23.2	-3	Negligible	27.3	26.0	-3	Negligible
Receptor 6	30.7	29.9	-2	Slight Beneficial	35.1	34.2	-2	Slight Beneficial
Receptor 7	24.5	24.6	0	Negligible	27.6	27.7	0	Negligible
Receptor 8	23.9	24.4	1	Negligible	26.9	27.5	2	Negligible
Receptor 9	34.1	30.2	-10	Moderate Beneficial	39.0	34.6	-11	Substantial Beneficial
Receptor 10	27.4	25.1	-6	Slight Beneficial	30.8	28.0	-7	Moderate Beneficial
Receptor 11	27.4	26.0	-3	Negligible	31.1	29.4	-4	Slight Beneficial
Receptor 12	24.1	24.7	2	Negligible	26.8	27.6	2	Negligible
Receptor 13	24.0	23.5	-1	Negligible	27.0	26.5	-1	Negligible
Receptor 14	24.6	24.1	-1	Negligible	27.7	27.0	-2	Negligible
Objective	**40**		-	-	***40***		-	-

[a] In line with Defra‟s forecasts.

[b] % changes are relative to the objective and have been rounded to the nearest whole number.

[c] Assuming higher emissions from modern diesel vehicles as described in Paragraph A4.10 in Appendix A4.

Table 12: Predicted Impacts on Annual Mean PM_{10} Concentrations in 2021 (µg/m^3)

Receptor	Annual Mean PM_{10} (µg/m^3)			
	Without Scheme	With Scheme	% Change [a]	Impact Descriptor
Receptor 1	16.4	16.2	0	Negligible
Receptor 2	15.3	15.3	0	Negligible
Receptor 3	15.2	15.5	1	Negligible
Receptor 4	16.5	16.6	0	Negligible
Receptor 5	15.2	15.1	0	Negligible
Receptor 6	17.3	17.3	0	Negligible
Receptor 7	15.2	15.4	0	Negligible
Receptor 8	15.1	15.4	1	Negligible
Receptor 9	17.8	17.3	-1	Negligible
Receptor 10	15.9	15.9	0	Negligible
Receptor 11	15.8	15.8	0	Negligible
Receptor 12	15.3	15.7	1	Negligible
Receptor 13	15.1	15.3	0	Negligible
Receptor 14	15.2	15.2	0	Negligible
Criterion	32 [b]		-	-

[a] % changes are relative to the criterion and have been rounded to the nearest whole number.

[b] While the annual mean PM_{10} objective is 40 µg/m^3, 32 µg/m^3 is the annual mean concentration above which an exceedence of the 24-hour mean PM_{10} objective is possible, as outlined in LAQM.TG16 (Defra, 2016b). A value of 32 µg/m^3 is thus used as a proxy to determine the likelihood of exceedence of the 24-hour mean PM_{10} objective, as recommended in EPUK & IAQM guidance (Moorcroft and Barrowcliffe et al, 2017).

Table 13: Predicted Impacts on Annual Mean $PM_{2.5}$ Concentrations in 2021 (µg/m³)

Receptor	Annual Mean $PM_{2.5}$ (µg/m³)			
	Without Scheme	With Scheme	% Change [a]	Impact Descriptor
Receptor 1	11.3	11.2	0	Negligible
Receptor 2	10.6	10.6	0	Negligible
Receptor 3	10.6	10.7	1	Negligible
Receptor 4	11.3	11.3	0	Negligible
Receptor 5	10.5	10.5	0	Negligible
Receptor 6	11.7	11.7	0	Negligible
Receptor 7	10.6	10.6	0	Negligible
Receptor 8	10.5	10.6	1	Negligible
Receptor 9	12.0	11.7	-1	Negligible
Receptor 10	11.0	10.9	0	Negligible
Receptor 11	10.9	10.9	0	Negligible
Receptor 12	10.6	10.8	1	Negligible
Receptor 13	10.5	10.6	0	Negligible
Receptor 14	10.6	10.6	0	Negligible
Objective	25 [b]		-	-

[a] % changes are relative to the criterion and have been rounded to the nearest whole number.

[b] The $PM_{2.5}$ objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it.

Nitrogen Dioxide

6.2 The annual mean nitrogen dioxide concentrations are predicted to be below the objective at all receptor locations in 2021.

6.3 A reduction in concentrations is predicted at most receptors with a percentage reduction relative to the air quality objective (when rounded) of 1% to 10% at ten receptors. There is predicted to be an increase in concentrations at three receptors with changes in concentrations of 1 to 2%, although at all of these receptors concentrations are well below the objective.

6.4 Using the matrix in Table A2.1 (Appendix A2), the impacts are described as negligible at the majority of receptors, a slight beneficial impact at three receptors and a moderate beneficial impact at two receptors.

6.5 The annual mean nitrogen dioxide concentrations are below 60 µg/m³ at all of the receptor locations. It is, therefore, unlikely that the 1-hour mean nitrogen dioxide objective will be exceeded.

6.6 The Junction Improvement Scheme affects three factors which influence nitrogen dioxide concentrations at receptors:

- an increase in the number of daily traffic movements, leading to an increase in emissions;
- increases in speeds leading to a reduction of emissions; and
- changes in road alignment, relocating emissions closer to receptors.

6.7 At the majority of the receptors these factors result in a negligible or beneficial change in concentrations. Receptors 3, 8 and 12 are located on the inbound side of the junction where the road re-alignment is significant, and therefore influenced to a greater extent by the closer source resulting in adverse impacts. However the change is so small that the impacts are negligible.

6.8 A visual representation of the annual average emissions (based on vehicle flows and speed) with and without the Junction Improvement Scheme is presented in Figure 3 to provide an indication of the overall effects of the opposing factors of traffic flow and speeds on emissions. Note that the number of lanes will influence the emission per link.

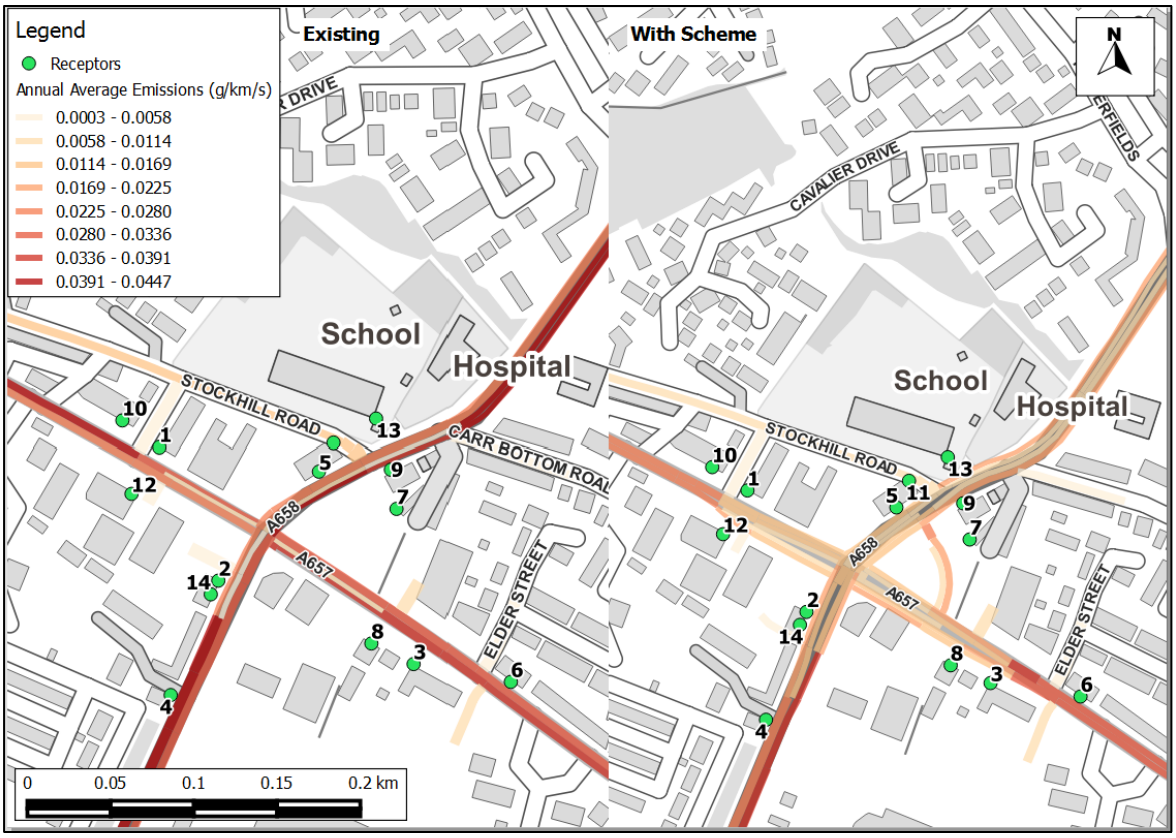

Figure 3: Annual Average Emissions (per road link)[3]

Worst-case Sensitivity Test

6.9 The results from the worst-case sensitivity test show that all receptors are below the annual mean objective. The magnitude of beneficial impacts is greater within the sensitivity test as there are two slight beneficial impacts, three moderate beneficial impacts and one substantial beneficial impact predicted.

PM_{10} and $PM_{2.5}$

6.10 The annual mean PM_{10} and $PM_{2.5}$ concentrations are well below the annual mean objectives at all receptors, with or without the scheme. Furthermore, as the annual mean PM_{10} concentrations are below 32 µg/m^3, it is unlikely that the 24-hour mean PM_{10} objective will be exceeded at any of the receptors.

3 Emissions only appear to be lower close to the junction because there are more links close to the junction (i.e. the vehicles are spread over a number of different links within the model). In practice, the highest emissions occur close to the junction.

6.11 The percentage changes in both PM_{10} and $PM_{2.5}$ concentrations, relative to the air quality objective (when rounded), are predicted to be zero, 1%, or -1% at all receptors. Using the matrix in Table A2.1 (Appendix A2), these impacts are described as *negligible.*

Significance of Operational Air Quality Impacts

6.12 The operational air quality impacts are judged to be „significant beneficial". This professional judgement is made in accordance with the methodology set out in Appendix A2, and also takes into account the results of the sensitivity test for nitrogen dioxide. Future year concentrations are expected to lie between the two sets of results.

6.13 More specifically, the judgement that the air quality impacts will be „significant" takes account of the assessment that:

- concentrations will be below the air quality objectives at all receptors; and
- impacts are predicted to range from negligible to substantial beneficial.

7 Mitigation

Construction Impacts

7.1 Measures to mitigate dust emissions will be required during the construction phase of the development in order to minimise impacts upon nearby sensitive receptors.

7.2 The site has been identified as a *Medium* Risk site during demolition and earthworks and *Low* Risk during trackout, as set out in Table 10. Comprehensive guidance has been published by IAQM (2016) that describes measures that should be employed, as appropriate, to reduce the impacts, along with guidance on monitoring during demolition and construction (IAQM, 2012). This reflects best practice experience and has been used, together with the professional experience of the consultant who has undertaken the dust impact assessment and the findings of the assessment, to draw up a set of measures that should be incorporated into the specification for the works. These measures are described in Appendix A6.

7.3 The mitigation measures for the application sites should be written into a dust management plan (DMP). The DMP may be integrated into a Code of Construction Practice or the Construction Environmental Management Plan, and may require monitoring.

7.4 Where mitigation measures rely on water, it is expected that only sufficient water will be applied to damp down the material. There should not be any excess to potentially contaminate local watercourses.

Road Traffic Impacts

7.5 The assessment has demonstrated that the scheme will not cause any exceedances of the air quality objectives and will, overall, benefit local air quality. Further improvements are also being delivered in the longer term by the introduction of more stringent emissions standards, largely via European legislation (which is written into UK law). The Council‟s Air Quality Action Plan will also be helping to deliver improved air quality as well as the Council‟s Low Emission Strategy.

8 Conclusions

8.1 The construction works have the potential to create dust. During construction it will therefore be necessary to apply a package of mitigation measures to minimise dust emission. With these measures in place, it is expected that any residual effects will be „not significant".

8.2 The operational impacts of the entire junction improvement scheme have been assessed. Concentrations have been modelled for 14 worst-case receptors, representing existing properties where impacts are expected to be greatest. In the case of nitrogen dioxide, a sensitivity test has also been carried out which considers the potential under-performance of emissions control technology on modern diesel vehicles.

8.3 It is concluded that concentrations of PM_{10} and $PM_{2.5}$ will remain below the objectives at all existing receptors in 2021, whether the junction improvement scheme proceeds or not. This conclusion is consistent with the outcomes of the reviews and assessments prepared by City of Bradford MBC, which show that exceedances of the PM_{10} objective are unlikely at any location.

8.4 In the case of nitrogen dioxide, the annual mean concentrations are predicted to be below the objective at all existing receptors in 2021, whether the Junction Improvement Scheme proceeds or not and taking account of the worst-case sensitivity test.

8.5 The changes in emissions as a result of the whole Junction Improvement Scheme (rather than just the proposed „P-Loop" Junction and Farmfoods access) will affect air quality at existing properties along the local road network. The assessment has demonstrated that the increase in concentrations of PM_{10} and $PM_{2.5}$ at relevant locations relative to the objectives will be -1% to 1% (when rounded) and the impacts will all be *negligible*. In the case of nitrogen dioxide, the percentage changes are predicted to range from -11% to 2%, and the impacts will range from *substantial beneficial* to *negligible*.

8.6 The overall operational air quality impacts of the development are beneficial and are judged to be „significant". This conclusion, which takes account of the uncertainties in future projections, in particular for nitrogen dioxide, is based on all impacts being negligible to substantial beneficial. All concentrations are below the objectives.

8.7 The proposed development is consistent with the NPPF. Furthermore, the scheme does not conflict with the requirements of „saved" Policy P1 of the RUDP.

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10 Glossary

AADT	Annual Average Daily Traffic
ADMS-Roads	Atmospheric Dispersion Modelling System model for Roads
AQC	Air Quality Consultants
AQAL	Air Quality Assessment Level
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
CURED	Calculator Using Realistic Emissions for Diesels
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
EPUK	Environmental Protection UK
Exceedence	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
HDV	Heavy Duty Vehicles (> 3.5 tonnes)
HMSO	Her Majesty‟s Stationery Office
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
LDV	Light Duty Vehicles (<3.5 tonnes)
µg/m3	Microgrammes per cubic metre
NO	Nitric oxide
NO2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
NPPF	National Planning Policy Framework
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the

	standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PM10	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter
PM2.5	Small airborne particles less than 2.5 micrometres in aerodynamic diameter
PPG	Planning Practice Guidance
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal
TEMPro	Trip End Model Presentation Program

11 Appendices

A1 Construction Dust Assessment Procedure

A1.1 The criteria developed by IAQM (2016), divide the activities on construction sites into four types to reflect their different potential impacts. These are:

- demolition;
- earthworks;
- construction; and
- trackout.

A1.2 The assessment procedure includes the four steps summarised below:

STEP 1: Screen the Need for a Detailed Assessment

A1.3 An assessment is required where there is a human receptor within 350 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s), or where there is an ecological receptor within 50 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A1.4 Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is negligible and that any effects will be „not significant". No mitigation measures beyond those required by legislation will be required.

STEP 2: Assess the Risk of Dust Impacts

A1.5 A site is allocated to a risk category based on two factors:

- the scale and nature of the works, which determines the potential dust emission magnitude (Step 2A); and
- the sensitivity of the area to dust effects (Step 2B).

A1.6 These two factors are combined in Step 2C, which is to determine the risk of dust impacts with no mitigation applied. The risk categories assigned to the site may be different for each of the four potential sources of dust (demolition, earthworks, construction and trackout).

Step 2A – Define the Potential Dust Emission Magnitude

A1.7 Dust emission magnitude is defined as either „Small", „Medium", or „Large". The IAQM guidance explains that this classification should be based on professional judgement, but provides the examples in Table A1.1.

Table A1.1: Examples of How the Dust Emission Magnitude Class May be Defined

Class	Examples
Demolition	
Large	Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20 m above ground level
Medium	Total building volume 20,000 m3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level
Small	Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months
Earthworks	
Large	Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry to due small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes
Medium	Total site area 2,500 m^2 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m – 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes
Small	Total site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <10,000 tonnes, earthworks during wetter months
Construction	
Large	Total building volume >100,000 m^3, piling, on site concrete batching; sandblasting
Medium	Total building volume 25,000 m^3 – 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching
Small	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber)
Trackout [a]	
Large	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m
Medium	10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m
Small	<10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m

[a] These numbers are for vehicles that leave the site after moving over unpaved ground.

Step 2B – Define the Sensitivity of the Area

A1.8 The sensitivity of the area is defined taking account of a number of factors:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- in the case of PM_{10}, the local background concentration; and
- site-specific factors, such as whether there are natural shelters to reduce the risk of wind-blown dust.

A1.9 The first requirement is to determine the specific sensitivities of local receptors. The IAQM guidance recommends that this should be based on professional judgment, taking account of the principles in Table A1.2. These receptor sensitivities are then used in the matrices set out in Table A1.3, Table A1.4 and Table A1.5 to determine the sensitivity of the area. Finally, the sensitivity of the area is considered in relation to any other site-specific factors, such as the presence of natural shelters etc., and any required adjustments to the defined sensitivities are made.

Step 2C – Define the Risk of Impacts

A1.10 The dust emission magnitude determined at Step 2A is combined with the sensitivity of the area determined at Step 2B to determine the risk of impacts with no mitigation applied. The IAQM guidance provides the matrix in Table A1.6 as a method of assigning the level of risk for each activity.

STEP 3: Determine Site-specific Mitigation Requirements

A1.11 The IAQM guidance provides a suite of recommended and desirable mitigation measures which are organised according to whether the outcome of Step 2 indicates a low, medium, or high risk. The list provided in the IAQM guidance has been used as the basis for the requirements set out in Appendix A6.

STEP 4: Determine Significant Effects

A1.12 The IAQM guidance does not provide a method for assessing the significance of effects before mitigation, and advises that pre-mitigation significance should not be determined. With appropriate mitigation in place, the IAQM guidance is clear that the residual effect will normally be „not significant".

A1.13 The IAQM guidance recognises that, even with a rigorous dust management plan in place, it is not possible to guarantee that the dust mitigation measures will be effective all of the time, for instance under adverse weather conditions. The local community may therefore experience occasional, short-term dust annoyance. The scale of this would not normally be considered sufficient to change the conclusion that the effects will be „not significant".

Table A1.2: Principles to be Used When Defining Receptor Sensitivities

Class	Principles	Examples
Sensitivities of People to Dust Soiling Effects		
High	users can reasonably expect enjoyment of a high level of amenity; or the appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected a to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land	dwellings, museum and other culturally important collections, medium and long term car parks and car showrooms
Medium	users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or the appearance, aesthetics or value of their property could be diminished by soiling; or the people or property wouldn"t reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land	parks and places of work
Low	the enjoyment of amenity would not reasonably be expected; or there is property that would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or there is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land	playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads
Sensitivities of People to the Health Effects of PM_{10}		
High	locations where members of the public may be exposed for eight hours or more in a day	residential properties, hospitals, schools and residential care homes
Medium	locations where the people exposed are workers, and where individuals may be exposed for eight hours or more in a day.	may include office and shop workers, but will generally not include workers occupationally exposed to PM_{10}
Low	locations where human exposure is transient	public footpaths, playing fields, parks and shopping streets
Sensitivities of Receptors to Ecological Effects		
High	locations with an international or national designation and the designated features may be affected by dust soiling; or locations where there is a community of a particularly dust sensitive species	Special Areas of Conservation with dust sensitive features
Medium	locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or locations with a national designation where the features may be affected by dust deposition	Sites of Special Scientific Interest with dust sensitive features
Low	locations with a local designation where the features may be affected by dust deposition	Local Nature Reserves with dust sensitive features

Table A1.3: Sensitivity of the Area to Dust Soiling Effects on People and Property [4]

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table A1.4: Sensitivity of the Area to Human Health Effects [4]

Receptor Sensitivity	Annual Mean PM_{10}	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m^3	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m^3	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24 µg/m^3	>10	Low	Low	Low	Low	Low

4 For demolition, earthworks and construction, distances are taken either from the dust source or from the boundary of the site. For trackout, distances are measured from the sides of roads used by construction traffic. Without mitigation, trackout may occur from roads up to 500 m from sites with a *large* dust emission magnitude, 200 m from sites with a *medium* dust emission magnitude and 50 m from sites with a *small* dust emission magnitude, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Receptor Sensitivity	Annual Mean PM_{10}	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table A1.5: Sensitivity of the Area to Ecological Effects [4]

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Table A1.6: Defining the Risk of Dust Impacts

Sensitivity of the Area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible
Earthworks			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Construction			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Trackout			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

A2 EPUK & IAQM Planning for Air Quality Guidance

A2.1 The guidance issued by EPUK and IAQM (Moorcroft and Barrowcliffe et al, 2017) is comprehensive in its explanation of the place of air quality in the planning regime. Key sections of the guidance not already mentioned above are set out below.

Air Quality as a Material Consideration

"Any air quality issue that relates to land use and its development is capable of being a material planning consideration. The weight, however, given to air quality in making a planning application decision, in addition to the policies in the local plan, will depend on such factors as:

- *the severity of the impacts on air quality;*
- *the air quality in the area surrounding the proposed development;*
- *the likely use of the development, i.e. the length of time people are likely to be exposed at that location; and*
- *the positive benefits provided through other material considerations".*

Recommended Best Practice

A2.2 The guidance goes into detail on how all development proposals can and should adopt good design principles that reduce emissions and contribute to better air quality management. It states:

"The basic concept is that good practice to reduce emissions and exposure is incorporated into all developments at the outset, at a scale commensurate with the emissions".

A2.3 The guidance sets out a number of good practice principles that should be applied to all developments that:

- include 10 or more dwellings;
- where the number of dwellings is not known, residential development is carried out on a site of more than 0.5 ha;
- provide more than 1,000 m^2 of commercial floorspace;
- are carried out on land of 1 ha or more.

A2.4 The good practice principles are that:

- New developments should not contravene the Council"s Air Quality Action Plan, or render any of the measures unworkable;

- Wherever possible, new developments should not create a new "street canyon", as this inhibits pollution dispersion;
- Delivering sustainable development should be the key theme of any application;
- New development should be designed to minimise public exposure to pollution sources, e.g. by locating habitable rooms away from busy roads;
- The provision of at least 1 Electric Vehicle (EV) "rapid charge" point per 10 residential dwellings and/or 1000 m^2 of commercial floorspace. Where on-site parking is provided for residential dwellings, EV charging points for each parking space should be made available;
- Where development generates significant additional traffic, provision of a detailed travel plan (with provision to measure its implementation and effect) which sets out measures to encourage sustainable means of transport (public, cycling and walking) via subsidised or free-ticketing, improved links to bus stops, improved infrastructure and layouts to improve accessibility and safety;
- All gas-fired boilers to meet a minimum standard of <40 mgNOx/kWh;
- Where emissions are likely to impact on an AQMA, all gas-fired CHP plant to meet a minimum emissions standard of:
  - Spark ignition engine: 250 mgNOx/Nm^3;
  - Compression ignition engine: 400 mgNOx/Nm^3;
  - Gas turbine: 50 mgNOx/Nm^3.
- A presumption should be to use natural gas-fired installations. Where biomass is proposed within an urban area it is to meet minimum emissions standards of 275 mgNOx/Nm^3 and 25 mgPM/Nm^3.

A2.5 The guidance also outlines that offsetting emissions might be used as a mitigation measure for a proposed development. However, it states that:

"It is important that obligations to include offsetting are proportional to the nature and scale of development proposed and the level of concern about air quality; such offsetting can be based on a quantification of the emissions associated with the development. These emissions can be assigned a value, based on the "damage cost approach" used by Defra, and then applied as an indicator of the level of offsetting required, or as a financial obligation on the developer. Unless some form of benchmarking is applied, it is impractical to include building emissions in this approach, but if the boiler and CHP emissions are consistent with the standards as described above then this is not essential".

A2.6 The guidance offers a widely used approach for quantifying costs associated with pollutant emissions from transport. It also outlines the following typical measures that may be considered to offset emissions, stating that measures to offset emissions may also be applied as post assessment mitigation:

- Support and promotion of car clubs;
- Contributions to low emission vehicle refuelling infrastructure;
- Provision of incentives for the uptake of low emission vehicles;
- Financial support to low emission public transport options; and
- Improvements to cycling and walking infrastructures.

Screening

Impacts of the Local Area on the Development

"There may be a requirement to carry out an air quality assessment for the impacts of the local area's emissions on the proposed development itself, to assess the exposure that residents or users might experience. This will need to be a matter of judgement and should take into account:

- *the background and future baseline air quality and whether this will be likely to approach or exceed the values set by air quality objectives;*
- *the presence and location of Air Quality Management Areas as an indicator of local hotspots where the air quality objectives may be exceeded;*
- *the presence of a heavily trafficked road, with emissions that could give rise to sufficiently high concentrations of pollutants (in particular nitrogen dioxide), that would cause unacceptably high exposure for users of the new development; and*
- *the presence of a source of odour and/or dust that may affect amenity for future occupants of the development".*

Impacts of the Development on the Local Area

A2.7 The guidance sets out two stages of screening criteria that can be used to identify whether a detailed air quality assessment is required, in terms of the impact of the development on the local area. The first stage is that you should proceed to the second stage if any of the follow apply:

- 10 or more residential units or a site area of more than 0.5 ha residential use;
- more than 1,000 m^2 of floor space for all other uses or a site area greater than 1 ha.

A2.8 Coupled with any of the following:

- the development has more than 10 parking spaces;

- the development will have a centralised energy facility or other centralised combustion process.

A2.9 If the above do not apply then the development can be screened out as not requiring a detailed air quality assessment of the impact of the development on the local area. If they do apply then you proceed to stage 2, the criteria for which are set out below. The criteria are more stringent where the traffic impacts may arise on roads where concentrations are close to the objective. The presence of an AQMA is taken to indicate the possibility of being close to the objective, but where whole authority AQMAs are present and it is known that the affected roads have concentrations below 90% of the objective, the less stringent criteria is likely to be more appropriate.

- the development will lead to a change in LDV flows of more than 100 AADT within or adjacent to an AQMA or more than 500 AADT elsewhere;
- the development will lead to a change in HDV flows of more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere;
- the development will lead to a realigning of roads (i.e. changing the proximity of receptors to traffic lanes) where the change is 5m or more and the road is within an AQMA;
- the development will introduce a new junction or remove an existing junction near to relevant receptors, and the junction will cause traffic to significantly change vehicle acceleration/deceleration, e.g. traffic lights, or roundabouts;
- the development will introduce or change a bus station where bus flows will change by more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere;
- the development will have an underground car park with more than 100 movements per day (total in and out) with an extraction system that exhausts within 20 m of a relevant receptor;
- the development will have one or more substantial combustion processes where the combustion unit is:
  - any centralised plant using bio fuel;
  - any combustion plant with single or combined thermal input >300 kW; or
  - a standby emergency generator associated with a centralised energy centre (if likely to be tested/used >18 hours a year).
- the development will have a combustion unit of any size where emissions are at a height that may give rise to impacts through insufficient dispersion, e.g. through nearby buildings.

A2.10 Should none of the above apply then the development can be screened out as not requiring a detailed air quality assessment of the impact of the development on the local area.

A2.11 The guidance also outlines what the content of the air quality assessment should include, and this has been adhered to in the production of this report.

Impact Descriptors and Assessment of Significance

A2.12 There is no official guidance in the UK in relation to development control on how to describe the nature of air quality impacts, nor how to assess their significance. The approach developed by EPUK and IAQM (Moorcroft and Barrowcliffe et al, 2017) has therefore been used. This approach involves a two stage process:

- a qualitative or quantitative description of the impacts on local air quality arising from the development; and
- a judgement on the overall significance of the effects of any impacts.

Impact Descriptors

A2.13 Impact description involves expressing the magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion. Table A2.1 sets out the method for determining the impact descriptor for annual mean concentrations at individual receptors, having been adapted from the table presented in the guidance document. For the assessment criterion the term Air Quality Assessment Level or AQAL has been adopted, as it covers all pollutants, i.e. those with and without formal standards. Typically, as is the case for this assessment, the AQAL will be the air quality objective value. Note that impacts may be adverse or beneficial, depending on whether the change in concentration is positive or negative.

Table A2.1: Air Quality Impact Descriptors for Individual Receptors for All Pollutants [a]

Long-Term Average Concentration At Receptor In Assessment Year [b]	Change in concentration relative to AQAL [c]				
	0%	**1%**	**2-5%**	**6-10%**	**>10%**
75% or less of AQAL	Negligible	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Negligible	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Negligible	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Negligible	Moderate	Substantial	Substantial	Substantial

[a] Values are rounded to the nearest whole number.

[b] This is the „without scheme" concentration where there is a decrease in pollutant concentration and the „with scheme" concentration where there is an increase.

[c] AQAL = Air Quality Assessment Level, which may be an air quality objective, EU limit or target value, or an Environment Agency „Environmental Assessment Level (EAL)".

Assessment of Significance

A2.14 The EPUK and IAQM guidance (Moorcroft and Barrowcliffe et al, 2017) is that the assessment of significance should be based on professional judgement, with the overall air quality impact of the scheme described as either „significant" or „not significant". In drawing this conclusion, the following factors should be taken into account:

- the existing and future air quality in the absence of the development;
- the extent of current and future population exposure to the impacts;
- the influence and validity of any assumptions adopted when undertaking the prediction of impacts;
- the potential for cumulative impacts and, in such circumstances, several impacts that are described as „*slight*" individually could, taken together, be regarded as having a significant effect for the purposes of air quality management in an area, especially where it is proving difficult to reduce concentrations of a pollutant. Conversely, a „*moderate*" or „*substantial*" impact may not have a significant effect if it is confined to a very small area and where it is not obviously the cause of harm to human health; and
- the judgement on significance relates to the consequences of the impacts; will they have an effect on human health that could be considered as significant? In the majority of cases, the impacts from an individual development will be insufficiently large to result in measurable changes in health outcomes that could be regarded as significant by health care professionals.

A2.15 The guidance is clear that other factors may be relevant in individual cases. It also states that the effect on the residents of any new development where the air quality is such that an air quality objective is not met will be judged as significant. For people working at new developments in this situation, the same will not be true as occupational exposure standards are different, although any assessment may wish to draw attention to the undesirability of the exposure.

A2.16 A judgement of the significance should be made by a competent professional who is suitably qualified. A summary of the professional experience of the staff contributing to this assessment is provided in Appendix A2.1.

A3 Professional Experience

Penny Wilson, BSc (Hons) CSci MIEnvSc MIAQM

Ms Wilson is an Associate Director with AQC, with more than seventeen years‟ relevant experience in the field of air quality. She has been responsible for air quality assessments of a wide range of development projects, covering retail, housing, roads, ports, railways and airports. She has also prepared air quality review and assessment reports and air quality action plans for local authorities and appraised local authority assessments and air quality grant applications on behalf of the UK governments. Ms Wilson has arranged air quality and dust monitoring programmes and carried out dust and odour assessments. She has provided expert witness services for planning appeals and is Member of the Institute of Air Quality Management and a Chartered Scientist.

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is a Technical Director with AQC and has seventeen years‟ experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government‟s air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist.

Lucy Hodgins, BSc (Hons) MIEnvSc MIAQM

Miss Hodgins is a Consultant with AQC, with over 6 years‟ experience in the field of air quality. She has been involved in the assessment of air quality impacts for a range of industrial, commercial and residential projects using qualitative and quantitative methods, including dispersion modelling, utilising a variety of models including ADMS Roads, Breeze Roads and Breeze Aermod. She has undertaken numerous operational dust assessments for mineral and waste facilities, as well as assessments of construction dust emissions. She has also undertaken assessments for energy from waste and anaerobic digestion facilities for a range of air pollutants, along with nuisance dust and odour. She has also been responsible for the preparation of road traffic emissions assessments for residential and industrial developments. Miss Hodgins has extensive experience in nuisance dust and ambient air quality monitoring and the interpretation of monitoring data. She is a Member of the Institute of Air Quality Management and the Institution of Environmental Sciences.

Full CVs are available at www.aqconsultants.co.uk.

A4 Modelling Methodology

Model Inputs

Road Traffic

A4.1 Predictions have been carried out using the ADMS-Roads dispersion model (v4.0). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics. Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the EFT (Version 7.0) published by Defra (2017a).

A4.2 Hourly sequential meteorological data from Leeds Bradford for 2016 have been used in the model. The Leeds Bradford meteorological monitoring station is located at Leeds Bradford airport, approximately 5 km to the northeast of the proposed development site. It is deemed to be the nearest monitoring station representative of meteorological conditions at the proposed development site.

A4.3 AADT flows, speeds and vehicle fleet composition have been provided by Fore Consulting Ltd. These have been derived from the traffic model for the junction improvement scheme, which has been run for the peak hours, with links separated by lanes. Peak hour flows have been factored to AADT flows for each of the road links. The modelled AADT flows for 2017 have been factored backwards to the verification year of 2016 using growth factors derived from the National Transport Model and associated guidance (DfT, 2009), adjusted to local conditions using the TEMPro System v7.0 (DfT, 2016).

A4.4 Congestion and queuing have been taken into account using modelled vehicle speeds which have been defined by lane and separate out the network into relatively short sections. None of the modelled speeds are less than 5 kilometres per hour (kph) and so the EFT is considered to capture the effect of slow-moving traffic adequately.

A4.5 Traffic speeds have been based on the transport model outputs for the modelled hours (0700-1000 and 1500-1900). The assessment therefore does not take account of any improvements in flow and speeds during periods outside of the peak hours.

A4.6 The traffic data for the 2016 and 2021 baseline scenarios are presented within Table A4.1 and a figure showing the modelled road network is presented in Figure A4.1.

Table A4.1: Summary of Traffic Data for Without Scheme Scenario (AADT Flows)

Road Link		2016[a]		2021 (Without Scheme)[b]	
		AADT	Speed	AADT	Speed
1		7,007	19.8	7582	20

Road Link		2016[a]		2021 (Without Scheme)[b]	
		AADT	Speed	AADT	Speed
1a	New Line West	1,132	10.3	1,434	6
2		8,131	38.2	9,022	28
3		7,987	47.9	8,906	18
4		8,952	43.0	10,118	43
5		8,880	46.0	10,074	45
2425		8,200	40	8,869	14
3198		8,740	49	9,648	48
2998		8,743	48	9,636	48
6	Harr Rd North	9,747	22.4	10,796	23
6a		1,276	13.1	1,364	9
7		9,302	28.3	10,262	23
7a		1,368	40.0	1,510	36
8		8,474	44.9	8,645	45
9		10,285	48.4	10,597	48
2789		10,722	39	11,536	20
10	New Line East	7,798	17.3	8,798	17
10a		1,661	12.4	1,905	10
11		9,799	31.9	11,073	27
12		10,119	38.3	10,728	38
13		9,816	39.7	10,423	40
3175		10,066	34	11,074	29
3005		10,081	44	10,424	44
2352		9,975	42	11,143	28
2344		10,637	47	11,017	47
14	Harrogate Road South	7,685	34.2	7,778	35
14a		1,082	9.0	1,005	7
15		7,697	30.3	7,768	31
15a		1,074	18.5	1,000	10
16		9,755	40.8	11,069	41
16a		82	34.3	93	34
17		9,846	38.7	11,183	38
2890		9,007	22	8,763	11
20	Retail Park Access	421	14	444	14
18	Stockhill	2,158	13.9	2,340	12

Road Link		2016[a]		2021 (Without Scheme)[b]	
		AADT	Speed	AADT	Speed
	Road				
2443	Car Bottom Rd	242	23	250	15
2744	Sainsbury's Access	2,829	16	2,905	16
696	New Line Retail Park	339	29	327	27
2402	The Grove	709	31	755	25
2764	Asda Access	1,850	24	1,971	22
2343	Eider Street	1,155	27	1,259	25
2757	Sainsbury's Petrol Access	2,452	25	2,554	21

[a] Vehicle composition 4.18% HGVs

[b] Vehicle composition 4.01% HGVs

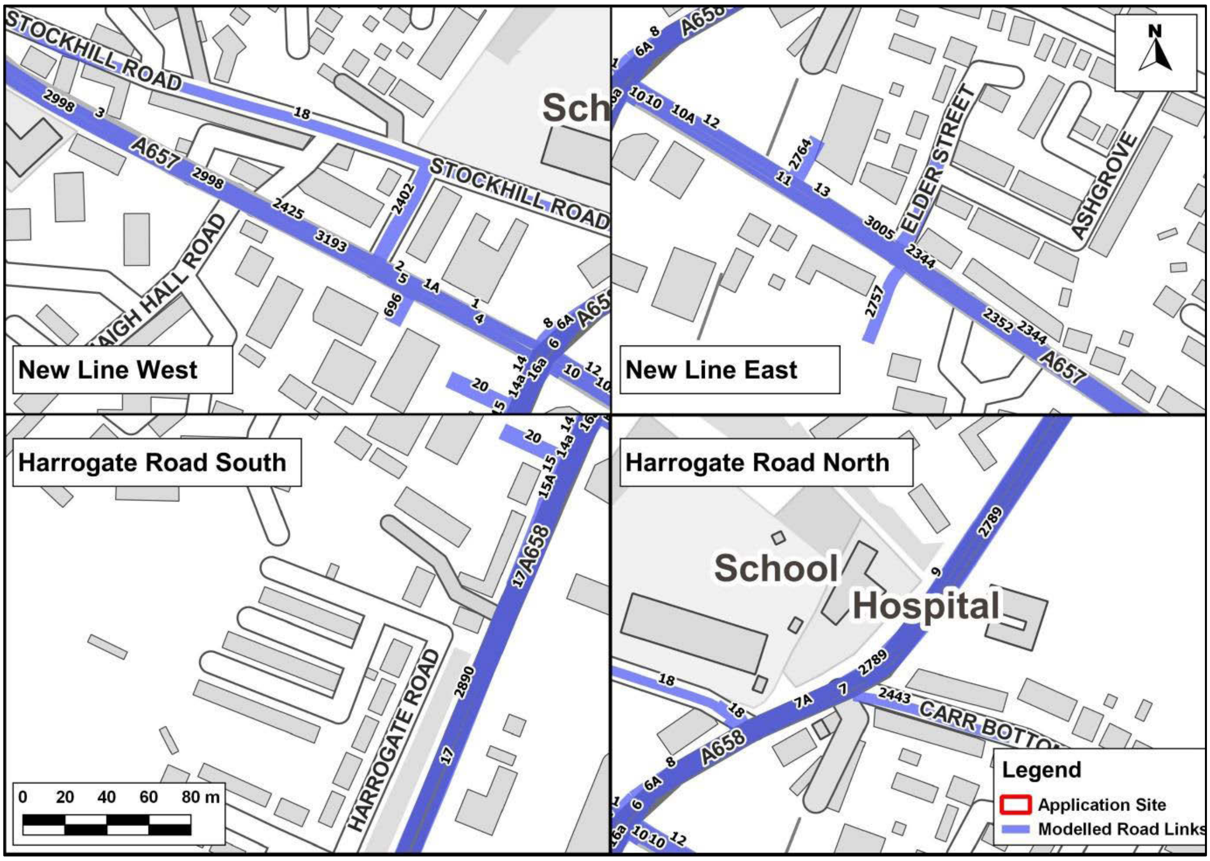

Figure A4.1: Modelled Road Network (Without Scheme)

A4.7 The traffic data for the junction improvements and a figure showing the modelled road network are presented in Table A4.2 and Figure A4.2.

Table A4.2: Summary of Traffic Data for With Scheme Scenario (AADT Flows)

Road Link		2021 (With Scheme)		Road Link		2021 (With Scheme)	
		AADT	Speed			AADT	Speed
101	New Line West	4,732	25	116a	New Line East	3,209	35
101a	New Line West	3,016	14	117	New Line East	6,347	30
101b	New Line West	1,599	18	117a	New Line East	4,701	26
102	New Line West	6,376	48	118	Harrogate Road South	6,006	28
102b	New Line West	2,971	48	118a	Harrogate Road South	4,305	24
103	New Line West	9,199	50	119	Harrogate Road South	6,434	39
104	New Line West	5,945	42	119a	Harrogate Road South	3,849	35
104a	New Line West	4,014	41	120	Harrogate Road South	6,578	35
105	New Line West	6,346	38	120a	P-loop	4,555	31
105a	New Line West	3,595	32	120b	P-loop	89	33
106	New Line West	9,597	48	121	P-loop	11,237	33
107	Harrogate Road North	4,458	23	122	P-loop	4,050	15
107a	Harrogate Road North	3,711	18	122a	P-loop	1,510	15
108	Harrogate Road North	7,894	42	2425	New Line West	9,195	48
108a	Harrogate Road North	4,267	44	3193	New Line West	9,568	44
109	Harrogate Road North	8,170	47	3008	New Line East	4,729	29
109a	Harrogate Road North	3,636	48	3008a	New Line East	6,237	27
110	Harrogate Road North	6,007	45	2863	New Line East	6,718	37
110a	Harrogate Road North	3,889	43	2863a	New Line East	4,657	37
110b	Harrogate Road North	1,538	19	3005	New Line East	11,050	33
111	Harrogate Road North	6,023	48	2352	New Line East	10,585	42
111a	Harrogate Road North	3,872	47	2344	New Line East	11,448	47
112	Harrogate Road North	8,401	46	2890	Harrogate Road South	10,276	45
112a	Harrogate Road North	3,421	50	2443	Carr Bottom Road	404	25
113	New Line East	5,346	26	2744	Sainsbury's Access	7,387	16
113a	New Line East	4,383	24	125	Farmfood's Access	459	14
113b	New Line East	2,368	21	696	New Line Retail Park	274	30
114	New Line East	5,104	36	2402	The Grove	694	30

114a		5,513	36	**2764**	**Asda Access**	1,899	28
115		10,976	34	**2343**	**Eider Street**	1,363	26
116		4,117	36	**2757**	**Sainsbury's' Petrol**	2,782	23
				123	**Stockhill Road**	2,288	18

[a] Vehicle composition 4.18% HGVs

[b] Vehicle composition 4.01% HGVs

A4.8 Figure A4.2 shows the road network included within the model and defines the study area.

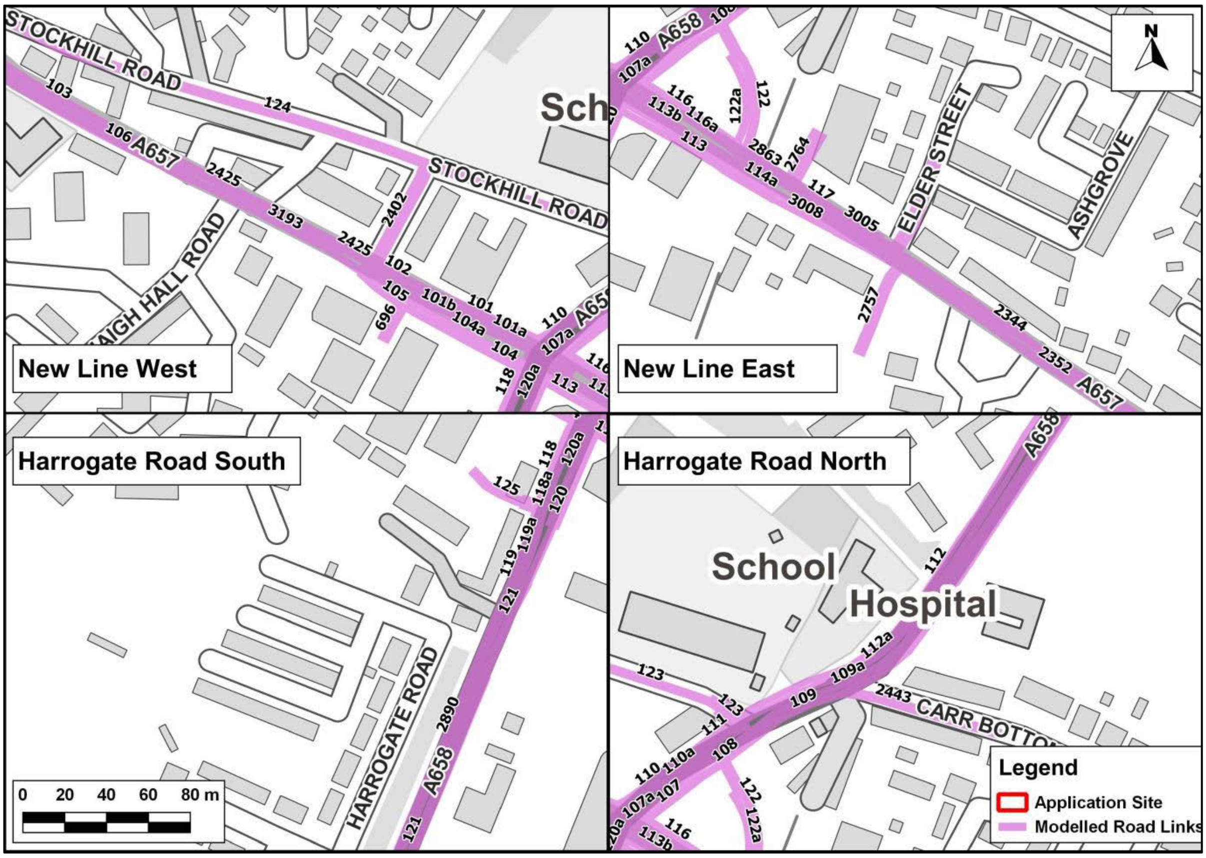

Figure A4.2: Modelled Road Network (With Scheme)

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A4.9 A site-specific diurnal flow profile has been derived from two weekly traffic counts undertaken on three arms of the junction in 2017.

Sensitivity Test for Nitrogen Oxides and Nitrogen Dioxide

A4.10 As explained in Section 3, AQC has carried out a detailed analysis which showed that, where previous standards had limited on-road success in reducing nitrogen oxides emissions from diesel vehicles, the „Euro VI‟ and „Euro 6‟ standards are delivering real on-road improvements (AQC, 2016b). Furthermore, these improvements are expected to increase as the Euro 6 standard is fully implemented. Despite this, the detailed analysis suggested that, in addition to modelling using the EFT (V7.0), a sensitivity test using elevated nitrogen oxides emissions from certain diesel vehicles should be carried out (AQC, 2016b). A worst-case sensitivity test has thus been carried out by applying the adjustments set out in Table A4.3 to the emission factors used within the EFT[5], using AQC‟s CURED (V2A) tool (AQC, 2016a). The justifications for these adjustments are given in AQC (2016b). Results are thus presented for two scenarios: first the „official prediction‟, which uses the EFT with no adjustment, and second the „worst-case sensitivity test‟, which applies the adjustments set out in Table A4.3. The results from this sensitivity test are likely to over-predict emissions from vehicles in the future and thus provide a reasonable worst-case upper-bound to the assessment.

Table A4.3: Summary of Adjustments Made to Defra's EFT (V7.0)

Vehicle Type		Adjustment Applied to Emission Factors
All Petrol Vehicles		No adjustment
Light Duty Diesel Vehicles	**Euro 5 and earlier**	No adjustment
	Euro 6	Increased by 78%
Heavy Duty Diesel Vehicles	**Euro III and earlier**	No adjustment
	Euro IV and V	Set to equal Euro III values
	Euro VI	Set to equal 20% of Euro III emissions [a]

[a] Taking account of the speed-emission curves for different Euro classes as explained in AQC (2016b).

Background Concentrations

A4.11 The background pollutant concentrations across the study area have been defined using the national pollution maps published by Defra (2017a). These cover the whole country on a 1x1 km grid and are published for each year from 2013 until 2030. The background maps for 2016 have been calibrated against concurrent measurements from national monitoring sites. The calibration factor calculated has also been applied to future year backgrounds. This has resulted in slightly higher predicted concentrations for the future assessment year than that derived from the Defra maps (AQC, 2016c).

Background NO_2 Concentrations for Sensitivity Test

A4.12 The road-traffic components of nitrogen dioxide in the background maps have been uplifted in order to derive future year background nitrogen dioxide concentrations for use in the sensitivity test. Details of the approach are provided in the report prepared by AQC (2016c).

5 All adjustments were applied to the COPERT functions. Fleet compositions etc. were applied following the same methodology as used within the EFT.

Model Verification

A4.13 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements.

A4.14 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict the annual mean NO_x concentrations during 2015 at HR1, HR2, HR3, HR4 and HR5 diffusion tube monitoring sites. Concentrations have been modelled at 2 m, 1.5 m, 2.5 m, 2 m and 1.5 m, the approximate height of the monitors, respectively.

A4.15 The model output of road-NO_x (i.e. the component of total NO_x coming from road traffic) has been compared with the „measured" road-NO_x. Measured road-NO_x has been calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NO_x from NO_2 calculator (Version 5.1) available on the Defra LAQM Support website (Defra, 2017a).

A4.16 An adjustment factor has been determined as the slope of the best-fit line between the „measured" road contribution and the model derived road contribution, forced through zero (Figure A4.3). The calculated adjustment factor of **2.6526** has been applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations.

A4.17 The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NO_x concentrations with the predicted background NO_2 concentration within the NO_x to NO_2 calculator. Figure A4.4 compares final adjusted modelled total NO_2 at each of the monitoring sites to measured total NO_2, and shows a close agreement.

A4.18 The results imply that the model has under predicted the road-NOx contribution. This is a common experience with this and most other road traffic emissions dispersion models.

Model Verification for NOx and NO_2 Sensitivity Test

A4.19 The approach set out above has been repeated using the predicted road-NO_x and background concentrations specific to the sensitivity test. This has resulted in an adjustment factor of **2.2832**, which has been applied to all modelled road-NO_x concentrations within the sensitivity test.

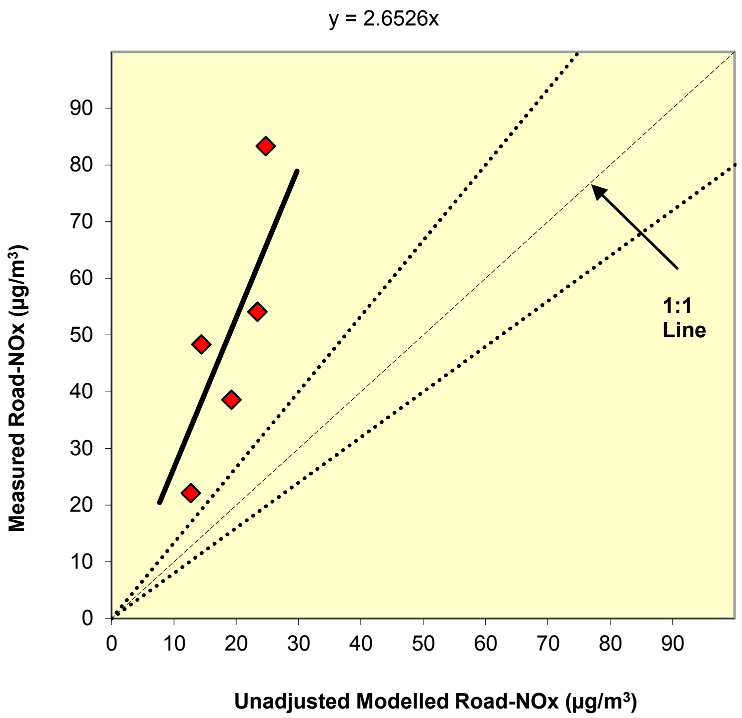

Figure A4.3: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

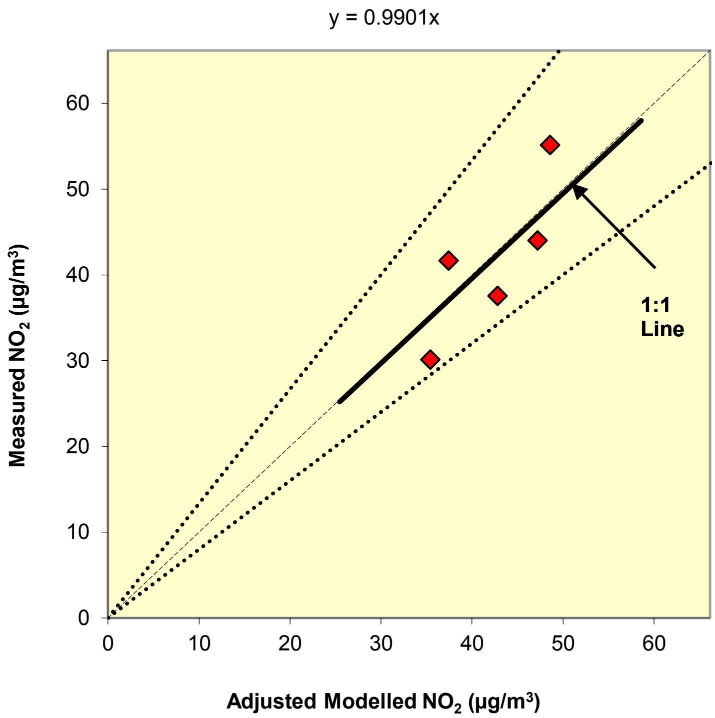

Figure A4.4: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

Model Post-processing

Road Traffic

Nitrogen oxides and nitrogen dioxide

A4.20 The model predicts road-NOx concentrations at each receptor location. These concentrations have been adjusted using the adjustment factor set out above, which, along with the background NO_2, has been processed through the NOx to NO_2 calculator available on the Defra LAQM Support website (Defra, 2017a). The traffic mix within the calculator has been set to “All other- urban UK traffic”, which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2.

A5 Adjustment of Short-Term Data to Annual Mean

A5.1 A diffusion tube monitoring study undertaken by City of Bradford MDC commenced in March 2016. Monitoring results for the period March 2016 to December 2016 have been annualised to represent a full calendar year. The data have been annualised based on the ratio between concentrations for the short-term monitoring period and the 2016 calendar year using three background sites operated as part of the Automatic Urban and Rural Network (AURN). This follows the guidance set out in Box 7.10 of LAQM.TG16 (Defra, 2016b).

A5.2 The annual mean and period mean nitrogen dioxide concentrations for the three automatic monitoring sites for each diffusion tube are presented. The adjustment factors for each automatic monitor and calculated average factor for each diffusion tube are presented in Table A5.1.

Table A5.1: Data used to Adjust Short-term Monitoring Data to 2016 Annual Mean Equivalent [a]

Automatic Monitor	Parameter	Automatic Monitor Annual Mean (A_m) 2016 ($\mu g/m^3$)	Diffusion Tube				
			HR1	HR2	HR3	HR4	HR5
Barnsley Gawber	Period Mean (P_m) ($\mu g/m^3$) Mar- Dec 2016 [b]	19.0	17.1	17.1	17.7	17.1	19.2
	Ratio A_m/P_m		1.11	1.11	1.07	1.11	0.99
Leeds Centre	Period Mean ($\mu g/m^3$) Mar- Dec 2016[b]	32.5	30.2	30.2	30.6	30.2	33.2
	Ratio A_m/P_m		1.08	1.08	1.06	1.08	0.98
Manchester Piccadilly	Period Mean ($\mu g/m^3$) Mar- Dec 2016[b]	40.1	38.3	38.3	38.2	38.3	40.2
	Ratio A_m/P_m		1.05	1.05	1.05	1.05	1.00
Average Annualisation Factor			**1.08**	**1.08**	**1.06**	**1.08**	**0.99**

[a] It is understood diffusion tubes were changed on a Wednesday in accordance with the diffusion tube calendar

[b] Annual and period mean calculated for each month separately, for the months with monitoring results available. Average of all the available months for annual and period mean are presented.

A5.3 The national bias adjustment factor for West Yorkshire Analytical Services 50% TEA in acetone method has been applied[6]. The 2016 factor is 0.75.

A5.4 Annualised and bias adjusted diffusion tube results are presented in Table 3.

[6] National Bias Adjustment Factor Spreadsheet version number 06/17

A6 Construction Mitigation

A6.1 The following is a set of measures that should be incorporated into the specification for the works:

Communications

- develop and implement a stakeholder communications plan that includes community engagement before and during work 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 environmental manager/engineer or the site manager; and
- display the head or regional office contact information.

Dust Management Plan

- Develop and implement a Dust Management Plan (DMP) approved by the Local Authority which documents the mitigation measures to be applied, and the procedures for their implementation and management.

Site Management

- Record all dust and air quality complaints, identify cause(s), 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; and
- record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the log book.

Monitoring

- 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; and
- 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 conditions.

Preparing and Maintaining the Site

- Plan the site layout so that machinery and dust-causing activities are located away from receptors, as far as is possible;

- erect solid screens or barriers around dusty area that are at least as high as any stockpiles on site;
- enclose site or 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;
- keep site fencing, barriers and scaffolding clean using wet methods;
- remove materials that have a 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 as described below; and
- cover, seed, or fence stockpiles to prevent wind whipping.

Operating Vehicle/Machinery and Sustainable Travel

- Ensure all vehicles switch off their 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; and
- produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.

Operations

- 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;
- ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate;
- use enclosed chutes, 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; and
- ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Waste Management

- Avoid bonfires and burning of waste materials.

Measures Specific to Demolition

- Ensure effective water suppression is used during demolition operations. Hand held 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; and
- bag and remove any biological debris or damp down such material before demolition.

Measures Specific to Earthworks

- use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Avoid scabbling (roughening of concrete surfaces), if possible;
- ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place;
- for supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.

Measures Specific to Trackout

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use;
- avoid dry sweeping of large areas;
- ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport; and
- access gates should be located at least 10 m from receptors, where possible.