7 Air Quality

7.1 Introduction

7.1.1 This chapter describes the potential local and regional air quality impacts and the greenhouse gas impacts associated with Proposed Scheme. The assessment has been carried out by Air Quality Consultants Ltd.

7.1.2 Local air quality impacts are caused by changes to the concentrations of air pollutants in ambient air. The regional air quality impacts and greenhouse gas (global) impacts are best assessed by describing the overall change in emissions that would occur as a result of the Proposed Scheme.

7.1.3 The Scheme would lead to changes in traffic flows on the existing local roads and introduced changes in the proximity of existing properties to the proposed new road, both of which may impact on air quality at the existing residential properties.

7.1.4 National research has identified that, at a local level in ambient air, the main air pollutants of concern related to traffic emissions are nitrogen dioxide and fine particulate matter (PM_{10} and $PM_{2.5}$). The regional pollutants considered are typically oxides of nitrogen and hydrocarbons. Hydrocarbon emissions are not available within the emissions model used. However, fine particulate matter is available and has been included in the regional impacts for information. Carbon dioxide emissions are treated as an indicator for total greenhouse gas emissions.

7.1.5 At a local scale, there is also the potential for construction activities to impact upon existing properties. The main pollutants of concern related to construction activities are dust and PM_{10}.

7.1.6 This report has been prepared taking into account all relevant local and national guidance and regulations, and follows a methodology agreed with North Ayrshire Council.

7.2 Scope of the Assessment

7.2.1 This report describes existing local air quality conditions, and the predicted air quality in the future assuming that the Proposed Scheme does, or does not proceed. The assessment of construction dust impacts focuses on the anticipated duration of the works. The assessment of traffic-related impacts focuses on 2016, which is the anticipated year of opening, and considers a design year of 2031.

Study Area

7.2.2 The study area has been defined as the same area as that of the transport model (produced by SIAS), which includes the majority of Dalry for the modelled road network (see Figure 7.1.

7.2.3 This study area was also defined using the guidance provided in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1, HA 207/07. This defines that affected roads will be those that meet any of the following criteria:

- road alignment will change by 5m or more; or

- daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) flow or more; or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/h or more; or
- peak hour speed will change by 20 km/h or more.

7.2.4 These criteria have been accounted for by SIAS, who screened the area for their transport model to include any roads which meet the criteria.

7.2.5 There are no designated ecological sites within 200m of roads affected by the Proposed Scheme (as defined above) and therefore no sites within the study area.

7.3 Legislative, Regulatory and Planning Context

Local Air Quality

Air Quality Strategy

7.3.1 The National Air Quality Strategy published by the Scottish Executive 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 (Defra, 2007). 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.

Greenhouse Gases

Kyoto Protocol

7.3.2 The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change that was adopted in Kyoto, Japan in December 1997 and came into force in February 2005. The Kyoto Protocol establishes legally binding commitments for the reduction of the three most important greenhouse gases (carbon dioxide, methane, and nitrous oxide) and three long-lived industrial greenhouse gases (sulfurhexafluoride, hydrofluorocarbons and perfluorocarbons).

7.3.3 Industrialised countries agreed to reduce their collective greenhouse gas emissions by at least 5% from 1990 levels as an average over the years 2008-2012. Each nation has agreed its own emission reduction target, and a cut of 12.5% was proposed by the UK.

UK Climate Change Act

7.3.4 The Act was introduced to improve carbon management, assist the transition to a low carbon economy and to demonstrate the UK's commitment to reducing greenhouse gas emissions. The UK has pledged to reduce CO_2 emissions by at least 26% by 2020, and by at least 80% by 2050 against a 1990 baseline.

UK Low Carbon Transition Plan

7.3.5 The UK Low Carbon Transition Plan (HMSO, 2009) sets out the plan for meeting the targets set in the UK Climate Change Act. Chapter 6: “Transforming Transport”, describes the aim to cut emissions from transport by 14% on 2008 levels, by 2020.

Climate Change (Scotland) Act

7.3.6 The Climate Change (Scotland) Act 2009 established even more ambitious emissions reduction targets than the UK Climate Change Act with a commitment to reduce carbon emissions by 42% by 2020 and by 80% by 2050.

The legislation creates a long-term framework that:

- introduces a statutory target to reduce Scotland's greenhouse gas emissions by at least 80 per cent by 2050;
- establishes an interim target of at least 42 per cent emissions reductions by 2020. There is a power to vary the interim target, and Scottish Ministers are committed to delivering the highest achievable emissions reductions based on expert advice from the UK Committee on Climate Change;
- establishes a framework of annual targets; and
- includes emissions from international aviation and international shipping.

Planning Policy

Regional and Local Plan

7.3.7 Ayrshire has developed its regional Structure Plan (Joint Ayrshire Councils, 2007), while North Ayrshire has development its local Plan. Changes to the planning legislation by the Scottish Government required the Council to replace the existing Structures Plan and Local Plan with a Local Development Plan (LDP).

7.3.8 North Ayrshire Council's Modified LDP (North Ayrshire Council, 2012) was submitted to the Scottish Government for examination in June 2013. The Modified LDP includes a general policy (Policy A1), which explicitly discusses environmental pollution:

> “*GENERAL POLICY*
>
> *…. (b) Amenity:*
>
> *Development should have regard to the character of the area in which it is located. Regard should be given to the impact on amenity of:*
>
> *… Levels and effects of emissions including smoke, soot, ash, dust and grit or any other environmental pollution;* …”

Local Transport Strategy

7.3.9 North Ayrshire Council has also published a Local Transport Strategy (North Ayrshire Council, 2008) which includes a vision to:

> “*Manage and contain any future growth in traffic and promote alternatives, to ensure that problems of traffic congestion and air pollution do not develop*.”

Assessment Criteria

Construction Dust Criteria

7.3.10 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, 2011) has therefore been used. Full details of this approach are provided in Appendix 7.2.

Operational Criteria

7.3.11 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 in Scotland are prescribed within the Air Quality (Scotland) Regulations, 2000, Scottish Statutory Instrument 2000 No. 97 (HMSO, 2000) and the Air Quality (Scotland) (Amendment) Regulations 2002, Scottish Statutory Instrument 2002 No. 297 (HMSO, 2002).

7.3.12 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 Air Quality (Scotland) Amendment Regulations 2002 define more stringent objectives for PM_{10} that will also apply from 2010. The $PM_{2.5}$ objective is to be achieved by 2020, but is not set in regulations.

7.3.13 The 1-hour nitrogen dioxide objective is, in practice, less stringent than the annual mean objective. Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 $\mu g/m^3$ (Defra, 2009). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level.

7.3.14 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, 2009). 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.

7.3.15 The European Union (EU) has also set limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same levels as the UK and Scotland objectives, but applied from 2010 (HMSO, 2010). The limit values for PM_{10} and $PM_{2.5}$ are the same level as the UK statutory objectives, but applied from 2005 for PM_{10} and will apply from 2015 for $PM_{2.5}$. For PM_{10} the Scottish objectives are more stringent than both the UK objectives and EU limit values. For $PM_{2.5}$, the Scottish objective is more stringent than the UK and EU limit values and it is used as the relevant criterion in this assessment.

7.3.16 The relevant air quality criteria for this assessment are provided in Table 7.1.

Table 7.1: 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 7 times a year
	Annual mean	18 µg/m^3
Fine Particles ($PM_{2.5}$)[a]	Annual mean	12 µg/m^3

[a] 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.

Descriptors for Air Quality Impacts and Assessment of Significance

Construction Dust Significance

7.3.17 In the absence of official guidance, the approach developed by the IAQM (IAQM, 2011) to assess the significance of construction dust has been used. This approach includes elements of professional judgement. Full details of this approach are provided in Appendix 7.2, with the professional experience of the consultants preparing the report set out in Appendix 7.3.

Operational Significance

7.3.18 There is no official guidance in the UK on how to describe air quality impacts nor to assess their significance. The approach developed by the IAQM (IAQM, 2009), and incorporated in Environmental Protection UK's (EPUK) guidance document on planning and air quality (Environmental Protection UK , 2010), has therefore been used. This approach includes elements of professional judgement. Full details of this approach are provided in Appendix 7.4, with the professional experience of the consultants preparing the report set out in Appendix 7.3.

7.4 Methods of Assessment

7.4.1 The overall methodology follows, where appropriate, the approach defined within the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, HA 207/07 and includes a Scottish Transport Appraisal Guidance (STAG) assessment.

Traffic Data

7.4.2 Two datasets were available for the With Scheme scenario: one assuming that the Scheme does not generate new traffic in the area and one assuming that it does attract new traffic into the area. As a worst-case scenario the traffic generating scenario has been used in this assessment.

Consultation

7.4.3 The assessment follows a methodology agreed with North Ayrshire Council via discussions between John Murray (Air Quality officer at North Ayrshire Council) and Air Quality Consultants held during September and October 2012.

Local Air Quality Impacts

Existing Conditions

7.4.4 Existing sources of emissions within the study area have been defined using a number of approaches. A site visit has been carried out to identify existing sources from a visual inspection of the area. Industrial and waste management sources that may affect the area have been identified using Defra's Pollutant Release and Transfer Register (Defra, 2012) which includes data from the Scottish Environmental Protection Agency (SEPA). Local sources have also been identified through discussion with North Ayrshire Council, as well as through examination of the Council's air quality Review and Assessment reports.

7.4.5 Information on existing air quality has been obtained by collating the results of monitoring carried out by the local authority. This covers both the study area and nearby sites, the latter being used to provide context for the assessment. The background concentrations across the study area have been defined using the national pollution maps published by Defra, available on their website, which have been adjusted to assume both that traffic emissions do not reduce into the future and do reduce at official rates. These have also been calibrated against local background monitoring as agreed with North Ayrshire Council (see Appendix 7.1). These background maps cover the whole country on a 1x1 km grid.

Construction Impacts

UUSensitive Locations

7.4.6 Locations sensitive to dust emitted during construction are generally places where members of the public are regularly present. Residential properties and commercial operations close to the development are most sensitive to construction dust. Any areas of sensitive vegetation or ecology that are very close to dust sources may also be susceptible to some negative effects.

Assessment Approach

7.4.7 It is very difficult to quantify emissions of dust from construction activities. It is thus common practice to provide a qualitative assessment of potential impacts, making reference to the assessment criteria set out in Appendix 7.2.

Road Traffic Impacts – Discrete Receptors

Sensitive Locations

7.4.8 Concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been predicted at a number of locations close to the roads within the study area. Receptors have been identified to represent likely worst-case exposure within these locations. When selecting these receptors, particular attention has been paid to assessing impacts close to junctions, where traffic may become congested, and where there is a combined effect of several road links. The receptors have been located on the façades of the properties closest to the sources.

7.4.9 One hundred and eighty-nine existing residential properties have been identified as receptors for the assessment. The locations of these properties are shown in Figure 7.2. In addition, concentrations have been modelled at the diffusion tube monitoring sites located within Dalry and at the hamlet at Highfield, in order to verify the modelled results (see Appendix 7.1 for verification method).

Assessment Scenarios

7.4.10 Predictions of nitrogen dioxide, PM_{10} and $PM_{2.5}$ concentrations have been carried out for a base year (2012), the proposed year of opening (2016) and the design year (2031). For 2016 and 2031, predictions have been made assuming both that the development does proceed (With Scheme), and does not proceed (Without Scheme). A further 2016 sensitivity test has been carried out for nitrogen dioxide that involves assuming no reduction in emission factors for road traffic from the baseline year. This is to address the issue recently identified by Defra (Carslaw, D., Beevers, S., Westmoreland, E. and Williams, M, 2011) that road traffic emissions have not been declining as expected (see later section on uncertainty). Nitrogen dioxide concentrations in 2016 with and without the Scheme are thus presented for two scenarios: 'With Emissions Reduction' and 'Without Emissions Reduction'. Assuming no emission reduction to the design year of 2031 would be inappropriate. The introduction of Euro VI HDVs and Euro 6 Light Duty Vehicles (LDVs) in 2014/5 are expected to result in a real on road change in emissions. Therefore, by 2031, emissions reductions are likely to occur.

Modelling Methodology

7.4.11 Concentrations have been predicted for the baseline and future years (2016 and 2031) using the ADMS-Roads dispersion model. Details of the model inputs and the model verification are provided in Appendix 7.1, together with the method used to derive current and future year background nitrogen dioxide concentrations.

7.4.12 Emissions have been modelled using the Analysis of Instantaneous Road Emissions (AIRE) model, which was developed by SIAS for Transport Scotland. This calculates emissions on a half second by half second basis. AIRE produces estimates of the oxides of nitrogen, particulate matter and total carbon emissions that result from the combustion of fuel throughout each simulated vehicle's journey. The estimates produced by AIRE are for vehicle exhaust emissions only and therefore do not include brake and tyre wear and resuspension of $PM_{2.5}$ and PM_{10}.

7.4.13 Emissions of $PM_{2.5}$ and PM_{10} from brake and tyre wear and road surface abrasion have been calculated based on vehicle flow, composition and speed using the Emission Factor Toolkit (EFT) (Version 5.1.3) published by Defra on their website.

7.4.14 AIRE does not include emission factors for Euro VI HDVs or Euro 6 LDVs vehicles. Any vehicle within the fleet composition that is defined as either Euro 6 or VI has therefore be downgraded and reclassified as a Euro V HDVs or Euro 5 LDVs. This is a limitation with the approach. However, the outcome will be worst-case, as the penetration of the newer lower-emission vehicles into the fleet from 2013/14 onwards has not been included. This will result in the future-year concentrations being over predicted.

Road Traffic Impacts – STAG

7.4.15 In addition to predicting pollutant concentrations at specific receptors, the assessment has also included a count of properties that would be expected to experience either an increase or a reduction in pollutant concentrations as a result of the Proposed Scheme. This is not, strictly, a requirement of the DMRB assessment, but it does provide a useful indication of the overall impacts of a scheme. The property count has included all ordnance survey, non-business, address points that are within 200m of one of the explicitly included road links (as shown in Figure 7.3). There are 4,668 residential properties within 200m of the defined links. These properties would potentially be affected by changes in emissions from all roads in the study area. It is not practicable to model the changes in concentrations at all of these properties. However, the STAG (Transport Scotland, 2012) provides a method for assessing the overall impact at all the properties. The STAG methodology accounts for all properties within 200m of links. This involves modelling concentrations using the DMRB screening model at 20m; 70m; 115m; and 175m from each road to represent four distance bandings: 0-50m; 50-100m; 100-150m; and 150-200m, as suggested within STAG. Impacts over 200m from any of the roads are considered to be insignificant.

7.4.16 Concentrations for each band have been calculated using the DMRB screen model following the approach set out in Appendix 7.5.

7.4.17 The difference between the With and Without Scheme represents the change due to the Scheme, which may be +ve or –ve, depending on whether pollutant concentrations increase or decrease. The +ve and –ve values are summed to provide an indication of the overall number of properties expected to experience a deterioration or an improvement in air quality with the Scheme.

Regional Air Quality Impacts

7.4.18 The total emissions of oxides of nitrogen and particulate matter (PM_{10}) from the road traffic for each scenario have been calculated as the sum of the link emissions for each pollutant and each scenario, as provided by the AIRE model. Emissions of other pollutants were not available from the model, thus oxides of nitrogen emissions have been used to represent the regional impacts with PM_{10} emissions provided for information. This assessment addresses the change in total emissions that would result from the Proposed Scheme compared to the Without Scheme alternative. The assessment of oxides of nitrogen emissions has been carried out for the years 2016 both with and without predicted emission reductions[1]; and for the year 2031 emissions, assuming these reduce at 'officially' predicted rates. Fleet composition changes and therefore real on road emission reductions are expected to occur by 2031. For PM_{10} the assessment has been carried out for the years 2016 and 2031 assuming emissions reduce at 'officially' predicted rates.

7.4.19 The same limitations as for the local air quality assessment apply to the regional air quality impacts, in that the lower-emission Euro VI and 6 vehicles have not been included. This leads to over prediction of future year emissions. Again, the estimates produced by AIRE are for vehicle exhaust emissions only and therefore do not include brake and tyre wear and road surface abrasion of PM_{10}. Emissions of PM_{10} from brake and tyre wear and road surface abrasion have been calculated based on vehicle flow, composition, speed and length of each link using the Emission Factor Toolkit (EFT) (Version 5.1.3) published by Defra (Defra, 2012).

7.4.20 Regional air quality impacts have been calculated following the "detailed" methodology set out in DMRB Volume 11, Section 3, Part 1, HA 207/07. All of the roads included in

[1] 2016 and 2012 fleet compositions have been used to represent the with and without reductions in road traffic emissions for NOx

the traffic model within the study area have been included in the assessment, the AIRE model accounts for diurnal profiles in the traffic emissions. Regional emissions from the road traffic have been calculated for 2016 Without Scheme and With Scheme, as well as for 2031 Without Scheme and With Scheme.

Greenhouse Gas Impacts

7.4.21 Greenhouse gas impacts have been estimated following the "detailed" methodology set out in DMRB Volume 11, Section 3, Part 1, HA 207/07 for the same road links, and following the same assumptions as described for the regional air quality impact assessment.

7.4.22 The AIRE emissions model provides total carbon emissions which are converted to carbon dioxide (CO_2) equivalent using a factor of 3.67 based on the molecular weight of CO_2 relative to carbon.

7.4.23 CO_2 emissions have also been predicted using the EFT, based on the traffic flows, composition, speed and length for each link. This is to account for uncertainty in the estimates of the CO_2 emissions.

7.4.24 A monetary value can be associated with the changes in carbon dioxide emissions over a 60 year period from 2016 using the WebTAG spreadsheet: Greenhouse Gases[2]. The values used are based on present value base year of 2013 to account for the discount factors[3] and CO_2 prices based on 2011.

7.5 Baseline Conditions

7.5.1 The existing main route in the area (A737) passes through Dalry town centre. The route of the new road would pass through predominately agricultural land/countryside to the east of Dalry.

Baseline Local Air Quality

Industrial sources

7.5.2 A search of the UK Pollutant Release and Transfer Register website, which includes data from SEPA, did not identify any industrial or waste management sources within 1 km of the Proposed Scheme.

Site Visit

7.5.3 A site visit was carried out on 19 September 2012. Other than road traffic, the only other major emission source identified was the industrial processes at the DSM Nutritional Products site to the north/northeast of Dalry town.

Air Quality Review and Assessment

7.5.4 North Ayrshire Council has investigated air quality within its area as part of its responsibilities under the LAQM regime. North Ayrshire Council has not declared any Air Quality Management Areas (AQMAs). However, the 2008 Air Quality Progress Report (PR) (North Ayrshire Council, 2011) identified an area of exceendence of the

[2]The STAG CO_2 Monetisation Spreadsheet contains a number of mistakes therefore the WebTAG spreadsheet has been used: 121214-U3_3_5X-Greenhouse-Gases-Spreadsheet.xls from http://www.dft.gov.uk/webtag/documents/expert/unit3.3.5.php
[3]Discount rate is 3.5% and 3% after 30 years as suggested by HMT Green Book. http://www.hm-treasury.gov.uk/green_book_guidance_discounting.htm

nitrogen dioxide annual mean objective in Dalry. A new traffic management system was implemented within Dalry in 2009 and resulted in a reduction in concentrations. Based on the 2008 PR North Ayrshire Council had expected to declare an AQMA within Dalry. However, due to the reductions, declaration has been postponed until the new data are assessed.

7.5.5 In terms of PM_{10}, the North Ayrshire Council concluded that the Scottish annual mean objective of 18 μg/m^3 had been marginally exceeded in the past.

Local Air Quality Monitoring

7.5.6 North Ayrshire Council operates one automatic monitoring station within its area. This site is located in Irvine, outside the study area defined for this assessment. The automatic monitor was commissioned in February 2009 replacing an old analyser. Data for the for the automatic monitor from 2009-2011 have been provided by North Ayrshire Council and presented in Table 7.2 to provide context in the wider area.

7.5.7 The Council also operates a number of nitrogen dioxide monitoring sites using diffusion tubes prepared and analysed by Glasgow Scientific Services (using the 20% TEA in water method). These include four sites located within Dalry (three kerbside sites and one urban background site) and one site located in Highfield hamlet at the kerbside. Data for these sites have been provided by North Ayrshire Council and the results for the years 2007 to 2011 are summarised in Table 7.2 and the monitoring locations shown in Figure 7.4.

Table 7.2: Summary of Nitrogen Dioxide (NO_2) Monitoring (2007-2011)[a]

Site No.	Site Type	Location	2007	2008	2009	2010	2011
Automatic Monitors - Annual Mean (μg/m^3) [b]							
-	K	High Street, Irvine	-	-	26	34	31
Objective			40				
Automatic Monitors - No. of Hours > 200 μg/m^3 [b]							
-	K	High Street, Irvine	-	-	0	1	0 (118)
Objective			18 (200) [c]				
Diffusion Tubes - Annual Mean (μg/m^3) [d]							
16	UB	12 Garnock St, Dalry	9	11	15	15	11
17	K	67 New St, Dalry	-	34	34	33	32
18	K	45 New St Dalry	**48**	**45**	39	37	**42**
19	K	2 Townhead St, Dalry	29	26	25	30	30
20	K	Highfield, Dalry	15	15	21	19	20
Objective			40				

[a] Exceedences of the objectives are shown in bold. Site type addreviation: K – kerbside and UB – Urban Background.

[b] Data have been provided by the Council.

[c] Values in parentheses are 99.8th percentiles, which are presented where data capture is <90%.

[d] Data have been provided by the Council. All data have been bias adjusted by the Council using the following factors: 2007 = 0.83; 2008 = 0.87; 2009 = 0.96; 2010 = 0.93; and 2011 = 0.79.

7.5.8 The automatic monitor in High Street, Irvine has not shown any exceedences of the nitrogen dioxide objectives over the period 2009-2011.

7.5.9 The kerbside monitoring site outside 45 New Street, Dalry showed exceedences of the annual mean nitrogen dioxide objective in 2007, 2008 and 2011. The 2009 and 2010 concentrations were marginally below the objective. New Street exhibits canyon like characteristics and this, combined with the queuing traffic on New Street, is the likely cause for the exceedence. The changes in management of the traffic lights during 2009 may have helped reduce the concentrations from 2009 onwards. However, it is clear there is still a problem in the area, although it is very localised to the junction with the traffic lights, as the diffusion tube outside 67 New Street (further away from the traffic lights) has concentrations below the objective.

7.5.10 There are no clear trends in monitoring results for the past five years (2007-2011). This contrasts with the expected decline due to the progressive introduction of new vehicles operating to more stringent standards. The implications of this are discussed later in the section on uncertainty in this chapter.

7.5.11 The automatic monitoring station in Irvine, approximately, 11km south of the study area, also measured PM_{10} concentrations during 2009 to 2011. Results are summarised in Table 7.3 below. There are no monitors measuring $PM_{2.5}$ concentrations in North Ayrshire.

7.5.12 During 2009 and 2011, PM_{10} concentrations were on the boundary of the Scottish Governments annual mean objective, while in 2010 the objective was exceeded. This is the only monitoring of PM in North Ayrshire. Local Authority reports have not flagged up any concerns with PM within Dalry.

Table 7.3: Summary of PM_{10} Automatic Monitoring (2009-2011) [a]

Site No.	Site Type	Location	2009	2010	2011
PM_{10} Annual Mean (µg/m^3)					
-	K	High Street, Irvine	18	**19**	18
Objective			18		
PM_{10} No. Days >50 µg/m^3					
-	K	High Street, Irvine	1	0	0
Objective			7		

[a] Exceedences of the objectives are shown in bold. Reference equivalent BAM data. Data provided by the Council.

Background Concentrations

7.5.13 In addition to these locally measured concentrations, estimated background concentrations in the study area have been determined for 2012 and the two assessment years 2016 and 2031 (Table 7.4). In the case of nitrogen dioxide concentrations for 2016, two sets of future-year backgrounds are presented to take into account uncertainty in short-term future year vehicle emission factors. The derivation of background concentrations is described in Appendix 7.1. The background concentrations are all well below the objectives.

Table 7.4: Estimated Annual Mean Background Pollutant Concentrations in 2012, 2016 and 2031 (µg/m^3)

Year	NO_2	PM_{10}	$PM_{2.5}$
2012 [a]	6.2 - 17.6	9.8 - 10.7	6.6 - 7.2
2016 – Without Reductions in Traffic Emissions [b]	4.9 - 14.2	n/a	n/a
2016 – With Reductions in Traffic Emissions [c]	4.7 - 14.0	9.5 - 10.3	6.3 - 6.8
2031 – With Reductions in Traffic Emissions [d]	3.7 - 12.6	9.2 - 10.0	6.0 - 6.5
Objectives	**40**	**18**	**12**

n/a = not applicable

[a] This assumes vehicle emission factors in 2012 remain the same as 2010 (See Appendix 7.1).

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

[c] This assumes vehicle emission factors reduce into the future at the current ‘official’ rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[d] Background concentrations are only available up to 2030. Therefore 2030 concentrations have been assumed to represent 2031 concentrations. This assumes vehicle emission factors reduce into the future at the current ‘official’ rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

Baseline Dispersion Model Results

7.5.14 Baseline concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been modelled at each of the receptor locations (see Figure 7.2). Results are summarised for locations that show the highest concentrations in 2012 (Receptors 89-94) in Table 7.5 and Table 7.6. The 2016 baseline for nitrogen dioxide covers the two scenarios: with the official reductions in vehicle emission factors and without these reductions. Maps showing the overall study area concentrations are shown in Figure 7.5 through to Figure 7.15.

7.5.15 To ensure the predicted concentrations are consistent with the local monitoring, the modelled road oxides of nitrogen contributions have been adjusted by a verification factor of 1.835, see Appendix 7.1 for details of the model verification.

Table 7.5: Modelled Annual Mean Baseline Concentrations of Nitrogen Dioxide (µg/m^3) at Existing Receptors

Receptor	2012[a]	2016 Without Scheme		2031 Without Scheme
		With 'Official' Emissions Reduction [b]	Without Emissions Reduction [c]	With 'Official' Emissions Reduction [b]
89	**48.1**	**44.1**	**46.9**	38.1
90	**43.7**	**40.7**	**43.4**	36.6
91	**49.0**	**46.0**	**48.8**	**41.2**
92	**45.2**	**42.2**	**45.0**	38.0
93	**41.3**	38.4	**41.1**	34.7
94	**41.2**	38.2	**40.9**	34.7
Objective	**40**			

[a] This assumes vehicle emission factors in 2012 remain the same as 2010 (See Appendix 7.1).

[b] This assumes vehicle emission factors reduce into the future at the current 'official' ratesbut does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[c] This assumes vehicle emission factors in 2016 remain the same as in 2012.

Table 7.6: Modelled Baseline Concentrations of PM_{10} and $PM_{2.5}$at Existing Receptors

Receptor	PM_{10} [a]						$PM_{2.5}$		
	Annual Mean (µg/m^3)			No. Days >50 µg/m^3			Annual Mean (µg/m^3)		
	2012	Without Scheme		2012	Without Scheme		2012	Without Scheme	
		2016	2031		2016	2031		2016	2031
89	13.0	12.3	12.0	<1	<1	<1	9.6	8.7	8.3
90	13.1	12.4	12.1	<1	<1	<1	9.7	8.8	8.5
91	13.6	12.9	12.6	<1	<1	<1	10.2	9.2	8.9
92	13.3	12.7	12.4	<1	<1	<1	9.9	9.0	8.7
93	13.1	12.4	12.1	<1	<1	<1	9.7	8.8	8.5
94	13.2	12.5	12.3	<1	<1	<1	9.8	8.8	8.5
Objective	**18**			**7**			**12**		

[a] The numbers of days with PM_{10} concentrations greater than 50 μg/m^3 have been estimated from the relationship with the annual mean concentration described in LAQM.TG (Defra, 2009).

7.5.16 The predicted annual mean concentrations of nitrogen dioxide in 2012 are below the objective at most receptor locations. However, there are exceedences of the objective at six locations. These exceedences are along New Street, where monitoring by North Ayrshire Council has identified potential air quality problems. All of the predictions for PM_{10} and $PM_{2.5}$ are well below the objectives and limit values.

With 'Official' Emission Reduction

7.5.17 The predicted annual mean concentrations of nitrogen dioxide are below the objective in 2016 and 2031 at most receptor locations. However, there are exceedences of the annual mean objective at four locations in 2016 and one location in 2031. These exceedences are along New Street, where concentrations are predicted to be currently exceeding the objective (in 2012). All of the predictions for PM_{10} and $PM_{2.5}$ in both 2016 and 2031, are well below the objectives and limit values.

Without Emission Reduction

7.5.18 The predicted annual mean concentrations of nitrogen dioxide are below the objective in 2016 at most receptor locations. However, there are exceedences of the annual mean objective at six locations in 2016. These exceedences are along New Street, where concentrations are predicted to be currently exceeding the objective (in 2012).

7.5.19 These results are consistent with the conclusions of North Ayrshire Council in the outcome of its air quality review and assessment work.

Baseline Regional Air Quality

7.5.20 Table 7.7 sets out the predicted baseline emissions of nitrogen oxides and PM_{10} from the road network included in the traffic model.

Table 7.7: Baseline Emissions of Nitrogen Oxides and PM_{10} (kg per year)

Pollutant	2012	2016 Without Scheme With 'Official' Emissions Reduction [a]	2016 Without Scheme Without Emissions Reduction [b]	2031 Without Scheme With 'Official' Emissions Reduction [a]
Nitrogen Oxides	43,394	38,075	44,053	37,346
PM_{10}	3,303	3,104	N/A	3,236

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates, but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

7.5.21 Between 2012 and 2016, if road traffic emissions are predicted to reduce at 'official' rates (but not including the reductions due to the introduction of Euro VI and Euro 6 vehicles), emissions of nitrogen oxides and PM_{10} are expected to reduce despite the increases in traffic flows, as newer, cleaner vehicles enter the fleet. However, if it is assumed that emission reductions do not occur at the predicted rate from 2012 then nitrogen dioxide emissions are predicted to marginally increase as a result of predicted increases in traffic volumes. By 2016 a reasonable penetration of lower-emission Euro VI and Euro 6 is expected in the fleet and so that the actual emissions are likely to be lower than those shown, which do not allow for Euro VI and Euro 6 vehicles. Emissions of nitrogen oxides and PM_{10} are predicted to be lower in 2031 than in 2012 and 2016.

Baseline Greenhouse Gas Emissions

7.5.22 Table 7.8 sets out the predicted baseline emissions of carbon dioxide from the road network included in the traffic model based on both the AIRE emissions and the EFT emissions.

Table 7.8: Baseline Emissions of Carbon Dioxide (tonnes per year as carbon dioxide equivalent)

	2012		2016 Without Scheme		2031 Without Scheme	
	AIRE	EFT	AIRE	EFT	AIRE	EFT
Carbon Dioxide	17,227	15,357	17,293	14,784	18,304	14,673

7.5.23 Between 2012 and 2016, baseline emissions calculated with the AIRE model show a small increase, but those calculated with the EFT show a decrease. Emissions based on the AIRE model are predicted to continue to increase between 2016 and 2031, while those calculated using the EFT continue to decline. This difference between the two sets of results is due to differences in the way in which emissions from the future vehicle fleet are treated.

7.6 Predicted Impacts

Local Air Quality Impacts

Construction Impacts

7.6.1 Construction works would give rise to a risk of dust impacts during earthworks and construction, as well as from trackout of dust and dirt by vehicles onto the public highway. There are various sensitive receptors that may be affected by dust, including residential properties, and less sensitive commercial premises. There are no significant highly sensitive ecological receptors that might be affected.

7.6.2 The construction may be phased so at any one time the number of receptors may be relatively small. However, this assessment would assume that the full route would be developed simultaneously.

Demolition

7.6.3 There is no requirement for demolition on site.

Earthworks

7.6.4 The Proposed Scheme extends for a length of 3.8km. Most of the route would be subject to earthworks, involving removal of the foundations of existing roads and breaking up of a paved area along with formation of new bunds and banks. There would be a small number of properties within 20m of areas subjected to earthworks (approximately 16 properties, see Figure 7.16). This number may be reduced at any one time based on the construction being phased. There would also be a small number of properties (around 10, see Figure 7.16) between 20-100m from earthworks, with a large number of properties between 100-350m from the site (see Figure 7.16). Dust would arise mainly from the vehicles travelling over unpaved ground and from the handling of dusty materials. Most of the earthworks would, involve the removal of subsoil, which would largely be damp and not prone to dust generation. In accordance with criteria in Appendix 7.2, the dust emission class for the earthworks is considered to be Large.

Construction

7.6.5 Dust would arise from vehicles travelling over unpaved ground, the handling and storage of dusty materials, and from the cutting of concrete. There would be a small number of properties within 20m of the area subject to construction (approximately 16 properties, see Figure 7.16). This number is likely to be reduced at any one time if the construction is phased. Approximately 10 properties (see Figure 7.16) are located between 20-100m from construction works, with a large number of properties between 100-350m from the site (see Figure 7.16). The overall Scheme construction would take place over an 18-month period. However, construction may be phased reducing the potential time of local impact. The dust emission class for the construction is considered to be Large.

Trackout

7.6.6 The number of vehicles accessing the site, which may track out dust and dirt is currently unknown. However, given the size of the Scheme it is likely that there would at times be large number of vehicle movements per day (25-100). There are a small number of properties lying within 20m of the public highway within 500m of the site entrance/exit, which are at risk of being affected by dust (see Figure 7.16). The dust emission class for trackout is considered to be Large**.**

Risk and Significance

7.6.7 Using the criteria in Appendix 7.2 the risk categories for the four construction activities are judged to be as set out in Table 7.9.

Table 7.9: Summary of Risk of Effects Without Mitigation

Source	Dust Soiling	PM_{10} Effects	Ecological Effects
Demolition	None	None	None
Earthworks	High Risk Site	High Risk Site	None
Construction	High Risk Site	High Risk Site	None
Trackout	High Risk Site	High Risk Site	None

7.6.8 The sensitivity of the areas around the site is judged to be Medium for human receptors and Low for ecological receptors, as shown in Table 7.10.

Table 7.10: Sensitivity of the Area

Sensitivity of area	Human Receptors	Ecological Receptors	
	Factors for Classification of Sensitivity	Sensitivity of area	Factors for Classification of Sensitivity
Earthworks			
Medium	Rural area. Local PM_{10} concentrations well below the objectives (less than 75%). Approximately 16 properties within 20m.	Low	No designations.
Construction			

Sensitivity of area	Human Receptors	Ecological Receptors	
	Factors for Classification of Sensitivity	Sensitivity of area	Factors for Classification of Sensitivity
Medium	Rural area. Local PM_{10} concentrations well below the objectives (less than 75%). Approximately 16 properties within 20m.	Low	No designations.
Trackout			
Medium	Rural area. Local PM_{10} concentrations well below the objectives (less than 75%).	Low	No designations.

7.6.9 On this basis the significance of dust effects without mitigation Moderate Adverse, as set out in Table 7.11, according to the criteria in Appendix 7.2.

Table 7.11: Summary Significance Table Without Mitigation

Source	Dust soiling effects	PM_{10} effects	Ecological effects
Demolition	None	None	None
Earthworks	Moderate adverse	Moderate adverse	None
Construction	Moderate adverse	Moderate adverse	None
Trackout	Moderate adverse	Moderate adverse	None
Overall significance	**Moderate adverse**		

Road Traffic Impacts 2016 – Discrete Receptors

7.6.10 Predicted annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$, as well as days with PM_{10}>50 µg/m^3, are shown in Figures 7.17 to 7.21. The six receptors identified to have experienced exceedences of the nitrogen dioxide annual mean in 2012 are set out in Table 7.12, Table 7.13 and Table 7.14 for both the "Without Scheme" and "With Scheme" scenarios. These tables also describe the impacts at each receptor using the impact descriptors given in Appendix 7.4. Maps showing the overall impacts can be found in Figures 7.22 to 7.26. For nitrogen dioxide, results are presented for two scenarios to reflect current uncertainty in Defra's, DfT's and Transport Scotland's future-year vehicle emission factors.

<u>NO_2: With 'Official' Emission Reduction</u>

7.6.11 With the Scheme, the annual mean nitrogen dioxide concentrations are below the objective at all receptors apart from Receptor 89. The magnitudes of change are:

- *imperceptible* at 99 receptor locations;
- *small* increases at 12 and *small* reductions at 42 receptor locations;
- *medium* increases at 2 and *medium* reductions at 18 receptor locations; and
- *large* increases at 0 and large *reductions* at 20 receptor locations;

and thus, taking into account the absolute concentrations and the impact descriptors in the tables in Appendix 7.4, the impacts are:

- *negligible* at 171 receptor locations;
- *slightadverse* at 0 and *slight* beneficial at 17 receptor locations;
- *moderateadverse* at 0 and *moderatebeneficial* at 2 receptor locations; and
- *substantialadverse* at 0 and *substantialbeneficial* at 3 receptor location.

7.6.12 The Scheme removes three of the four exceedences predicted in 2016 without the Scheme (Receptors 90-92). All three receptors are predicted to experience a *substantial beneficial* impact due to the Scheme. Receptor 89 is predicted to remain in exceedence of the objective with the Scheme. However, it experiences a *slight beneficial* impact. Furthermore, this receptor is located on the façade of a hotel at ground floor where there is no relevant exposure to the nitrogen dioxide annual mean objective.

NO_2: Without Emission Reduction

7.6.13 With the Scheme, the annual mean nitrogen dioxide concentrations are below the objective at all receptors apart from Receptor 89. The magnitudes of change are:

- *imperceptible* at 82 receptor locations;
- *small* increases at 0 and *small* reductions at 65 receptor locations;
- *medium* increases at 0 and *medium* reductions at 23 receptor locations;
- *large* increases at 0 and *large* reductions at 23 receptor locations; and

and thus, taking into account the absolute concentrations and the tables in Appendix 7.4, the impacts are:

- *negligible* at 167 receptor locations;
- *slight adverse* at 0 and *slight beneficial* at 20 receptor locations;
- *moderate adverse* at 0 and *moderate beneficial* at 1 receptor locations; and
- *substantial adverse* at 0 and *substantial beneficial* at 5 receptor location.

7.6.14 The Scheme removes five of the six exceedences predicted in 2016 without the Scheme (Receptors 90-94). All five receptors are predicted to experience a *substantial beneficial* impact due to the Scheme. Receptor 89 is predicted to remain in exceedence of the objective with the Scheme. However, it experiences a *slight beneficial* impact. Furthermore, this receptor is located on the façade of a hotel at ground floor where there is no relevant exposure to the nitrogen dioxide annual mean objective.

Table 7.12: Predicted Impacts on Annual Mean Nitrogen Dioxide Concentrations in 2016 (µg/m^3)

Receptor	With 'Official' Emission Reduction [a]			Without Emissions Reduction [b]		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
89	**44.1**	**42.3**	Slight Beneficial	**46.9**	**45.1**	Slight Beneficial
90	**40.7**	28.8	Substantial Beneficial	**43.4**	30.5	Substantial Beneficial
91	**46.0**	31.9	Substantial Beneficial	**48.8**	33.6	Substantial Beneficial

Receptor	With 'Official' Emission Reduction [a]			Without Emissions Reduction [b]		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
92	**42.2**	28.0	Substantial Beneficial	**45.0**	29.7	Substantial Beneficial
93	38.4	25.3	Moderate Beneficial	**41.1**	26.8	Substantial Beneficial
94	38.2	24.9	Moderate Beneficial	**40.9**	26.5	Substantial Beneficial
Objective	**40**		**-**	**40**		**-**

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

PM_{10} and $PM_{2.5}$

7.6.15 In terms of PM_{10} , with the Scheme, the annual mean concentrations are below the objective at all receptors. The magnitudes of change are:

- *imperceptible* at 152 receptor locations;
- *small* increases at 1 and *small* reductions at 30 receptor locations;
- *medium* increases at 0 and *medium* reductions at 10 receptor locations; and
- *large* increases at 0 and *large* reductions at 0 receptor locations;

and thus, taking into account the absolute concentrations and the tables in Appendix 7.4, the impacts are:

- *negligible* at all193 receptor locations.

7.6.16 In terms of $PM_{2.5}$, with the Scheme, the annual mean concentrations are below the objective at all receptors. The magnitudes of change are:

- *imperceptible* at 147 receptor locations;
- *small* increases at 1 and *small* reductions at 38 receptor locations;
- *medium* increases at 0 and *medium* reductions at 7 receptor locations; and
- *large* increases at 0 and *large* reductions at 0 receptor locations;

and thus, taking into account the absolute concentrations and the tables in Appendix 7.4, the impacts are:

- *negligible* at all 193 receptor locations.

7.6.17 In terms of number of days with PM_{10}greater than 50µg/m^3, no exceedences of the objectives are predicted; the magnitudes of change are all *imperceptible* and thus all of the impacts are *negligible.*

Table 7.13: Predicted PM_{10} Impacts in 2016($\mu g/m^3$)

Receptor	Annual Mean ($\mu g/m^3$)			Days with PM_{10}> 50 $\mu g/m^3$ [a]		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
89	12.3	12.1	Negligible	<1	<1	Negligible
90	12.4	11.5	Negligible	<1	<1	Negligible
91	12.9	11.7	Negligible	<1	<1	Negligible
92	12.7	11.5	Negligible	<1	<1	Negligible
93	12.4	11.4	Negligible	<1	<1	Negligible
94	12.5	11.5	Negligible	<1	<1	Negligible
Objective	**18**		-	**7**		-

[a] The numbers of days with PM_{10} concentrations greater than 50 $\mu g/m^3$ have been estimated from the relationship with the annual mean concentration described in LAQM.TG (Defra, 2009).

Table 7.14: Predicted $PM_{2.5}$ Impacts in 2016 ($\mu g/m^3$)

Receptor	Annual Mean ($\mu g/m^3$)		
	Without Scheme	With Scheme	Impact Descriptor
89	8.7	8.5	Negligible
90	8.8	7.9	Negligible
91	9.2	8.2	Negligible
92	9.0	8.0	Negligible
93	8.8	7.8	Negligible
94	8.8	7.9	Negligible
Objective	**12**		-

Road Traffic Impacts 2016 – STAG

Number of Properties that might be Affected by Changes in Local Air Quality in 2016

7.6.18 As is explained in the methodology section, the DMRB screening model has been used to classify the likely direction of any changes in air quality at every residential property within 200m of roads included in the study area.

7.6.19 It is important to note that all predicted changes in concentration have been counted and presented in Table 7.15; including those changes of less that 1% of the annual mean objective, which have been counted as *imperceptible*. As can be inferred from the modelled concentrations at individual receptors, the vast majority of the changes described in Table 7.15 are *negligible*. The largest impacts from road traffic tend to be close to roads and it is thus important to note that in the first distance band in Table 7.15 (i.e. within 50m of road centrelines), more properties are expected to experience an improvement in air quality than a deterioration.

Table 7.15: Number of Properties Expected to Experience Improved and Deteriorated Air Quality as a Result of the Proposed Scheme.

Distance From Road Centreline	Number of residential properties likely to experience deteriorated air quality	Number of residential properties likely to experience improved air quality	Number of residential properties with imperceptible change [a]
NO_2 With 'official ' reductions			
0 m – 50 m	93	235	1392
50m – 100m	69	64	1187
100m – 150m	0	35	927
150m – 200m	24	0	642
Totals	186	334	4148
NO_2 Without reductions			
0 m – 50 m	64	268	1388
50m – 100m	69	68	1183
100m – 150m	0	35	927
150m – 200m	24	0	642
Totals	157	371	4140
PM_{10}			
0 m – 50 m	64	220	1436
50m – 100m	17	64	1239
100m – 150m	0	6	956
150m – 200m	24	0	642
Totals	105	290	4273

[a] An imperceptible change is considered to be 1% of the objective/level: <0.4 $\mu g/m^3$ for NO_2 and <0.18 $\mu g/m^3$ for PM_{10}.

STAG Assessment Score: 2016

7.6.20 The STAG assessment score is presented in Table 7.16. Summing the +ve and –ve changes at all properties within 200 m of the modelled road network shows that the Scheme would lead to an overall reduction in exposure to nitrogen dioxide and PM_{10} in 2016, whether emissions reductions are assumed or not (in the case of nitrogen dioxide). Taking account of the number of properties, the score shows that the Scheme would have a very small impact on average pollutant concentrations with an average decrease in a nitrogen dioxide concentration of 0.13 $\mu g/m^3$ (assuming emission reductions) and 0.16 $\mu g/m^3$ (assuming no reductions) and an average decrease in a PM_{10} concentration of 0.04 $\mu g/m^3$. The scores in Table 7.16 show the Scheme would have an overall beneficial impact on air quality.

Table 7.16: STAG score in 2016.

Pollutant	With 'Official' Emissions Reduction [a]	Without Scheme Without Emissions Reduction [b]
Nitrogen Dioxide	-6,245	-7,450
PM_{10}	-1,839	NA

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

Road Traffic Impacts 2031 – Discrete Receptors

7.6.21 Predicted annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$, as well as days with PM_{10}>50 µg/m^3, are presented in Figures 7.27 to 7.30. Concentrations for the six receptors identified to have experienced exceedences of the nitrogen dioxide annual mean in 2012 are set out in Table 7.17. Predicted concentrations of PM_{10} and $PM_{2.5}$, at those same receptors are presented in Table 7.18 and Table 7.19, for both the "Without Scheme" and "With Scheme" scenarios. These tables also describe the impacts at each receptor using the impact descriptors given in Appendix 7.4. Maps showing the overall impacts in 2031 can be found in Figures 7.31 to 7.34.

Table 7.17: Predicted Impacts on Annual Mean Nitrogen Dioxide Concentrations in 2031 (µg/m^3)

Receptor	With 'Official' Emission Reduction [a]		
	Without Scheme	With Scheme	Impact Descriptor
89	38.1	35.5	Moderate Beneficial
90	36.6	25.3	Moderate Beneficial
91	**41.2**	28.0	Substantial Beneficial
92	38.0	24.7	Moderate Beneficial
93	34.7	22.2	Slight Beneficial
94	34.7	21.9	Slight Beneficial
Objective	**40**		**-**

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[b] This assumes vehicle emission factors in 2031 remain the same as in 2012.

Table 7.18: Predicted PM_{10} Impacts in 2031(µg/m³)

Receptor	Annual Mean (µg/m³)			Days with PM_{10}> 50 µg/m³ [a]		
	Without Scheme	With Scheme	Impact Descriptor	Without Scheme	With Scheme	Impact Descriptor
87	12.0	11.7	Negligible	<1	<1	Negligible
88	12.1	11.2	Negligible	<1	<1	Negligible
89	12.6	11.4	Negligible	<1	<1	Negligible
90	12.4	11.2	Negligible	<1	<1	Negligible
91	12.1	11.1	Negligible	<1	<1	Negligible
92	12.3	11.1	Negligible	<1	<1	Negligible
Objective	**18**		-	**7**		-

[a] The numbers of days with PM_{10} concentrations greater than 50 µg/m³ have been estimated from the relationship with the annual mean concentration described in LAQM.TG (Defra, 2009).

Table 7.19: Predicted $PM_{2.5}$ Impacts in 2031 (µg/m³)

Receptor	Annual Mean (µg/m³)		
	Without Scheme	With Scheme	Impact Descriptor
87	8.3	8.1	Negligible
88	8.5	7.6	Negligible
89	8.9	7.8	Negligible
90	8.7	7.6	Negligible
91	8.5	7.5	Negligible
92	8.5	7.6	Negligible
Objective	**12**		-

NO_2: With 'Official' Emission Reduction

7.6.22 The annual mean nitrogen dioxide concentrations are below the objective at all receptors. The magnitudes of change are:

- *imperceptible* at 81 receptor locations;
- *small* increases at 17 and *small* reductions at 54 receptor locations;
- *medium* increases at 0 and *medium* reductions at 22 receptor locations; and
- *large* increases at 0 and *large* reductions at 19 receptor locations;

and thus, taking into account the absolute concentrations and the impact descriptors in the tables in Appendix 7.4, the impacts are:

- *negligible* at 173 receptor locations;
- *slight adverse* at 0 and *slight beneficial* at 16 receptor locations;
- *moderate adverse* at 0 and *moderate beneficial* at 3 receptor locations; and

- *substantial adverse* at 0 and *substantial beneficial* at 1 receptor location.

7.6.23 The Scheme removes the exceedence predicted in 2031 without the Scheme (Receptors 91). The impact at this receptor *substantial beneficial*.

PM_{10} and $PM_{2.5}$

7.6.24 In terms of $PM_{10,}$with the Scheme, the annual mean concentrations are below the objective at all receptors. The magnitudes of change are:

- *imperceptible* at 153 receptor locations;
- *small* increases at 1 and *small* reductions at 29 receptor locations;
- *medium* increases at 0 and *medium* reductions at 10 receptor locations; and
- *large* increases at 0 and *large* reductions at 0 receptor locations;

and thus, taking into account the absolute concentrations and the tables in Appendix 7.4, the impacts are:

- *negligible* at all193 receptor locations.

7.6.25 In terms of $PM_{2.5,}$with the Scheme, the annual mean concentrations are below the objective at all receptors. The magnitudes of change are:

- *imperceptible* at 144 receptor locations;
- *small* increases at 1 and *small* reductions at 41 receptor locations;
- *medium* increases at 0 and *medium* reductions at 7 receptor locations; and
- *large* increases at 0 and *large* reductions at 0 receptor locations;

and thus, taking into account the absolute concentrations and the tables in Appendix 7.4, the impacts are:

- *negligible* at all 193 receptor locations.

7.6.26 In terms of number of days with PM_{10} greater than 50$\mu g/m^3$, no exceedences of the objectives are predicted; the magnitudes of change are all *imperceptible* and thus all of the impacts are *negligible.*

Road Traffic Impacts 2031 – STAG

Number of Properties that might be Affected by Changes in Local Air Quality in 2031

7.6.27 As is explained earlier, modelling has been used to classify the likely direction of any changes in air quality at every residential property within 200m of roads within the study.

7.6.28 It is important to note that all predicted changes in concentration have been counted in Table 7.15; including those changes of less that 1% of the annual mean objective, which have been counted as *imperceptible*. As can be inferred from the modelled concentrations at individual receptors, the vast majority of the changes described in Table 7.15 are *negligible*. The largest impacts from road traffic tend to be close to roads and it is thus important to note that in the first distance band in Table 7.15 (i.e. within 50m of road centrelines), more properties are expected to experience an improvement in air quality than a deterioration.

Table 7.20: Number of Properties Expected to Experience Improved and Deteriorated Air Quality as a Result of the Proposed Scheme.

Distance From Road Centreline	Number of residential properties likely to experience deteriorated air quality	Number of residential properties likely to experience improved air quality	Number of residential properties with imperceptible change [a]
NO_2 With 'official ' reductions			
0 m – 50 m	414	947	359
50m – 100m	322	491	507
100m – 150m	128	191	643
150m – 200m	24	0	642
Totals	888	1629	2151
PM_{10}			
0 m – 50 m	58	251	1411
50m – 100m	0	120	1200
100m – 150m	0	54	908
150m – 200m	24	0	642
Totals	82	425	4161

[a] An imperceptible change is considered to be 1% of the objective/level: <0.4 $\mu g/m^3$ for NO_2 and <0.18 $\mu g/m^3$ for PM_{10}.

STAG Assessment Score: 2031

7.6.29 The STAG assessment score for 2013 is presented in Table 7.21. Summing the +ve and –ve changes at all properties within 200 m of the modelled road network show that the Scheme would give rise to an overall reduction in exposure to nitrogen dioxide and PM_{10} in 2031. Taking into account the number of properties, the score shows that the Scheme would have a very small impact on average pollutant concentrations with an average decrease in a nitrogen dioxide concentration of 0.26 $\mu g/m^3$ and an average decrease in a PM_{10} concentration of 0.05 $\mu g/m^3$. The scores in Table 7.21 show the Scheme to have an overall beneficial impact on air quality.

Table 7.21: STAG score in 2031.

Pollutant	With 'Official' Emissions Reduction [a]
Nitrogen Dioxide	-12,372
PM_{10}	-2,335

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

Uncertainty in Road Traffic Modelling Predictions

7.6.30 There are many components that contribute to the uncertainty of modelling predictions.

7.6.31 The model used in this assessment is dependent upon the modelled traffic data and any uncertainties in these data would carry into this assessment. All of the measurements presented in this chapter have an intrinsic margin of error. Defra and the Devolved Administrations (National Atmospheric Emissions Inventory, Defra) suggest that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements. There are then additional uncertainties, as the model is required to simplify real-world conditions into a series of algorithms. For example:

- it has been assumed that during each year, the vehicle fleet composition within the study area would conform to the national average for Scotland, which has been derived from factors within the latest version of the EFT published by Defra on their website;
- it has been assumed that wind conditions measured at Prestwick during 2011 would occur throughout the study area during 2012, 2016 and 2031; and
- it has been assumed that the subsequent dispersion of emitted pollutants would conform to a Gaussian distribution over flat terrain.

7.6.32 The STAG assessment needs to consider the potential for double counting impacts from the combined effects from several short links representing one continuous road. This means the impacts at the residential properties included within the STAG assessment may be amplified and therefore over-predicted.

7.6.33 As the model has been verified and adjusted, there can be reasonable confidence in the prediction of current year (2012) concentrations.

7.6.34 Predicting pollutant concentrations in future years would always be subject to greater uncertainty as the model cannot be verified in the future, and it is necessary to rely on a series of projections provided by DfT and Defra as to what would happen to traffic volumes, background pollutant concentrations, and vehicle emissions. Recently, a disparity between the road transport emission projections and measured annual mean concentrations of nitrogen oxides and nitrogen dioxide has been identified by Defra (Carslaw, D., Beevers, S., Westmoreland, E. and Williams, M., 2011). This is evident across the UK, although the effect appears to be greatest in inner London. Whilst the emission projections suggested that both annual mean nitrogen dioxide concentrations should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase.

7.6.35 The reason for the disparity is thought to relate to the on-road performance of modern diesel vehicles. New vehicles registered in the UK have 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 is often no better than that of earlier models (Carslaw, D., Beevers, S., Westmoreland, E. and Williams, M., 2011). The best current evidence is that, where previous standards have had limited on-road success, the ‘Euro VI’ and ‘Euro 6’ standards that new vehicles will have to comply with from 2013/15[4] will achieve the expected on-road improvements, as, for the first time, they will require compliance with the World Harmonized Test Cycle, which better represents real-world driving conditions and includes a separate slow-speed cycle for heavy duty vehicles.

[4] 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.

7.6.36 To account for the uncertainty, a sensitivity test has been conducted assuming that the future (2016 only) road traffic emissions per vehicle are unchanged from 2012 values. The predictions within this sensitivity test are likely to be over-pessimistic, as significant numbers of new, lower-emission Euro VI and Euro 6 vehicles will be on the road from 2014/15. By 2016 it is forecast that there will be a roughly 50-60% penetration of Euro VI HDVs and a roughly 15-20% penetration of Euro 6 LDVs. These new vehicles are expected to deliver real on-road reductions in nitrogen oxides emissions.

Significance of Operational Local Air Quality Impacts

7.6.37 The operational local air quality impact of the Proposed Scheme is judged to be *moderate beneficial*. This professional judgement is made in accordance with the methodology set out in Appendix 7.1. This takes into account the factors set out in Table 7.22,and the uncertainty over future projections of traffic-related nitrogen dioxide concentrations, which may not decline as rapidly as expected.

7.6.38 More specifically, the judgement that the air quality impacts would be *moderate beneficial* takes account of the assessment that concentrations would be below the air quality objectives and all of the impacts are predicted to be either beneficial or *negligible*. Furthermore, the Proposed Scheme is predicted to remove some exceedences of the objectives.

7.6.39 In terms of changes at properties in the wider area, the Scheme has been shown to be essentially neutral, while the STAG scores for 2016 and 2031 shows the Scheme to be a benefit. Thus overall it is concluded that the Scheme would be beneficial on local air quality.

Table 7.22: Factors Taken into Account in Determining the Overall Significance of the Scheme on Local Air Quality

Factors	Outcome of Assessment
Number of people affected by increases and/or decreases in pollutant concentrations and a judgement on the overall balance.	A large number of people are predicted to be exposed to lower pollutant concentrations.
The number of people exposed to pollutant levels above the objective or limit value.	A very small number of people are predicted to be exposed to levels above the nitrogen dioxide annual mean objective in both 2016 and 2031. These are at locations currently known to be of concern. However, the Scheme would reduce the number of exceedences.
The magnitude of the changes and the descriptions of the impacts at the receptors	In 2016, the impacts at the receptors range from *negligible* to *substantial beneficial*.
Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased.	No new areas of exceedence of the objective are predicted. Furthermore, the Scheme is predicted to reduce the number of exceedences of the objectives.
Uncertainty, including the extent to which worst-case assumptions have been made	The inclusion of a 'no emissions reduction' scenario for nitrogen dioxide in 2016 covers the uncertainty over vehicle emission factors. In addition the 'with official reduction' scenario does not include reductions due to the introduction of Euro VI and Euro 6 standards. Both these scenarios make the assessment worst-case.

Factors	Outcome of Assessment
The extent to which an objective or limit value is exceeded	The nitrogen dioxide annual mean objective is marginally exceeded at a very small number of locations within Dalry.
Whether or not the study area exceeds an objective or limit value and this exceedence is removed or the exceedence area is reduced.	There are no new exceedence of any of the objectives in the study area. The study area currently includes exceedences of the nitrogen dioxide objective, some of which are removed due to the Scheme.

Regional Air Quality Impacts

7.6.40 Table 7.23 sets out the total emissions and the predicted change in regional emissions based on the local traffic network modelled, with and without the Scheme in both 2016 and 2031.

Table 7.23: Predicted Emissions of Nitrogen Oxides and PM_{10} (kg per year)

Pollutant	Without Scheme	With Scheme	Change
2016 With 'Official' Emission Reduction [a]			
Nitrogen Oxides	3,8075	39,622	1547
PM_{10}	3,104	3,000	-104
2016 Without Emissions Reduction [b]			
Nitrogen Oxides	44,053	43,846	-207
PM_{10}	N/A	N/A	N/A
2031 With 'Official' Emission Reduction [a]			
Nitrogen Oxides	37,346	39,043	1697
PM_{10}	3,236	3,361	125

a This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

b This assumes vehicle emission factors in 2016 remain the same as in 2012.

7.6.41 Table 7.24 sets out an estimate of total emissions of nitrogen dioxide and PM_{10} across North Ayrshire to provide context for the changes in emissions. The most recent emission data for North Ayrshire are available for 2010 from the National Atmospheric Emissions Inventory. These emission data include all sources within North Ayrshire.

Table 7.24: Predicted Change in Emissions of Nitrogen Oxides and PM_{10}

Pollutant	2010 North Ayrshire (kg per year)	2010 North Ayrshire Road Transport (kg per year)	% Change relative to North Ayrshire Road Transport in 2010		
			2016 With 'Official' Emission Reduction [a]	2016Without Emissions Reduction [b]	2031With 'Official' Emission Reduction [a]
Nitrogen Oxides	1,792,300	497,055	0.31%	-0.04%	0.34%
PM_{10}	220,100	37,615	-0.28	N/A	0.33%

[a] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

7.6.42 The Proposed Scheme is predicted to cause an increase in the total emissions of pollutants from the modelled road network. When compared to the North Ayrshire road transport emissions, the predicted change is small.

Greenhouse Gas Impacts

7.6.43 Table 7.25 sets out the total carbon dioxide emissions and the predicted change in emissions in both 2016 and 2031 using emissions from both the AIRE model and the EFT.

Table 7.25: Predicted Emissions of Carbon Dioxide (equivalent) (tonnes per year)

Pollutant	AIRE			EFT		
	Without Scheme	With Scheme	Change [a]	Without Scheme	With Scheme	Change [a]
2016						
Carbon Dioxide	17,293	17,6704	377 (2.2%)	14784	14732	-52 (-0.4%)
2031						
Carbon Dioxide	18,304	18,759	455 (2.5%)	14673	14661.	-12 (-0.1%)

[a] The value in the parentheses represents the percentage change.

7.6.44 Table 7.26 sets out an estimate of total emissions of carbon dioxide across North Ayrshire from all sources and from road transport only, to provide context for the changes in emissions. The most recent emissions data for North Ayrshire are available for 2010 from the NAEI.

Table 7.26: Predicted Change in Emissions of Carbon Dioxide (equivalent)

Carbon Dioxide	2010 North Ayrshire (tonnes per year)	2010 North Ayrshire Road Transport (tonnes per year)	% Change relative to North Ayrshire Road Transport in 2010	
			2016	2031
AIRE	1,110,823	174,789	0.22%	0.26%
EFT			-0.03%	-0.01%

7.6.45 According to the predicted AIRE emissions, the Proposed Scheme is expected to generate an increase in the emissions of carbon dioxide from the modelled road network. When compared to the emissions data for North Ayrshire, the predicted change is extremely small. According to the predicted EFT emissions, the Proposed Scheme is expected to give rise to a decrease in the emissions of carbon dioxide from the modelled road network. When compared to the emissions data for North Ayrshire road transport, the predicted change is small.

7.6.46 A monetary value can be associated with the changes in carbon dioxide emissions over a 60 year period. Table 7.27 presents these values. Overall, the Scheme has an associated cost of approximately £1,440,699 (based on the predicted AIRE emissions) or a benefit of approximately £55,394 (based on the predicted EFT emissions).

Table 7.27: Emissions of Carbon Dioxide in 2013 Monetary terms

Carbon Dioxide	Change over 60 period (tonnes)	Net Present Value of Emissions	Sensitivity Analysis	
			Upper Estimate	Lower Estimate
AIRE	26,678	-£1,440,699	-£2,200,727	-£680,671
EFT	-1,053	£55,394	£84,161	£26,628

7.6.47 Using the AIRE emission estimates, the Scheme would increase carbon dioxide emissions, which runs counter to national targets to reduce greenhouse gas emissions. On the other hand, using the EFT emission estimates, the Scheme would have a benefit in terms of climate change impacts. Both models use the same traffic data, but treat emissions per vehicle in subtly different ways. In practice, it is considered that any net changes in emissions, either positive or negative, would be so small that they cannot be precisely quantified using available modelling methods.

7.7 Mitigation

Construction Impacts

7.7.1 Measures to mitigate dust emissions would be required during the construction phase in order to reduce impacts upon nearby sensitive receptors. Guidance has been published by IAQM on general mitigation measures to control dust and air emissions (IAQM, 2012) and 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 and the findings of the dust impact assessment, to draw up the following set of measures that should be incorporated into the specification for the works. Mitigation should be straightforward, as most of the necessary measures are routinely employed as 'good practice' on construction sites.

7.7.2 As comprehensive list of measures is detailed in Appendix 7.6.

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

7.7.4 The mitigation measures should to be written into a dust management plan (DMP), which would be integrated into a Code of Construction Practice or the Construction Environmental Management Plan, and monitored by the contractor.

Road Traffic Impacts

7.7.5 The assessment has shown that regional emissions of nitrogen oxides and PM_{10} and greenhouse gas emissions are predicted to increase. This is associated with the assumption that the Scheme would increase traffic flows.

7.7.6 The assessment of local air quality has demonstrated that the Scheme would not cause any exceedences of the air quality objectives and is likely to remove some current exceedences. The Proposed Scheme would act as a mitigation measure in that it would reduce pollutant emissions from road traffic that currently impact sensitive receptors within Dalry.

7.7.7 Other general mitigation measures are principally being delivered in the longer term by the introduction of more stringent emissions standards, largely via European legislation. It is not considered appropriate to propose further mitigation measures for this Scheme.

7.8 Residual Effects

Construction Impacts

7.8.1 Table 7.28 provides an overall summary table of the residual effects of dust and PM_{10} during construction with mitigation in place.

Table 7.28: Summary Significance Table With Mitigation

Source	Dust soiling effects	Ecological effects	PM_{10} effects
Demolition	None	None	None
Earthworks	Negligible	Negligible	None
Construction	Negligible	Negligible	None
Trackout	Negligible	Negligible	None
Overall significance	**Negligible**		

7.8.2 Overall there is judged to be a *negligible* risk of dust effects during the construction period with mitigation in place.

Road Traffic Impacts

7.8.3 The residual Impacts would be the same as those identified in section 7.6 on the Predicted Impacts.

7.9 Conclusion

7.9.1 The local and regional air quality and greenhouse gas impacts of the Proposed Scheme have been assessed. Existing conditions within the study area show poor local air quality within the centre of Dalry, with concentrations of nitrogen dioxide exceeding the annual mean objective along New Street.

Local Air Quality

7.9.2 The construction works have the potential to create dust. During construction (and earthworks) it would therefore be necessary to apply a package of mitigation measures to minimise dust emission. With these in place, the overall impacts during construction are judged to be *negligible*.

7.9.3 Once operational, the Proposed Scheme would improve air quality within Dalry. In the case of nitrogen dioxide, the Scheme would remove exceedences of the annual mean objective at a number of locations in the centre of the town. Impacts of the Scheme near to the bypass itself would be negligible and so the impacts of the Scheme as a whole would range from *negligible* to *substantial beneficial*. In terms of PM_{10} and $PM_{2.5}$, concentrations would remain below the objectives at all receptors and the impacts would all be *negligible*.

7.9.4 The Scottish Transport Appraisal Guidance balances the number of people who would experience improved air quality against those who would experienced deteriorated air quality and shows that the Proposed Scheme would have an overall beneficial impact on air quality.

7.9.5 The overall operational air quality impacts of the development are thus judged to be *moderate beneficial*.

Regional Air Quality

7.9.6 The Proposed Scheme is predicted to increase the emissions of pollutants from the wider modelled road network. When compared with the traffic emissions from the whole of North Ayrshire, the predicted change is small.

Greenhouse Gases

7.9.7 Two alternative emissions models have been used to quantify the impacts of the Scheme on emissions of carbon dioxide. One shows that the scheme would increase emissions, while the other suggests that it would reduce emissions. Both models use the same traffic data, but treat emissions per vehicle in subtly different ways. In practice, it is considered that any net changes in emissions, either positive or negative, would be so small that they cannot be precisely quantified using available modelling methods.