Dover District Council

Local Plan Air Quality Inputs

Dispersion Modelling Assessment

January 2021

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Contact Details		
Company Name	Bureau Veritas UK Limited	Dover District Council
Contact Name	Hannah Smith	Lauren Coker
Position	Senior Consultant	Senior Planning Policy Officer
Address	5th Floor 66 Prescot Street London E1 8HG	Dover District Council Council Offices White Cliffs Business Park Whitfield Dover CT16 3PJ
Telephone	020 7661 0774	01304 872 407
e-mail	hannah.smith@uk.bureauveritas.com	lauren.coker@dover.gov.uk
Websites	www.bureauveritas.co.uk	www.dover.gov.uk

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	Name	Job Title	Signature
Prepared By	P Stockton	Graduate Consultant	
Approved By	H Smith	Senior Consultant	

Bureau Veritas UK Limited
5th Floor, 66 Prescot Street
London
E1 8HG

Telephone: +44 (0) 161 446 4600
Registered in England 1758622
www.bureauveritas.co.uk

Registered Office
Suite 206 Fort Dunlop
Fort Parkway
Birmingham B24 9FD

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Executive Summary

Bureau Veritas UK Ltd has been commissioned by Dover District Council to complete an Air Quality Assessment to supplement the Council's New Local Plan for future development across the district over the next 20 years.

The assessment considered exposure of existing residential and ecological receptors, alongside new development receptors to concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}), using the Cambridge Environmental Research Consultants ADMS-Roads™ dispersion model (version 5.0).

Implementation of the Local Development Plan has a negligible effect upon annual mean concentrations of NO_2 and PM_{10} at most receptor locations. However, there were some receptor locations that have been associated with slight or moderate adverse effects and one predicted exceedance of the NO_2 AQS objective, associated with the Dover Waterfront development. However, the predicted exceedance was also reported in the Do Minimum scenario and the increase in NO_2 associated with the implementation of the Local Plan was only 0.5µg/m^3 at this location. Consideration should be given to the proposed use of the Dover Waterfront development to avoid introduction of receptors to an area of poor air quality. Although there were significant increases at some receptor locations associated with implementation of the Local Development Plan, no exceedances of the AQS objective for PM_{10} were reported for all receptor locations. Therefore, provided the mitigation measures are followed, the impact on local air quality conditions arising from increased traffic flows as a result of the implementation of the Local Development Plan can be described as **not significant** with regards to human receptors.

The assessment also considered the contribution towards CO_2 emissions in Dover as a result of the implementation of the Local Development Plan. There is a predicted increase of 15.9kt CO_2/year under the DS scenario when compared to the DM scenario, equating to an increase of 10%. This suggests that the planned local development across the region will have an impact on the district's CO_2 contribution from the transport sector. In order to reduce overall CO_2 emissions within the borough, a borough wide approach is required that targets all areas of the borough rather than transport emissions alone.

The assessment has also considered emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. When considering nutrient nitrogen deposition, NO_x PECs are above the relevant AQS respective assessment metric at one receptor location, ER46 (located within Thanet Coast & Sandwich Bay) however, the process contribution attributed to the Local Development Plan is below 1µg m^{-3} at all receptor locations. Regarding the nitrogen deposition rates and acid deposition rates, there are exceedances of the CL_{min} at all sites. However, in each case the background deposition rate alone exceeds the CL_{min} prior to the addition of the road contribution. Each of the exceedances are therefore primarily attributed to the background deposition rate. NOx impacts on ecological receptors from the road contribution can therefore be regarded as **not significant**.

1. Introduction

Bureau Veritas UK Ltd has been commissioned by Dover District Council ('the Council' / DDC) to complete a detailed dispersion modelling assessment to inform the Council's New Local Plan for development across the district that covers the period of 2020 to 2040.

The Housing and Economic Land Availability Assessment (HELAA) has identified multiple sites across the District that are suitable, available and achievable for housing and economic development uses over the Plan period to 2040. Additionally an Employment Site Assessment has identified additional sites for development for employment purposes. The dispersion modelling assessment has been undertaken to assess the impact of the proposed development sites on the air quality that current and future residents will be subject to.

The HELAA and Employment Site locations are illustrated in Figure 3-1.

1.1 Scope of Assessment

Extensive analysis of the transport impacts of the proposed developments has already been undertaken. Based upon the requirements provided by the Council the main objectives of this assessment are as follows:

- To model future NO_2 and PM_{10} annual mean concentrations in order to ascertain the likely air quality impacts associated with the allocation of land for housing;
- Quantify any likely air quality impacts associated with housing developments taking place on the proposed land allocations across Dover and provide recommendations for mitigation;
- Consideration of internationally designated sites and sensitive ecological receptor locations to determine whether they will be negatively impacted by any proposed development in the region;
- To assess the overall CO_2 emissions that are associated with the modelled total traffic flows.

The approach adopted in this assessment to evaluate the impact of road traffic emissions on air quality has utilised Cambridge Environmental Research Consultants (CERC) ADMS-Roads™ dispersion model (version 5.0) with the latest vehicle emission factors released by the Department for Environment, Food and Rural Affairs (Defra) Emissions Factors Toolkit (EFT) version 10.1, focusing on NO_2 and PM_{10}. These pollutants are the main pollutants of concern associated with traffic emissions for comparison against the relevant Air Quality Standard (AQS) objectives, both nationally and within the Council's administrative area. The EFT has also been used to calculate the total CO_2 emissions generated as a consequence of total traffic flows modelled within Dover. Further general information in relation to these pollutants and urban pollution is provided in Appendix A.

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance and tools provided by Defra (LAQM TG(16)[1]) have been used where relevant.

[1] LAQM Technical Guidance LAQM TG(16) – February 2018. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

2. Air Quality – Legislative Context

2.1 Air Quality Strategy

The importance of existing and future pollutant concentrations can be assessed in relation to the national air quality standards and objectives established by Government. The Air Quality Strategy (AQS)[2] provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the UK Government and Devolved Administrations to protect human health. The air quality objectives incorporated in the AQS and the UK Legislation are derived from Limit Values prescribed in the EU Directives transposed into national legislation by Member States.

The CAFE (Clean Air for Europe) programme was initiated in the late 1990s to draw together previous directives into a single EU Directive on air quality. The CAFE Directive[3] has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive[4]. The Directive introduces new obligatory standards for $PM_{2.5}$ for National Government but places no statutory duty on Local Governments to work towards achievement of these standards.

The Air Quality Standards (England) Regulations[5] 2010 came into force on 11 June 2010 in order to align and bring together in one statutory instrument the UK Government's obligations to fulfil the requirements of the new CAFE Directive.

The objectives for ten pollutants – benzene (C_6H_6), 1,3-butadiene (C_4H_6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), particulate matter - PM_{10} and $PM_{2.5}$, ozone (O_3) and Polycyclic Aromatic Hydrocarbons (PAHs), have been prescribed within the AQS[2].

The EU Limit Values are considered to apply everywhere with the exception of the carriageway and central reservation of roads and any location where the public do not have access (e.g. industrial sites).

The AQS objectives apply at locations outside buildings or other natural or man-made structures above or below ground, where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period. Typically these include residential properties and schools/care homes for long-term (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives. Table 2-1, taken from LAQM TG(16)[1], provides an indication of those locations that may or may not be relevant for each averaging period.

This assessment focuses on NO_2 and PM_{10} as these are the pollutants of most concern within the Council's administrative area. Moreover, as a result of traffic pollution the UK has failed to meet the EU Limit Values for NO_2 by the 2010 target date. Therefore, as a result, the UK Government has submitted time extension applications for compliance with the EU Limit Values; continued failure to achieve these limits may lead to EU fines.

In July 2017, the UK Government published its plan for tackling roadside NO_2 concentrations, which are, in many places within the UK, in exceedance of the EU Limit Values. This sets out UK Government policies for bringing NO_2 within statutory limits in the shortest possible time. Following on from the 2017 publication, the draft Clean Air Strategy was published in 2018, with the final version being published in January 2019. The strategy outlines how the UK will meet international

[2] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland.

[3] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[4] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic hydrocarbons in ambient air.

[5] The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.

commitments to significantly reduce emissions by 2020 and 2030 under the adopted revised National Emissions Ceiling Directive (NECD), with a focus on five of the most damaging air pollutants. The five pollutants cited are fine particulate matter, ammonia, nitrogen oxides, sulphur dioxide, and non-methane volatile organic compounds.

The AQS objectives for the pollutants that the assessment focuses on are presented in Table 2-2.

Table 2-1 – Examples of where the AQS Objectives should apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24-hour mean and 8-hour mean	All locations where the annual mean objectives would apply, together with hotels. Gardens or residential properties[1].	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer.	

Notes:
[1] For gardens and playgrounds, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

Table 2-2 – Relevant AQS Objectives for the Assessed Pollutants in England

Pollutant	AQS Objective	Concentration Measured as:	Date for Achievement
Nitrogen Dioxide (NO_2)	200 µg/m³ not to be exceeded more than 18 times per year	1-hour mean	31 December 2005
	40 µg/m³	Annual mean	31 December 2005
Particulate Matter (PM_{10})	50 µg/m³ not to be exceeded more than 35 times per year	24-hour mean	31 December 2010
	40 µg/m³	Annual mean	31 December 2010

2.2 National Planning Policy

The National Planning Policy Framework[6] (NPPF) was published in March 2012 and revised in February 2019. The framework details the English Government's vision for growth in England, outlining the need to favour sustainable development. One of the overarching objectives for achieving sustainable development is the environmental objective:

"to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy."

With regard to air quality, the NPPF additionally states:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas.

... Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

The Planning Practice Guidance (PPG), updated in November 2019, provides further detail about the assessment of air quality effects and when an air quality assessment is required. It states:

"As well as having direct effects on public health, habitats and biodiversity, … pollutants can combine in the atmosphere to form ozone, a harmful air pollutant (and potent greenhouse gas) which can be transported great distances by weather systems.

… 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, or where the need for emissions reductions has been identified.

…Whether 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 have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species). Air quality may also be a material consideration if the proposed development would be particularly sensitive to poor air quality in its vicinity."

2.3 Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995[7] places a statutory duty on local authorities to periodically Review and Assess the current and future air quality within their area, and determine whether they are likely to meet the AQS objectives set down by Government for a number of pollutants – a process known a Local Air Quality Management (LAQM). The AQS objectives that apply to LAQM are defined for seven pollutants: benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and particulate matter.

Where the results of the Review and Assessment process highlight that problems in the attainment of health-based objectives for air quality will arise, the authority is required to declare an Air Quality Management Area (AQMA) – a geographic area defined by high concentrations of pollution and exceedances of health-based standards.

[6] National Planning Policy Framework. Published February 2019. Available at : https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

[7] Part IV of the Environment Act 1995. Published by the UK Government, 1st February 1996. Available at: http://www.legislation.gov.uk/ukpga/1995/25/part/IV

Where an authority has declared an AQMA, and development is proposed to take place either within or near the declared area, further deterioration to air quality resulting from a proposed development can be a potential barrier to gaining consent for the development proposal. Similarly, where a development would lead to an increase of the population within an AQMA, the protection of residents against the adverse long-term impacts of exposure to existing poor air quality can provide the barrier to consent. As such, following an increased number of declarations across the UK, it has become standard practice for planning authorities to require an air quality assessment to be carried out for a proposed development (even where the size and nature of the development indicates that a formal Environmental Impact Assessment (EIA) is not required).

One of the objectives of the LAQM regime is for local authorities to enhance integration of air quality into the planning process. Current LAQM Guidance recognises land-use planning as having a significant role in terms of reducing population exposure to elevated pollutant concentrations. Generally, the decisions made on land-use allocation can play a major role in improving the health of the population, particularly at sensitive locations – such as schools, hospitals and dense residential areas.

2.4 Local Planning Policy

A number of local policy documents set out measures that relate to air quality, namely:

- Core Strategy (to be replaced by new Local Plan)[8]
- Saved Policies from the Dover District Local Plan (Adopted 2002, currently being updated)[9]
- Land Allocations Local Plan (Adopted 2015, to be replaced by new Local Plan)[10]
- Dover Transport Strategy (2007 – currently being updated)[11]
- The Local Transport Plan for Kent[12]
- Kent Environment Strategy[13]
- Kent and Medway Energy and Low Emissions Strategy (June 2020)[14]

Principal among these is the Dover Core Strategy, which is the District's key plan in the local development framework up to 2026. The core policies within the plan specifically addressing air quality are as follows:

Policy CP7 – Green Infrastructure Network – protecting and enhancing the existing network of green infrastructure. Proposals that would introduce additional pressure on the existing and proposed green infrastructure network are only permitted if they incorporate quantitative and qualitative measures, as appropriate, sufficient to address that pressure. Air quality monitoring will be used to help assess the need for mitigation measures and, if required, establish the nature of those measures.

[8] Core Strategy (2010) https://www.dover.gov.uk/Planning/Planning-Policy-and-Regeneration/Adopted-Development-Plans/Core-Strategy.aspx

[9] http://dover.devplan.org.uk/document.aspx?document=26&display=contents

[10] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Land-Allocations/Land-Allocations.aspx

[11] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Evidence-Base/Studies/TRANSDoverTransportStrategy.pdf

[12] http://www.kent.gov.uk/about-the-council/strategies-and-policies/transport-and-highways-policies/local-transport-plan

[13] http://www.kent.gov.uk/about-the-council/strategies-and-policies/environment-waste-and-planning-policies/environmental-policies/kent-environment-strategy

[14] https://www.kent.gov.uk/__data/assets/pdf_file/0009/112401/Kent-and-Medway-Energy-and-Low-Emissions-Strategy.pdf

Policy CP8 – Dover Waterfront – Planning permission only granted along the waterfront provided the proposals incorporate avoidance and mitigation measures to address impact on air quality issues associated with the A20 trunk road and the Port operations.

A second key facet of Dover's strategy towards air quality is its participation in the Kent and Medway Air Quality Partnership (KMAQP), which aims to co-ordinate efforts across the numerous districts and boroughs in the region to improve air quality. As part of this, the partnership prepared Air Quality Planning Guidance (options A and B) aimed at providing clarity and consistency of approach for developers, the local planning authority and local communities. The two approaches differ only slightly in their approach to mitigation. As part of this, an annual review is also published tracking trends and changes across the region, which gives the Council an appreciation of the impact improvement measures are having in a wider context. Working with the partnership, the Council has been able to implement further direct measures to improve air quality, as referenced in the Council's 2020 Annual Status Report.

2.5 Air Quality and Planning

The Kent and Medway Air Quality Partnership published Air Quality Planning Guidance (Mitigation Options A and B) in December 2015[15]. This guidance is available as technical guidance or for use as a Supplementary Planning document. The aim of the document is to provide advice for developers and their consultants on addressing local air quality when making a planning application.

The guidance initially provides detail on when an air quality assessment is required to accompany a planning application, and following this provides a comprehensive overview of the approach(es) to be taken within any air quality assessment to be completed.

The key concern with regard to the air quality impacts of a development is the likely effect on human health. It is important that an air quality assessment evaluates modelled air quality in terms of changes in pollution concentrations where there is relevant public exposure. The local authority may also need to consider the impact of the development on air quality in neighbouring authorities.

In addition to the Kent and Medway Air Quality Planning Guidance, the EPUK/IAQM Guidance details the magnitude of impact due to an increase in annual mean NO_2, PM_{10} and other pollutants, using the criteria in Table 2-3.

Table 2-3 – Impact Descriptors for Changes in Pollutant Concentrations at a Receptor

Long term average concentration at receptor at receptor in assessment year	Change in Concentration relative to Air Quality Assessment Level (AQAL)			
	1% [a]	2-5%	6-10%	>10%
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Explanation

1. 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)'.
2. The Table is intended to be used by rounding the change in percentage pollutant concentration to whole numbers, which then makes it clearer which cell the impact falls within. The user is encouraged to read the numbers with recognition of their likely accuracy and not assume a false level of precision. Changes of 0%, i.e. less than 0.5% will be described as Negligible.
3. The Table is only deigned to be used with annual mean concentrations.
4. Descriptors for individual receptors only; the overall significance is determined using professional judgement. For example, a 'moderate' adverse impact at one receptor may not mean that the overall impact has a significant effect. Other factors need to be considered.

[15] Kent and Medway Air Quality Planning Guidance http://kentair.org.uk/home/text/66

5. When defining the concentration as a percentage of the AQAL, use the 'without scheme' concentration where there is a decrease in pollutant concentration and the 'with scheme' concentration for an increase.
6. The total concentration categories reflect the degree of potential harm by reference to the AQAL value. At exposure levels less than 75% of this value, i.e. well below, the degree of harm is likely to be small. As the exposure approaches and exceeds the AQAL, the degree of harm increases. This change naturally becomes more important when the result is an exposure that is approximately equal to, or greater than the AQAL.
7. It is unwise to ascribe too much accuracy to incremental changes or background concentrations, and this is especially important when total concentrations are close to the AQAL. For a given year in the future, it is impossible to define the new total concentration without recognising the inherent uncertainty, which is why there is a category that has a range around the AQAL, rather than being exactly equal to it.

The impact descriptors are consistent with all other areas of the UK and are applicable to air quality assessments that are quantifying potential development impacts. These descriptors, and all relevant sections within the Kent and Medway Air Quality Planning Guidance will be taken into account within the assessment.

2.6 Climate Change Emissions

Although these pollutants are not included in the Air Quality Regulations for Local Air Quality Management, they are of global importance for their contribution to climate change. Many policies that reduce traffic flow will tend to bring about reductions in both carbon dioxide (CO_2) and local air pollutants. However, although these pollutants are closely linked, it cannot be assumed that this will be the case for all measures. As a result, it is important to consider total CO_2 emissions alongside air quality assessments. The integration of climate change policies within the planning process is currently an evolving area with local authorities recognised to be at different stages of incorporating climate change policies into their general practices.

Local authorities have a responsibility to help secure progress on meeting the UK's emissions reduction targets, both through direct influence on energy use and emissions (by, for instance, encouraging renewable energy and promoting low-carbon modes of travel) and by bringing others together and encouraging co-ordinated local action. The UK emissions reduction targets are listed through the 2008 Climate Change Act, which has committed the government to:

- Reduce emissions by at least 80% of 1990 levels by 2050; and
- Contribute to global emissions reductions, to limit global temperature rise to as little as possible above 2ºC.

2.7 Critical Loads Relevant to the Assessment of Ecological Receptors

The APIS website provides specific information on the potential effects of nitrogen and acid deposition on various habitats and species. This information, relevant to habitats of some of the ecological receptors considered in this assessment, is presented in Table 2-4.

Table 2-4 - Typical Habitat and Species Information Concerning Nitrogen Deposition from APIS

Habitat and Species Specific Information	Critical Load (kg N ha^{-1} yr^{-1})	Specific Information Concerning Nitrogen Deposition
Saltmarsh	30-40	Many saltmarshes receive large nutrient loadings from river and tidal inputs. It is unknown whether other types of species-rich saltmarsh would be sensitive to nitrogen deposition.
Littoral Sediments	20-30	Increase in late-successional species, increased productivity but only limited information available for this type of habitat.
Coastal Stable Dune Grasslands	10-20	Increase late successional species, increase productivity increase in dominance of graminoids.
Alkaline Fens and Reed beds	10-35	Foredunes receive naturally high nitrogen inputs. Key concerns of the deposition of nitrogen in these habitats relate to changes in species composition.
Temperate and boreal forests	10-20	Nitrogen deposition provides fertilization. Increase in tall graminoids (grasses or Carex species) resulting in loss of rare species and decrease in diversity of subordinate plant species.
Hay Meadow	20-30	Increased nitrogen deposition in mixed forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth. Also can reduce the diversity of species due to increased growth rates of more robust plants.
Acid Grasslands	10-25	The key concerns are related to changes in species composition following enhanced nitrogen deposition. Indigenous species will have evolved under conditions of low nitrogen availability. Enhanced Nitrogen deposition will favour those species that can increase their growth rates and competitive status e.g. rough grasses such as false brome grass (Brachypodium pinnatum) at the expense of overall species diversity. The overall threat from competition will also depend on the availability of propagules
Raised bog and blanket bog	5-10	Nitrogen deposition provides fertilization to acid grasslands, this increase robust grass growth that may limit other species reducing diversity.
Oak Woodland	10-15	Nitrogen deposition provides fertilization, this increase robust vegetation growth that may limit other species reducing diversity

3. Review and Assessment of Air Quality Undertaken by the Council

3.1 Local Air Quality Management

The Council, under its obligations in Part IV of the Environment Act 1995, has maintained a thorough annual review and assessment of air quality through their statutory reporting, the most recent report (2020) can be found on the air quality section of the Councils website[16].

The Council have two declared AQMAs; A20 AQMA, declared in 2004 and amended in 2007 and 2009, and High Street/Ladywell AQMA, declared in 2007. Both AQMAs were designated due to exceedances of the annual mean Air Quality Strategy objective for concentrations of NO_2, caused primarily by traffic emissions.

3.2 Review of Air Quality Monitoring

3.2.1 Local Air Quality Monitoring

The most recent LAQM report the Council has published is the 2020 Air Quality Annual Status Report (ASR), inclusive of 2019 monitoring data that has been used in this assessment. In 2019 the Council undertook automatic continuous monitoring at one location, measuring PM_{10} and in addition NO_2 was monitored at 17 locations using passive diffusion tubes.

Details of monitoring locations across Dover, and the relevant 2019 pollutant concentrations are presented in Table 3-1, and Table 3-2. Two passive monitoring locations were not included in the modelling assessment: the urban background site DV04, due to the distance from modelled roads, and DV30 due to low data capture. Figure 3-1 shows a visual representation of the monitoring locations used within the assessment referenced against the AQMAs, future development sites and the modelled road links, as detailed in Section 4.

It can be seen from the 2019 monitoring results that there was only one exceedance of the annual mean AQS objective for NO_2 and no exceedances for PM_{10}. The exceedance was recorded at DV30, which has not been used in the assessment due to low data capture (50%). The highest NO_2 concentration at the monitoring sites used within the assessment, was recorded at the triplicate site DV06/07/08, which is located within the High Street/Ladywell AQMA.

Table 3-1 – 2019 Dover PM_{10} Continuous Monitoring

Site ID	Site Type	Data Capture (%)	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Annual Mean Concentration (µg/m³) PM_{10}	PM_{10} Daily Means in Excess of the 24-hour Objective (50µg/m³)
Dover Centre	Roadside	97%	632302	141465	22	8

Table 3-2 – 2019 Dover NO_2 Passive Monitoring

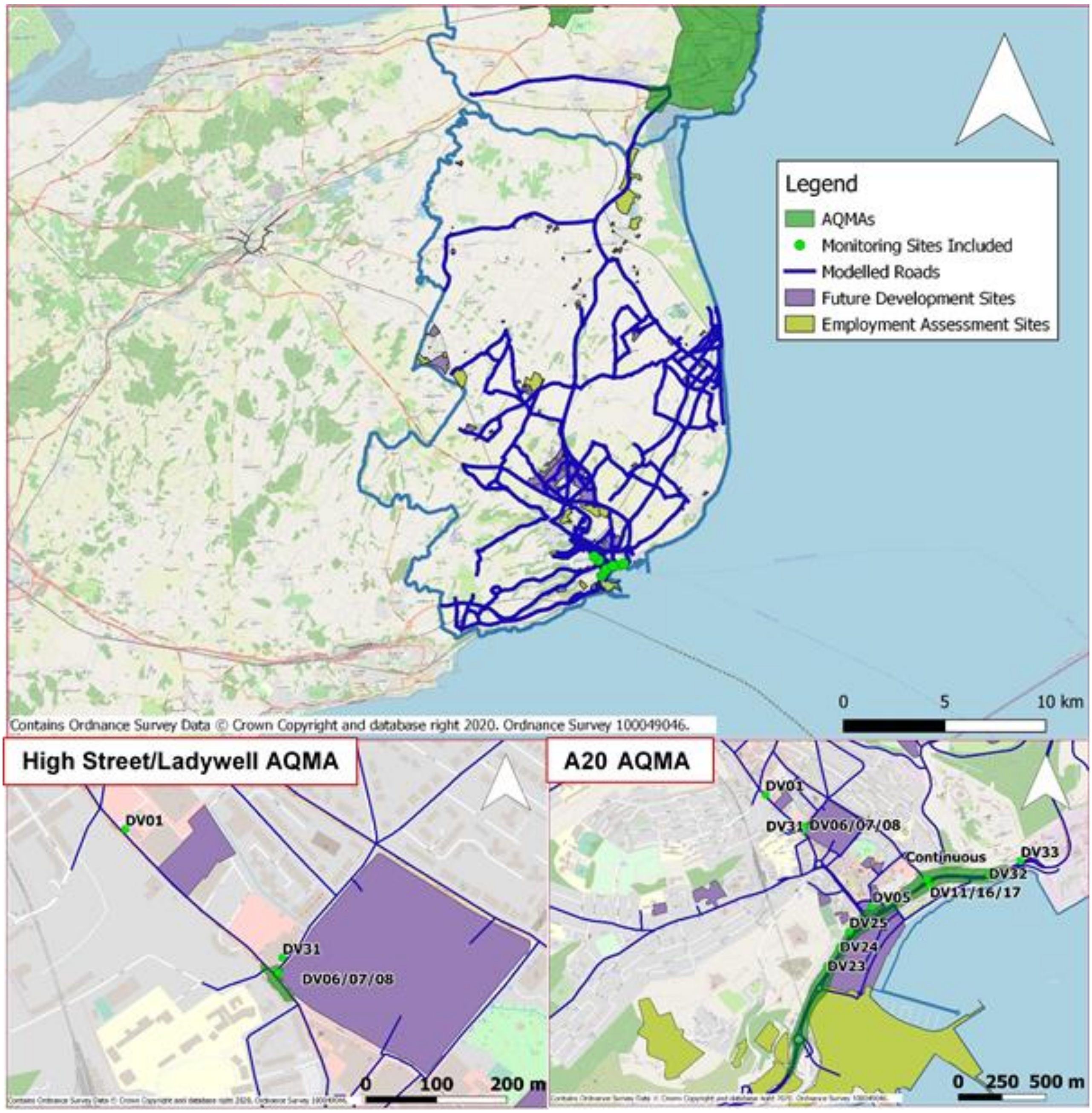
Site ID	Site Type	Data Capture (%)	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	In AQMA	Annual Mean (µg/m³)
DV01	Roadside	92	631376	141949	NO	30.8
DV04	Urban Background	92	630905	143362	NO	15.3
DV05	Urban Centre	92	631997	141296	A20	24.4

16 https://www.dover.gov.uk/Environment/Environmental-Health/Air-Quality/Air-Quality-Monitoring.aspx

Site ID	Site Type	Data Capture (%)	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	In AQMA	Annual Mean (µg/m³)
DV06/ DV07/ DV08	Roadside	92	631597	141748	High St /Ladywell	39.8
DV10	Roadside	83	632302	141465	A20	35.9
DV11/ DV16/ DV17	Roadside	92	632318	141422	A20	28.1
DV12/ DV18/ DV19	Roadside	92	631577	140468	A20	31.5
DV23	Roadside	92	631727	140966	A20	31.2
DV24	Roadside	83	631802	141079	A20	33.7
DV25	Roadside	83	631854	141164	A20	29.3
DV30	Kerbside	50	631550	141772	NO	**40.4**
DV31	Kerbside	83	631602	141771	NO	31.5
DV32	Roadside	92	632646	141496	A20	31.7
DV33	Roadside	75	632836	141572	NO	35.9
DV34	Kerbside	71	633088	158032	NO	25.9
DV35	Kerbside	71	633174	158094	NO	16.1
DV36	Roadside	100	635696	152325	NO	18.5

Exceedances of the objective are shown in bold.

Figure 3-1 – Dover District Council Monitoring Locations used in the Modelling Assessment with Reference to Modelled Roads, AQMAs and Future Development Sites



3.2.2 Background Concentrations

DEFRA maintain a nationwide model of existing and future background air quality concentrations at a 1 km grid square resolution[17]. The data sets include annual average concentration estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$, using a base year of 2018. The model used is semi-empirical in nature; it uses the national atmospheric emissions inventory (NAEI) emissions to model-predict the concentrations of pollutants at the centroid of each 1km grid square, but then calibrates these concentrations in relation to actual monitoring data.

[17] UK AIR Background Mapping Tool. Available at: https://uk-air.defra.gov.uk/data/laqm-background-home

Annual mean background concentrations have been obtained from the Defra published background maps[18], based on the 1km grid squares which cover the modelled area and the affected road network. To avoid double counting of sources, it is necessary to remove road contributions to the background concentrations that are explicitly modelled. As such, Trunk_A_Rd_in and Primary_A_Rd_in sector contributions have been removed. To complete this process the NO_x Sector Removal Tool[19] has been used. The background concentrations used in the modelling assessment are detailed in Table 3-3.

The modelling scenarios as detailed within Section 4 span across two separate years; 2019 as the baseline year and 2040 as the development opening year. Currently background maps are only available up to 2030; therefore for the assessment of 2040 background concentrations, concentrations will be taken from 2030. As background concentrations are expected to improve year on year, the utilisation of 2030 background concentrations provides for a more conservative assessment.

Table 3-3 - Defra Background Map Concentrations used in the Modelling Assessment

Year	Grid Square (E,N)	Background Concentrations Annual Mean Concentration (µg/m^3)		
		NO_2	NO_x	PM_{10}
2019 2030	624500, 138500	9.5 7.2	12.5 9.3	14.3 13.3
2019 2030	626500, 140500	8.9 6.8	11.6 8.7	14.0 13.0
2019 2030	631500, 140500	12.5 9.7	17.0 12.8	14.2 13.2
2019 2030	631500, 141500	12.4 9.7	16.8 12.9	14.7 13.6
2019 2030	630500, 140500	10.1 7.8	13.4 10.1	14.0 13.0
2019 2030	630500, 139500	9.6 7.5	12.6 9.6	13.4 12.5
2019 2030	629500, 141500	9.4 7.3	12.4 9.4	13.6 12.6
2019 2030	629500, 140500	9.1 7.0	11.9 8.9	13.3 12.3
2019 2030	628500, 139500	8.6 6.6	11.2 8.4	14.1 13.1
2019 2030	630500, 144500	10.2 7.8	13.5 10.1	14.5 13.5
2019 2030	630500, 145500	9.6 7.3	12.6 9.4	14.1 13.2
2019 2030	631500, 145500	9.2 7.0	12.0 9.0	13.7 12.8
2019 2030	630500, 146500	8.5 6.6	11.1 8.4	15.1 14.2
2019 2030	630500, 141500	10.8 8.3	14.3 10.8	14.6 13.6
2019 2030	629500, 145500	8.9 6.8	11.7 8.8	14.8 13.8
2019 2030	629500, 144500	9.0 7.0	11.8 8.9	14.1 13.1
2019 2030	628500, 147500	8.4 6.5	10.9 8.3	14.3 13.3
2019 2030	627500, 147500	8.4 6.5	11.0 8.3	14.8 13.9
2019 2030	627500, 146500	8.4 6.5	11.0 8.3	14.9 13.9

[18] Defra Background Maps http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

[19] NOx Sector Removal Tool https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxsector

Year	Grid Square (E,N)	Background Concentrations Annual Mean Concentration (µg/m^3)		
		NO_2	NO_x	PM_{10}
2019 2030	628500, 149500	8.9 6.9	11.6 8.9	13.9 13.0
2019 2030	626500, 148500	8.5 6.6	11.0 8.4	14.7 13.7
2019 2030	632500, 141500	13.0 10.4	17.7 13.8	13.9 12.9
2019 2030	625500, 138500	9.3 7.0	12.1 9.0	13.5 12.5
2019 2030	631500, 142500	11.3 8.8	15.1 11.5	14.4 13.4
2019 2030	632500, 142500	11.3 8.8	15.1 11.5	13.3 12.4
2019 2030	632500, 143500	10.2 7.8	13.4 10.1	13.6 12.6
2019 2030	631500, 146500	9.0 7.0	11.8 8.9	14.8 13.8
2019 2030	628500, 145500	8.7 6.7	11.3 8.6	15.1 14.1

4. Assessment Methodology

The approach applied to this assessment has been based on the following:

- Quantitative prediction of ambient NO_2 and PM_{10} concentrations to which existing and future receptors may be exposed to upon completion of developments in 2040; and

- Quantitative prediction of annual CO_2 emissions upon completion of developments in 2040.

4.1 Operational Effects – Road Traffic Emissions

Emissions from road traffic have been predicted at receptor locations using ADMS-Roads, an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The ADMS-roads software is used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the Environment Agency and local authorities.

The following scenarios have been assessed:

- 2019 Baseline (2019 B) – Without development base flows for the baseline year (2019). Used for model verification;

- 2040 Do Minimum (2040 DM) – Without development flows, but including other committed schemes, for the proposed year of completion (2040); and

- 2040 Do Something (2040 DS) – With development flows, including other committed schemes, for the proposed year of completion (2040).

4.1.1 Traffic Data

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, the proportion of different vehicle classes and vehicle speeds on the local roads. This data was provided by the appointed transport consultant, WSP. The reduction of vehicle speed at junctions is accounted for in the transport model. A desktop study identified multiple street canyons within the central high street area within Dover, thus requiring additional model adjustments.

The Emissions Factors Toolkit (EFT) version 10.1 developed by Defra[20] was then used to determine vehicle emissions for input into the ADMS-Roads model, based upon the traffic data inputs. As 2030 is the latest available year for calculating emission factors, this year was used for the 2040 future year scenarios. The Basic option was used that allowed the input of percentage of Heavy Duty Vehicles (HDVs: Heavy Goods Vehicles (HGVs) and Buses/Coaches with a total unladen weight ≥3.5 tonnes).

Due to the scale of the model, a summary of the traffic data used in this assessment has not been appended to the report but can be provided in Excel format upon request. The modelled road links are presented in Figure 3-1.

4.1.2 Modelled Receptors

All receptors considered in the assessment of emissions from road traffic are presented in Figure 4-1, further information about receptor locations can be provided in Excel-format upon request. Human Receptors (HR) represent existing residential properties across Dover and Thanet, where the receptors have been located on the façades of properties closest to the sources. Development Receptors (DR) relate to each HELAA growth strategy site and define locations that will introduce

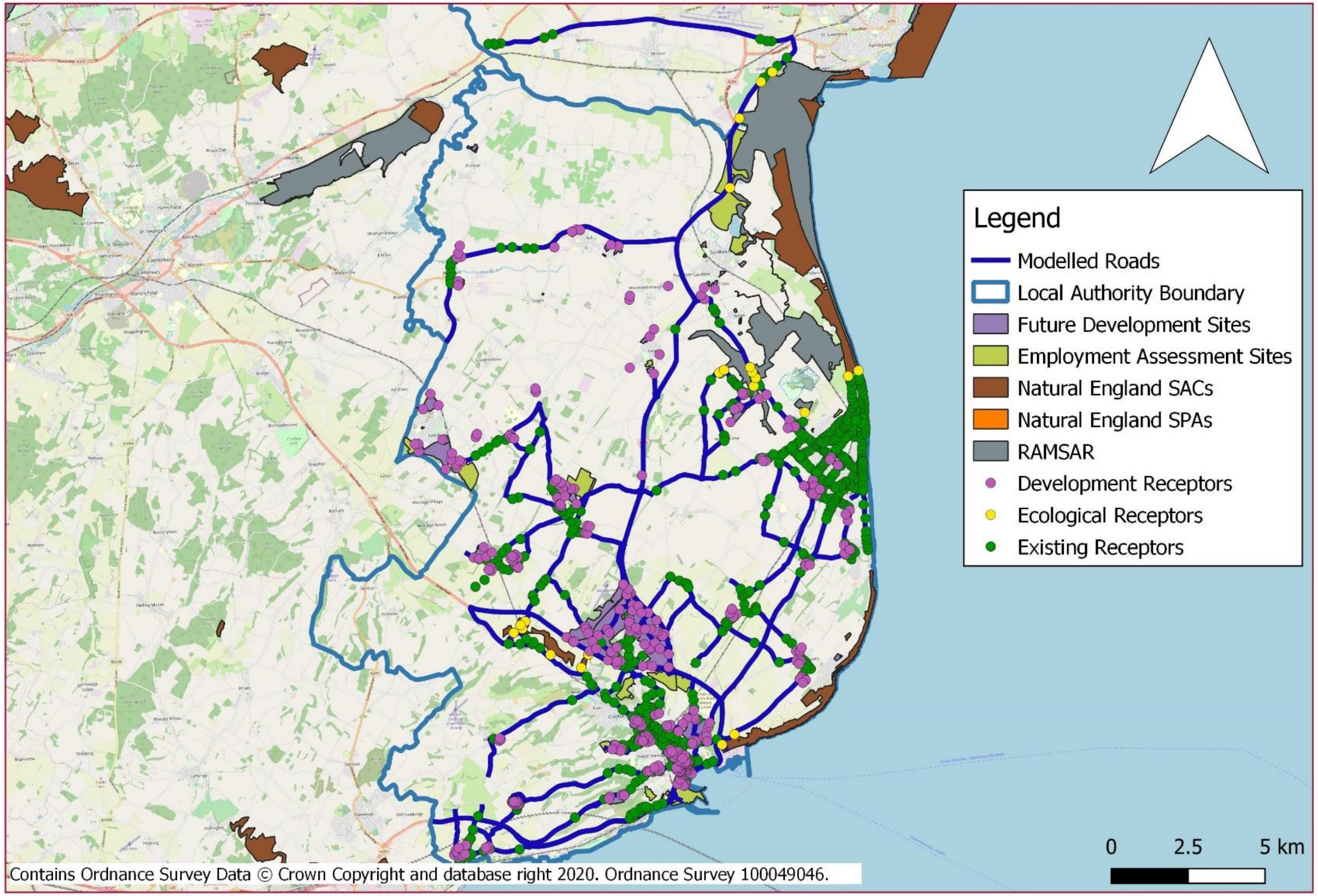
[20] Defra, Emission Factors Toolkit (2020). http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

new receptors at the development locations. Development receptors have not been included at sites that are solely allocated for employment as the Air Quality Strategy objectives do not apply at these locations, see Table 2-1. The ecological receptor points are those within the designated sites that are closest to the road and so are likely to demonstrate the maximum impacts (Table 4-1). It is likely that deposition rates will be at a lower level across the rest of the site. Residential receptors have been modelled at heights typical of human exposure i.e. 2m for ground level and 4m for first level exposure, there are a few exceptions dependant on the location and relevant exposure to the air quality objectives as per Table 2-1.

Table 4-1 - Ecological Receptor Locations

ID	ECO Site	Coordinates		Ecological Designation
		X	Y	
ER1	Dover to Kingsdown Cliffs	633168	142143	SAC
ER5	Dover to Kingsdown Cliffs	633568	142482	SAC
ER8	Lydden & Temple Ewell Downs	628587	144649	SAC
ER9	Lydden & Temple Ewell Downs	628819	145078	SAC
ER10	Lydden & Temple Ewell Downs	627585	145073	SAC
ER13	Lydden & Temple Ewell Downs	626666	145920	SAC
ER14	Lydden & Temple Ewell Downs	626764	146160	SAC
ER15	Lydden & Temple Ewell Downs	626609	146037	SAC
ER18	Lydden & Temple Ewell Downs	626393	145787	SAC
ER22	Thanet Coast & Sandwich Bay	635858	152967	RAMSAR
ER24	Thanet Coast & Sandwich Bay	634483	153468	RAMSAR
ER29	Thanet Coast & Sandwich Bay	634201	153826	RAMSAR
ER30	Thanet Coast & Sandwich Bay	634264	154090	RAMSAR
ER31	Thanet Coast & Sandwich Bay	634148	154278	RAMSAR
ER33	Thanet Coast & Sandwich Bay	634074	154441	RAMSAR
ER37	Thanet Coast & Sandwich Bay	633076	154258	RAMSAR
ER38	Thanet Coast & Sandwich Bay	633235	154349	RAMSAR
ER40	Thanet Coast & Sandwich Bay	637605	154332	SPA / RAMSAR
ER41	Sandwich Bay	637271	154149	SAC
ER43	Thanet Coast & Sandwich Bay	633423	160280	SPA / RAMSAR / SAC
ER45	Thanet Coast & Sandwich Bay	633730	162545	SPA / RAMSAR / SAC
ER46	Thanet Coast & Sandwich Bay	634433	163733	SPA / RAMSAR / SAC
ER48	Thanet Coast & Sandwich Bay	634804	164053	SPA / RAMSAR / SAC

Figure 4-1 – Modelled Road Links and Receptor Locations with respect to Future Development Sites and Ecological Sites

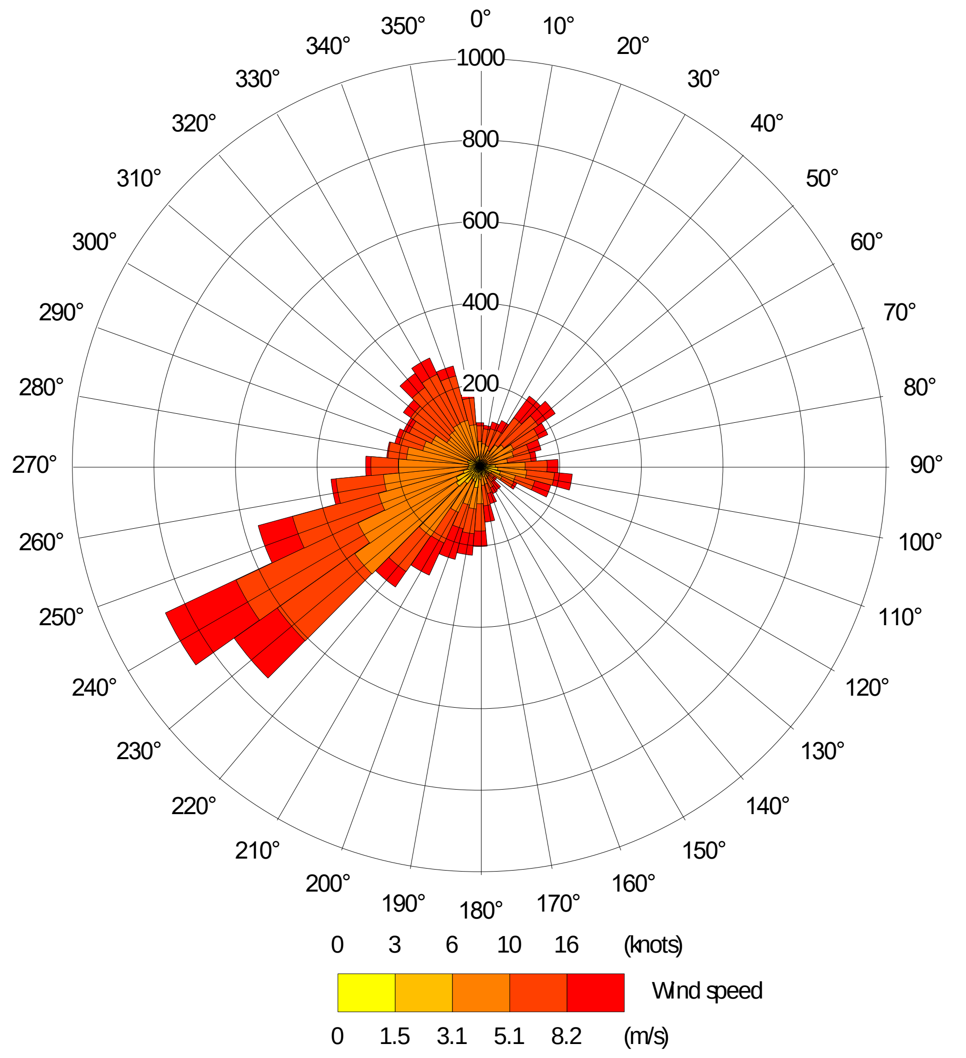


4.1.3 Meteorological Data

Meteorological data from a representative station to the study area is required as input to the dispersion model. 2019 meteorological data from the Langdon Bay weather station has been used in this assessment. A wind rose for this site for the year 2019 is shown in Figure 4-2. Most dispersion models do not use meteorological data if it relates to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75m/s. It is recommended in LAQM.TG(16)[1] that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. LAQM.TG(16) recommends that meteorological data should only be used if the percentage of usable hours is greater than 75%, and preferably 90%. The 2019 meteorological data from Langdon Bay includes 8,760 lines of usable hourly data out of the total 8,760 for the year, i.e. 100% usable data. This is therefore suitable for the dispersion modelling exercise.

A wind rose for this site for the year 2019 is presented in Figure 4-2.

Figure 4-2 – Wind Rose for Langdon Bay 2019 Meteorological Data



4.1.4 Deposition

The predominant route by which emissions will affect land in the vicinity of a process is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds, which can affect the character of the habitat through eutrophication and acidification.

Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging of the material in the plume. These processes lead to a variation with downwind distance of the plume strength and may alter the shape of the vertical concentration profile as dry deposition only occurs at the surface.

Near to sources of pollutants (< 2 km), dry deposition is the predominant removal mechanism (Fangmeier et al. 1994). Dry deposition may be quantified from the near-surface plume concentration and the deposition velocity (Chamberlin and Chadwick, 1953);

$$F_d = v_d C(x, y, 0)$$

where:

F_d = dry deposition flux (μg m^{-2} s^{-1})

v_d = deposition velocity (m s^{-1})

$C(x, y, 0)$ = ground level concentration (μg m^{-3})

Assuming irreversible uptake, the total wet deposition rate is found by integrating through a vertical column of air;

$$F_w = \int_0^z \Lambda C \, dz$$

where;

F_w = wet deposition flux (μg m^{-2} s^{-1})

Λ = washout co-efficient (s^{-1})

C = local airborne concentration (μg m^{-3})

z = height (m)

The washout co-efficient is an intrinsic function of the rate of rainfall.

Environment Agency guidance AQTAG06 (Environment Agency, 2014) recommends deposition velocities for various pollutants, according to land use classification (Table 4-2).

Table 4-2 - Recommended Deposition Velocities

Pollutant	Deposition Velocity (m s^{-1})	
	Short Vegetation	Long Vegetation/Forest
NO_x	0.0015	0.003

Source: Environment Agency (2014) 'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air', AQTAG06 Updated Version (March 2014)'

In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been created. These are generally defined as (e.g., Nilsson and Grennfelt, 1988):

> *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration of a material in air. The UK Air Pollution Information System (APIS) provides critical load data for ecological sites in the UK.

The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (kg N ha^{-1} y^{-1}) and kilo equivalents deposited per hectare per year (keq ha^{-1} y^{-1}). To enable a direct comparison against the critical loads, the modelled total wet and dry deposition flux (µg m^{-2} s^{-1}) must be converted into an equivalent value.

For a continuous release, the annual deposition flux of nitrogen can be expressed as:

$$F_{NTot} = \left(\frac{K_2}{K_3}\right) \cdot t \cdot \sum_{i=1}^{T} F_i \left(\frac{M_N}{M_i}\right)$$

where:

F_{NYot} = Annual deposition flux of nitrogen (kg N ha^{-1} y^{-1})

K_2 = Conversion factor for m^2 to ha (= 1x104 m^2 ha^{-1})

K_3 = Conversion factor for µg to kg (= 1x109 µg kg^{-1})

t = Number of seconds in a year (= 3.1536x107 s y^{-1})

i = 1,2,3…….T

T = Total number of nitrogen containing compounds

F = Modelled deposition flux of nitrogen containing compound (µg m^{-2} s^{-1})

M_N = Molecular mass of nitrogen (kg)

M = Molecular mass of nitrogen containing compound (kg)

The unit eq (1 keq ≡ 1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Conversion units are provided in AQTAG(06):

- 1 keq ha^{-1} y^{-1} = 14 kg N ha^{-1} y^{-1}
- 1 keq ha^{-1} y^{-1} = 16 kg S ha^{-1} y^{-1}

For the purposes of this assessment, dry deposition rates of nitrogen and acidic equivalents at the identified ecological receptors have been calculated by applying the 'short vegetation' deposition velocities (as detailed in Table 4-2) to the modelled annual mean concentrations of NO_x. Wet deposition has not been assessed since this is not a significant contributor to total deposition over shorter ranges (Fangmeier et al. 1994; Environment Agency, 2006).

Estimated background deposition rates of nutrient nitrogen and total acid deposition for the UK are available via the Air Pollution Information Service (APIS) website (http://www.apis.ac.uk). Table 4-3 provides the estimated deposition rates for the ecological receptors considered in this study, as obtained from the APIS website. It should be noted that the level of uncertainty associated with these modelled estimates is relatively high and the results are presented from the model across the UK on a coarse 5km grid square resolution.

Table 4-3 - Estimated Background Deposition Rates

ID	Background Nitrogen Deposition (kg N ha-1 y-1)	Background Nitric Acid Deposition (keq ha-1 y-1)
ER1	15.3	1.1
ER5	15.3	1.1
ER8	16.5	1.2
ER9	18.3	1.3
ER10	18.3	1.3
ER13	18.3	1.3
ER14	18.3	1.3
ER15	18.3	1.3
ER18	18.3	1.3
ER22	13.3	1.0
ER24	16.2	1.2
ER29	16.2	1.2
ER30	16.2	1.2
ER31	16.2	1.2
ER33	16.2	1.2
ER37	16.2	1.2
ER38	16.2	1.2
ER40	13.3	1.0
ER41	13.3	1.0
ER43	13.2	0.9
ER45	13.2	0.9
ER46	13.2	0.9
ER48	13.2	0.9
Source: Air Pollution Information Service (APIS) website (http://www.apis.ac.uk)		

4.1.5 Surface Roughness

Roughness length, z_0, represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. CERC (2020)[21] suggests typical roughness lengths for various land use categories (Table 4-4).

Table 4-4 – Typical Surface Roughness Lengths for Various Land Use Categories

Land Use	Surface Roughness: z_0 (m)
Large urban areas	1.5
Cities, woodlands	1.0
Parkland, open suburbia	0.5
Agricultural areas (max.)	0.3
Agricultural areas (min.)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005
Sea	0.0001

Increasing the surface roughness length increases turbulent mixing in the lower boundary layer. This can often have conflicting impacts in terms of ground level concentrations:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; and
- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated to the distance and orientation of a receptor from the emission source.

Surface roughness length is entered within the model for both the dispersion site (the model domain), and for the location of where the meteorological data has been measured. As detailed above in Section 4.1.3, the meteorological data utilised within the modelling has been taken from the Langdon bay station. The weather station is located within mixed-use open grassland and agricultural land with the sea to the south, approximately 4km south east of Dover town centre. Given the variability of land types at this location, the surface conditions at this location have been defined as the median value, 0.02, which is open grassland.

The surface roughness length for the model domain has been defined as 1.0, which is representative of the built-up areas within Dover.

[21] CERC, ADMS-Roads V5.0 User Guide (2020).

4.1.6 Minimum Monin-Obukhov Length

A Minimum Monin-Obukhov Length is used as a model input within ADMS Roads as a parameter to describe the turbulent length scale, which is dependent on meteorological conditions. A minimum length can be used to account for the urban heat island effect, whereby retained heat in cities causes convective turbulence, which prevents the formation of a very shallow boundary layer at night.

Table 4-5 – Typical Minimum Monin-Obukhov Length for Various Land Use Categories

Type of Surface	Minimum Monin-Obukhov Length
Large Conurbations > 1 million	100
Cities and Large Towns	30
Mixed Urban / Industrial	30
Small Towns < 10,000	10

In accordance with CERC's ADMS Roads user guide[21], a minimum Monin-Obukhov Length of 30m will be used for the ADMS Roads model to reflect the local topography of the overall model domain.

4.1.7 Model Outputs

The background pollutant values discussed in Section 3.2.2 have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x, NO_2 and PM_{10}.

For the prediction of annual mean NO_2 concentrations for the modelled scenarios, the output of the ADMS-Roads modelled for road-NO_x has been converted to total-NO_2 following the methodology in LAQM.TG(16) and using the NO_x to NO_2 conversion tool developed on behalf of Defra. This tool also utilises the total background NO_x and NO_2 concentrations. This assessment has utilised version 8.1 (August 2020) of the NO_x to NO_2 conversion tool. The road contribution is then added to the appropriate NO_2 background concentration value to obtain an overall total NO_2 concentration.

For the prediction of short term NO_2 impacts, LAQM.TG(16) advises that it is valid to assume that exceedances of the 1-hour mean AQS objective for NO_2 are only likely to occur where the annual mean NO_2 concentration is 60µg/m^3 or greater. This approach has thus been adopted for the purposes of this assessment.

Annual mean PM_{10} road contributions were also output from the model and processed in a similar manner, i.e. combined with the relevant background annual mean PM_{10} concentrations to obtain overall total PM_{10} concentrations.

For the prediction of short term PM_{10}, LAQM.TG(16) provides an empirical relationship between the annual mean and the number of exceedances of the 24-hour mean AQS objective for PM_{10} that can be calculated as follows:

$$Number\ of\ 24\ hour\ Mean\ Exceedences = -18.5 + 0.00145 * annual\ mean^3 + \frac{206}{annual\ mean}$$

This relationship has been adopted to determine whether exceedances of short-term PM_{10} AQS objective are likely in this assessment.

Verification of the modelled concentrations has been undertaken using 11 monitoring locations operated by the Council, in two separate domains, consisting of 11 NO_2 diffusion tubes in total. One verification domain used three monitoring locations and consisted of the central High Street area, distinguished by the presence of street canyons. The other eight monitoring locations formed the A20 verification domain, which was used for model-wide verification. All NO_2 and PM_{10} results presented in the assessment are those calculated following the process of model verification.

Full details of the model verification completed can be found in Appendix B.

4.2 Uncertainty

Due to the number of inputs that are associated with the modelling of the study area there is a level of uncertainty that has to be taken into account when drawing conclusions from the predicted concentrations of NO_2 and PM_{10}. The predicted concentrations are based upon a number of inputs from a number of different sources; traffic data, background concentrations, emission factors, meteorological data and availability of monitoring data from the assessment areas.

A degree of quality assurance/quality control (QA/QC) is completed throughout the modelling process, though the inputs, modelled outputs, and processing of results, to ensure that the accuracy of the modelled predictions is of a high standard to allow conclusions to be made upon them.

4.2.1 Uncertainty in NO_x and NO_2 Trends

Analyses of historical monitoring data within the UK has identified a disparity between measured concentration data and the projected decline in concentrations associated with emission forecasts for future years[22]. The report identifies that trends in ambient concentrations of NO_x and NO_2 in many urban areas of the UK have generally shown two characteristics; a decrease in concentration from about 1996 to 2002-2004, followed by a period of more stable concentrations from 2002-2004 up until 2009. Trends in more rural, less densely trafficked areas, tend to show downward trend in either NO_x or NO_2, which are more in line with those expected.

The reason for this disparity is thought to be related to the actual on-road performance of vehicles, in particular diesel cars and vans, when compared with calculations based on the Euro emission standards. Preliminary studies suggest the following:

- NO_x emissions from petrol vehicles appear to be in line with current projections and have decreased by 96% since the introduction of 3-way catalysts in 1993;

- NO_x emissions from diesel cars, under urban driving conditions, do not appear to have declined substantially, up to and including Euro 5. There is limited evidence that the same pattern may occur for motorway driving conditions; and

- NO_x emissions from HDVs equipped with Selective Catalytic Reduction (SCR) are much higher than expected when driving at low speeds.

This disparity in the historical national data highlights the uncertainty of future year projections of both NO_x and NO_2.

Defra and the Devolved Administrations have investigated these issues and have since published an updated version of the Emissions Factors Toolkit (EFT Version 10.1) utilising COPERT 5.3 emission factors, which may go some way to addressing this disparity, but it is considered possible that a gap still remains. This assessment has utilised the latest EFT version 10.1 and associated tools published by Defra to help minimise any associated uncertainty when forming conclusions from this assessment.

[22] Carslaw, D, Beevers, S, Westmoreland, E, Williams, M, Tate, J, Murrells, T, Steadman, J, Li, Y, Grice, S, Kent, A and Tsagatakis, I. 2011. Trends in NO_x and NO_2 emissions and ambient measurements in the UK. Prepared for Defra, 18th July 2011.

5. Air Quality Modelling Results – Human Receptors

This assessment has considered emissions of NO_x/NO_2 and PM_{10} from road traffic at existing receptor locations (HR), new receptor locations relating to the proposed developments (DR) and ecological receptors (ER). Predictions of concentrations have been carried out for three scenarios, as outlined in Section 4.1.

The results of the dispersion modelling are summarised below, for those receptor locations illustrated in Figure 4-1. A presentation of all relevant results has been included as Appendix C, and full results and receptor locations are available upon request.

5.1 Assessment of Nitrogen Dioxide (NO_2)

5.1.1 Baseline Concentrations – 2019 and 2040

Baseline 2019 concentrations for nitrogen dioxide across the model domain for all existing receptor locations (i.e. excluding development receptors and ecological receptors), are illustrated in Figure 5-1, with Dover centre illustrated in Figure 5-3 and the exceedance location shown in Figure 5-4. One exceedance has been predicted at an existing receptor (HR) location in the Upper Deal area, located on London Road, close to the junction with Manor Road. This receptor location predicted a concentration of 40.2µg/m^3, which is just over the AQO objective; this location is not within, or close to any declared AQMAs. Due to the inherent uncertainty in dispersion modelling, it is recommended that monitoring sites be deployed in the area where the exceedance was predicted in order to confirm the results and inform future planning decisions.

The 2040 Do Minimum (DM) scenario represents the future baseline scenario, i.e. assuming that that Development Plan does not proceed, but inclusive of any other known growth across the region. Figure 5-2 shows the concentrations for NO_2 across the model domain for all receptor locations (excluding ecological receptors) under the 2040 DM scenario. No exceedances of the AQS objective for NO_2 were recorded in the 2040 DM Scenario at existing receptor locations (HR), however one exceedance was reported at development receptor DR82, see Figure 5-5. This location is not representative of relevant exposure in the 2040 DM scenario, as the Dover Waterfront development is associated with the implementation of the Local Plan.

The empirical relationship given in LAQM.TG(16) states that exceedances of the 1-hour mean objective for NO_2 are only likely to occur where annual mean concentrations are 60µg/m^3 or above. Excluding development receptors, that would only be present in the case of development proceeding and therefore are not representative of receptors in 2019, annual mean NO_2 concentrations at all receptor locations are below this limit for all scenarios, and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations is considered to be not significant.

Concentrations of NO_2 are predicted to be much lower in 2040 when compared to 2019. This is associated with the predicted change in fleet composition and shift towards Euro 6 vehicles as a result of Government and EU policies and legislation to reduce pollutant emissions. The background concentrations across the UK are also predicted to decline between 2019 and 2040 due to reductions from numerous contributing sectors, including transport, industry and commercial[23]. The latest available year for predicted background maps is 2030, therefore 2030 was used in this assessment; this provides a conservative approach as background concentrations are expected to be lower in 2040 due to the aforementioned reasons.

[23] https://laqm.defra.gov.uk/documents/2018-based-background-maps-user-guide-v1.0.pdf

Figure 5-1 - Baseline 2019 NO_2 Annual Mean Concentrations at Existing Receptor Locations

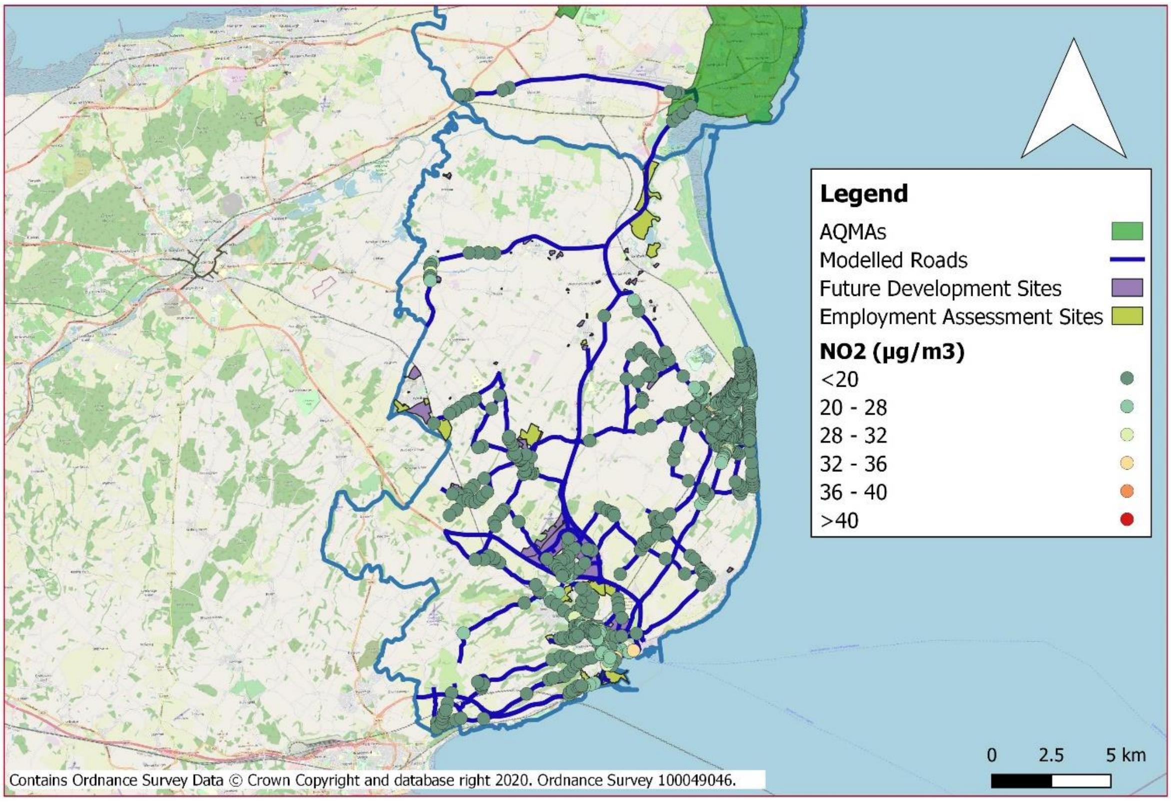


Figure 5-2 – Do Minimum 2040 NO_2 Annual Mean Concentrations at Existing and Development Receptor Locations

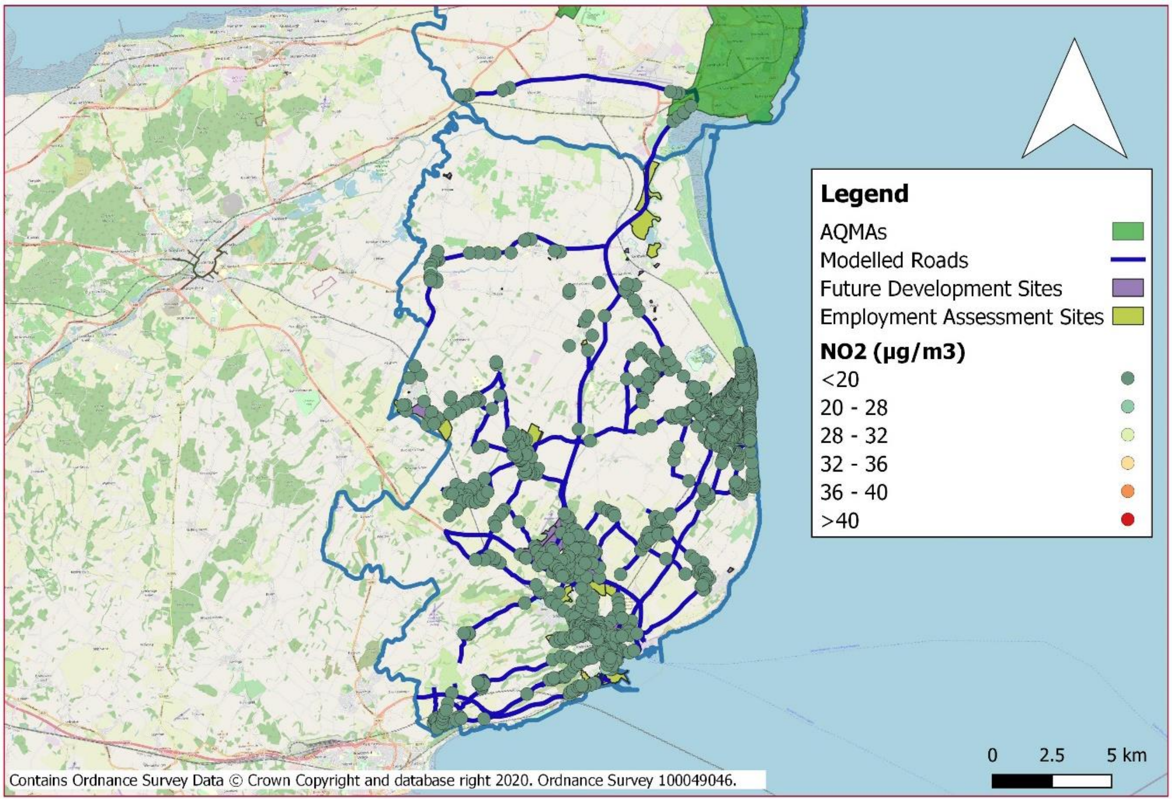
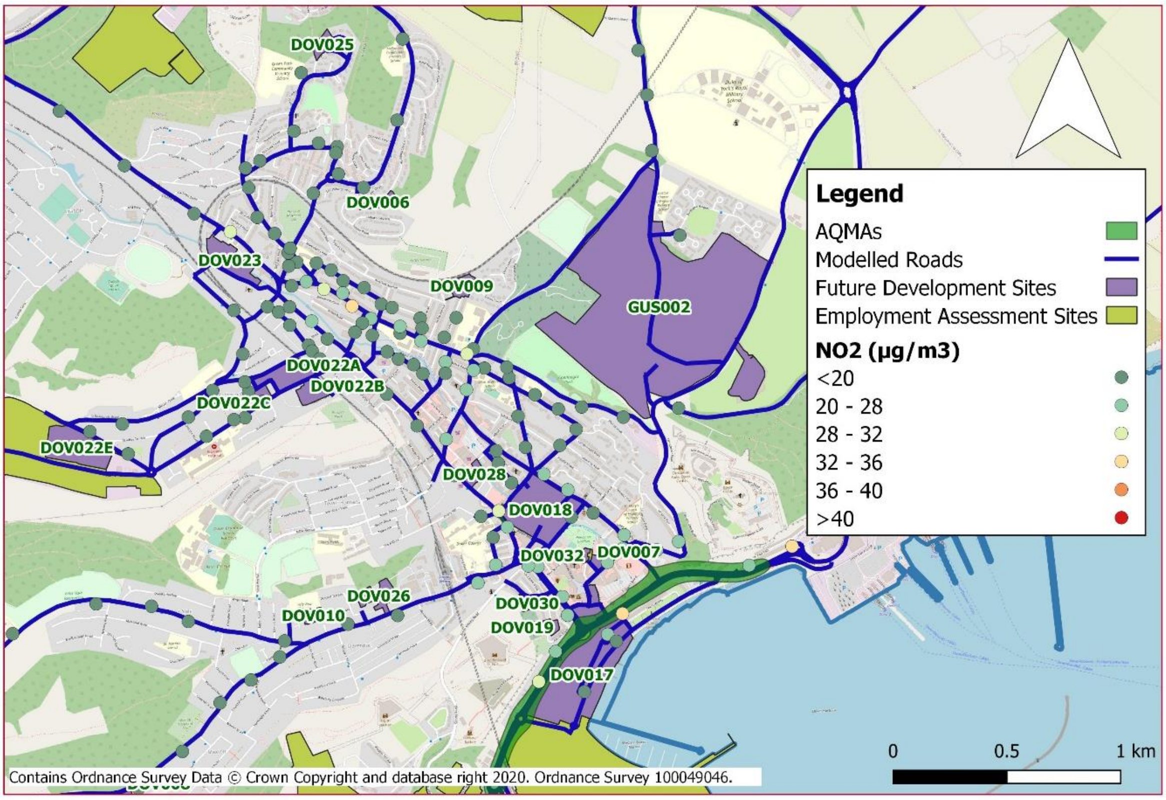
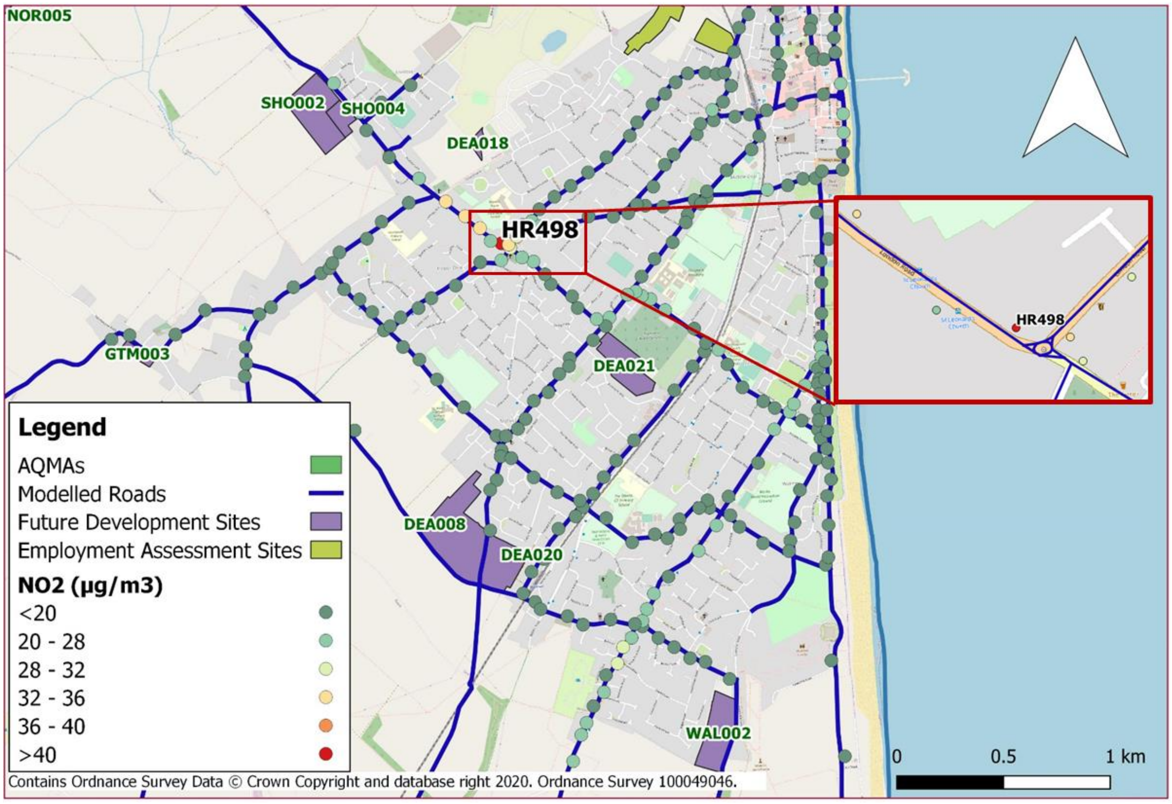


Figure 5-3 - Baseline 2019 NO_2 Annual Mean Concentrations at Dover Centre Existing Receptor Locations



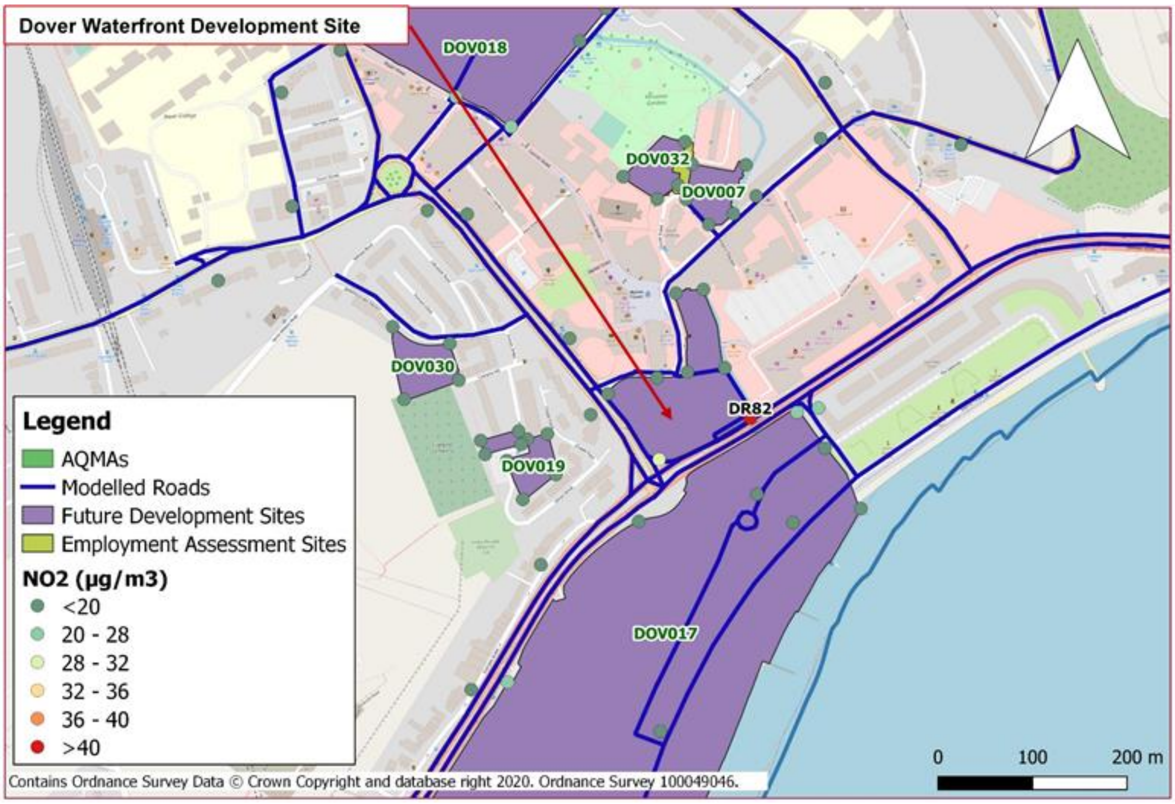
HELAA development site IDs labelled in green.

Figure 5-4 - Baseline 2019 NO_2 Annual Mean Concentrations at Deal / Walmer Existing Receptor Locations



HELAA development site IDs labelled in green. Exceedance locations labelled with receptor ID.

Figure 5-5 – 2040 Do Minimum NO_2 Annual Mean Concentrations at the Dover Waterfront Development Site, showing DR82 exceedance location



HELAA development site IDs labelled in green. Exceedance locations labelled with receptor ID.

5.1.2 Impact of the Local Development Plan

The 2040 Do Something (DS) scenario represents the future development scenario, i.e. assuming that the Development Plan proceeds alongside any other known growth across the region.

Figure 5-6 shows the concentrations for NO_2 across the model domain for all receptor locations (excluding ecological receptors) under the 2040 DS scenario, Figure 5-14 shows the exceedance location. One exceedance of the AQS objective for NO_2 was recorded in the 2040 DS Scenario, at receptor DR82, which is related to the Dover Waterfront development and close to the junction of Townwall Street and York Street, with a predicted concentration of 43.7µg/m^3. This represents 109% of the 40µg/m^3 annual mean AQS objective. It is worth noting that this receptor location was also exceeding in the 2040 DM scenario, reporting 43.2µg/m^3; therefore, the NO_2 concentration increase attributed to the implementation of the Local Plan only accounts for 0.5µg/m^3.

The empirical relationship given in LAQM.TG(16) states that exceedances of the 1-hour mean objective for NO_2 are only likely to occur where annual mean concentrations are 60µg/m^3 or above. Annual mean NO_2 concentrations at all receptor locations are below this limit, and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations is considered to be not significant.

A comparison of the two future year scenarios has been completed to show areas of improvement in NO_2 concentrations and areas that have been negatively impacted, this is illustrated in Figure 5-7. Negative values represent an improvement in NO_2 concentrations and positive values indicate a dis-benefit. It can be seen that the areas showing the greatest increase in NO_2 concentrations are associated with proposed development sites. Figure 5-8 – Figure 5-13 illustrate the developments associated with the greatest increases in NO_2 concentrations (i.e. showing increases of more than 1.0µg/m^3).

The greatest increase in NO_2 concentrations between the two scenarios, with a predicted increase of 3.5µg/m^3, was reported at receptor DR343 (see Figure 5-11), located in the Managed Expansion of Whitfield development. It is worth noting that this receptor is located on a new planned road associated with the development, therefore this road does not have any traffic flows in the 2040DM scenario. Furthermore, the predicted total annual mean NO_2 concentration at this location in the 2040DS scenario is 11.0µg/m^3, which is well below the objective of 40µg/m^3.

Table 5-1 presents the annual mean NO_2 concentrations predicted at existing residential and future development receptor locations for 2019 B, 2040 DM and 2040 DS scenarios, and a comparison against the 40µg/m^3 annual mean AQS objective. Due to the number of receptors, data is not shown for the 1,021 receptor locations classified as having a "Negligible" impact, as per the criteria set out in EPUK and IAQM planning guidance[24].

There are seven receptor locations that have been classified as "Slight" and one receptor location that has been classified as "Moderate" in terms of the IAQM/EPUK impact descriptor. Regarding the "Slight" receptors, four of these locations (DR159, DR329, DR330 and DR343) are associated with the Managed Expansion of Whitfield development (see Figure 5-11). Three of these receptors are located on a new road associated with the development, thus there are no traffic flows in the Do Minimum scenario, hence the large percentage change in NO_2 concentrations. The other receptor, DR159, is located at an entrance to the newly proposed site, along Sandwich Road, therefore also experiencing a large change in traffic flows between the DM and DS scenarios. The remaining two receptors, DR111 and DR112 that have been classified as "Slight" are associated with the Mid Town development (see Figure 5-8). These receptors are located at the worst-case locations associated with the site, close to the junctions with Priory Street and Worthington Street. It is worth noting that in these receptor locations, the predicted NO_2 concentrations in the 2040 DS scenario are well below the AQS objective of 40µg/m^3. Regarding the "Moderate" receptor, DR82 recorded an exceedance of the AQS objective in both the 2040 DM and 2040 DS scenarios and is associated with the Dover Waterfront development (see Figure 5-5). This location represents the worst-case receptor location associated with the Dover Waterfront development and it is therefore recommended that consideration is given to the proposed use of the Dover Waterfront development on the façade of the A20, i.e. to avoid introducing new receptors to an area of poor air quality.

Table 5-1 outlines the developments that have been associated with slight or moderate impacts caused by the proposed Local Development Plan. All other proposed HELAA development sites have been associated with negligible impacts. Apart from DR82, which is predicting an exceedance in both the 2040 DM and 2040 DS scenarios, all other receptor locations are reporting NO_2 concentrations below the AQS Objective in the 2040 DS scenario, i.e. assuming that the Local Development Plan proceeds. Therefore, with the proposed Local Development Plan in place, there will be generally good air quality conditions across Dover District and additionally, no adverse impacts of the Development Plan have been reported in Thanet District.

Provided that the mitigation methods outlined in Section 8 are followed for all proposed developments, with particular attention paid to those developments outlined in Table 5-1, the impact from the Local Development Plan in terms of NO_2 is deemed to be **not significant**.

[24] EPUK and IAQM Guidance, January 2017: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

Table 5-1 – Predicted Annual Mean NO_2 Concentrations at Receptors with a Slight or Moderate Impact Descriptor (i.e. excluding receptors with negligible impacts)

ID	Annual mean NO_2 (µg/m^3)				% Change relative to AQS Objective	2040 DS % OF AQS	IAQM/EPUK Impact Descriptor	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	AQS Objective	2019 B	2040 DM	2040 DS					
Development Receptors									
DR111	40	33.7	20.2	22.9	7%	57%	Slight (A)	Mid Town	DOV018
DR112	40	35.5	22.1	24.5	6%	61%	Slight (A)	Mid Town	DOV018
DR114	40	43.0	28.1	30.3	6%	76%	Slight (A)	Mid Town	DOV018
DR159	40	20.7	9.5	11.8	6%	29%	Slight (A)	Expansion of Whitfield	WHI008
DR329	40	9.9	7.2	9.4	6%	24%	Slight (A)	Expansion of Whitfield*	WHI008
DR330	40	9.8	7.1	9.9	7%	25%	Slight (A)	Expansion of Whitfield*	WHI008
DR343	40	10.9	7.5	11.0	9%	27%	Slight (A)	Expansion of Whitfield*	WHI008
DR82	40	67.7	43.2	43.7	1%	109%	Moderate (A)	Dover Waterfront	DOV017

(A) Adverse impact (B) Beneficial impact
* Receptor located on a new planned development road, therefore there are no traffic flows in a DM scenario, leading to a large percentage change

Figure 5-6 - Do Something 2040 NO_2 Annual Mean Concentrations at all Receptor Locations

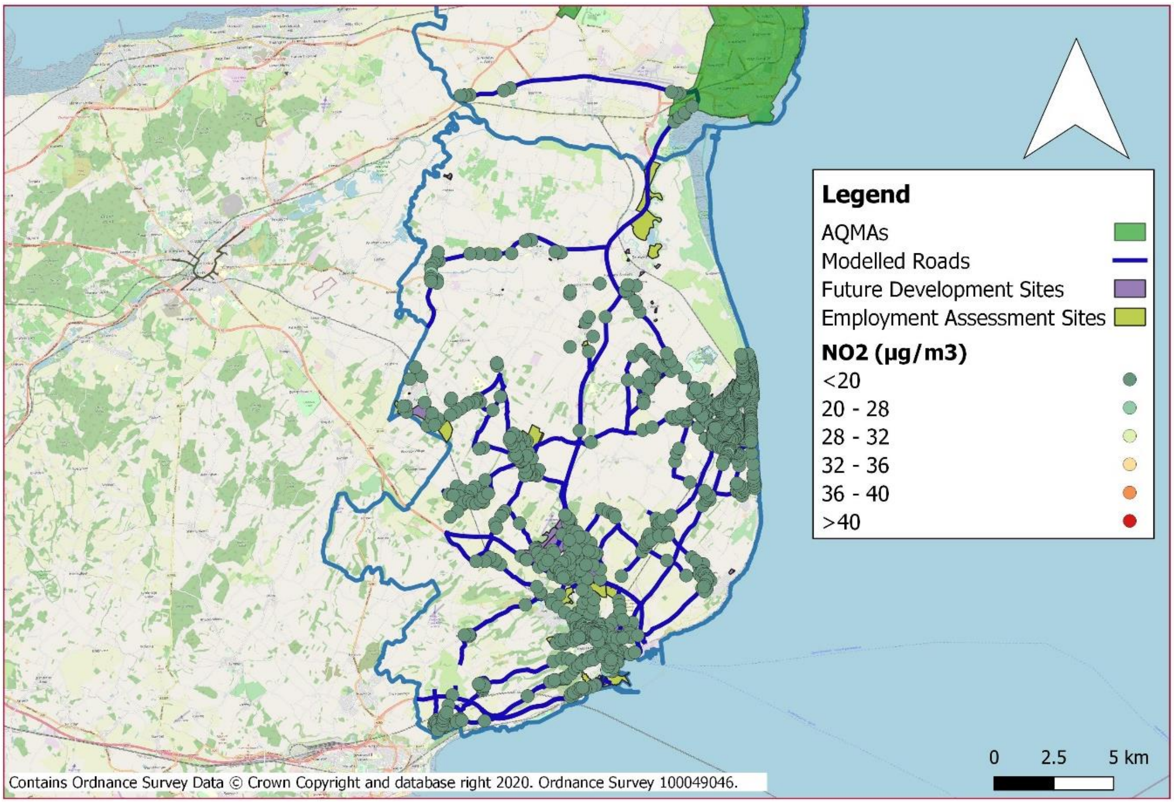


Figure 5-7 - Difference in NO_2 Annual Mean Concentrations between Do Minimum and Do Something 2040 scenarios at all Receptor Locations

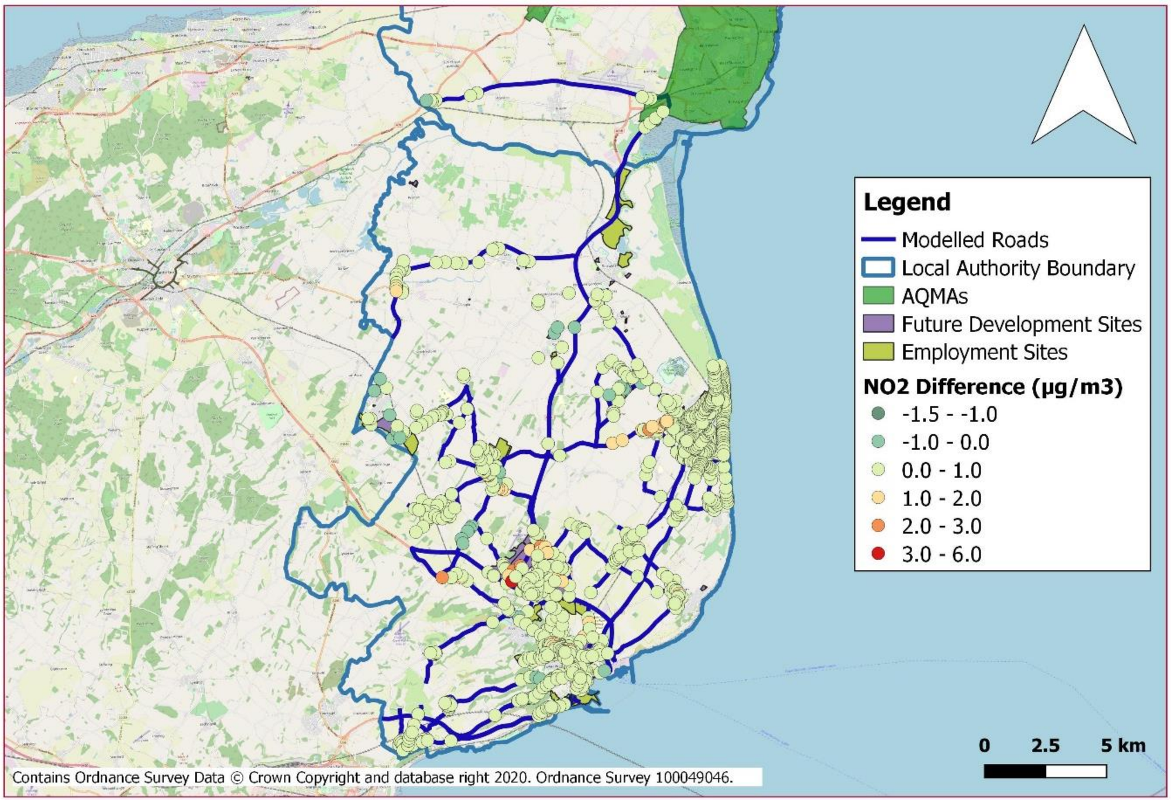
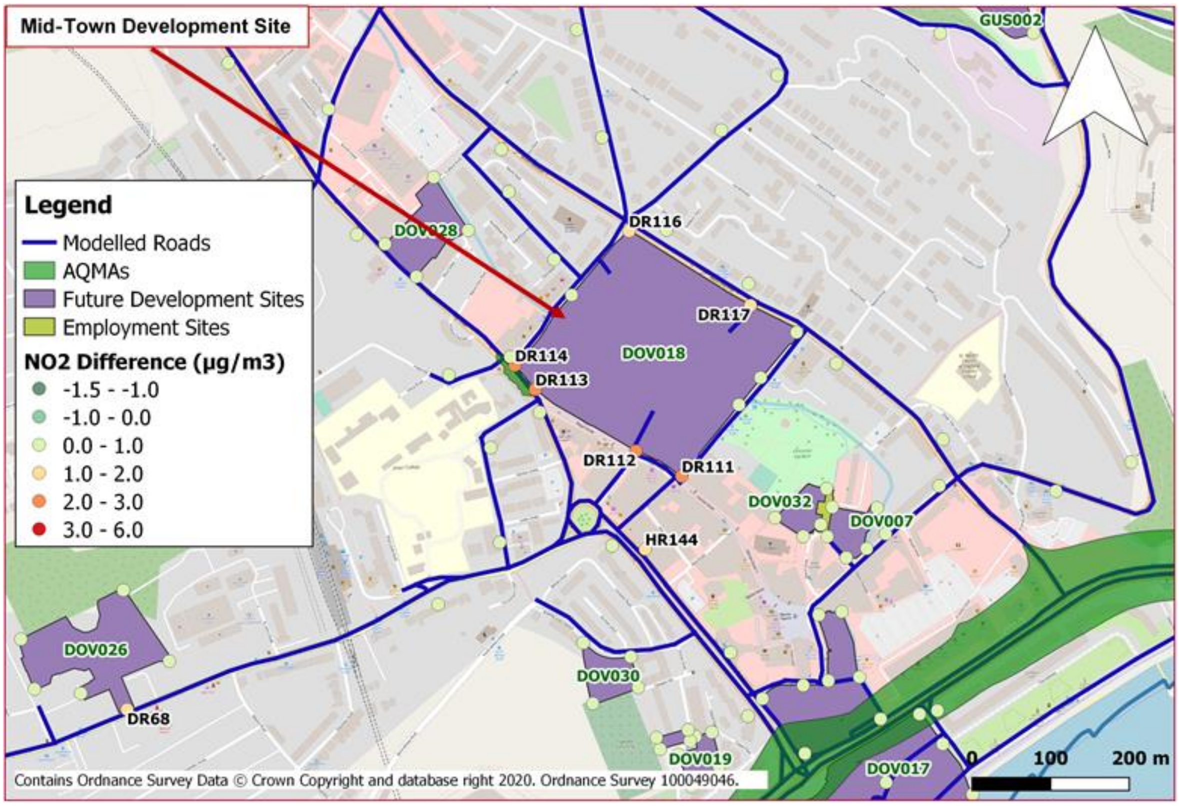
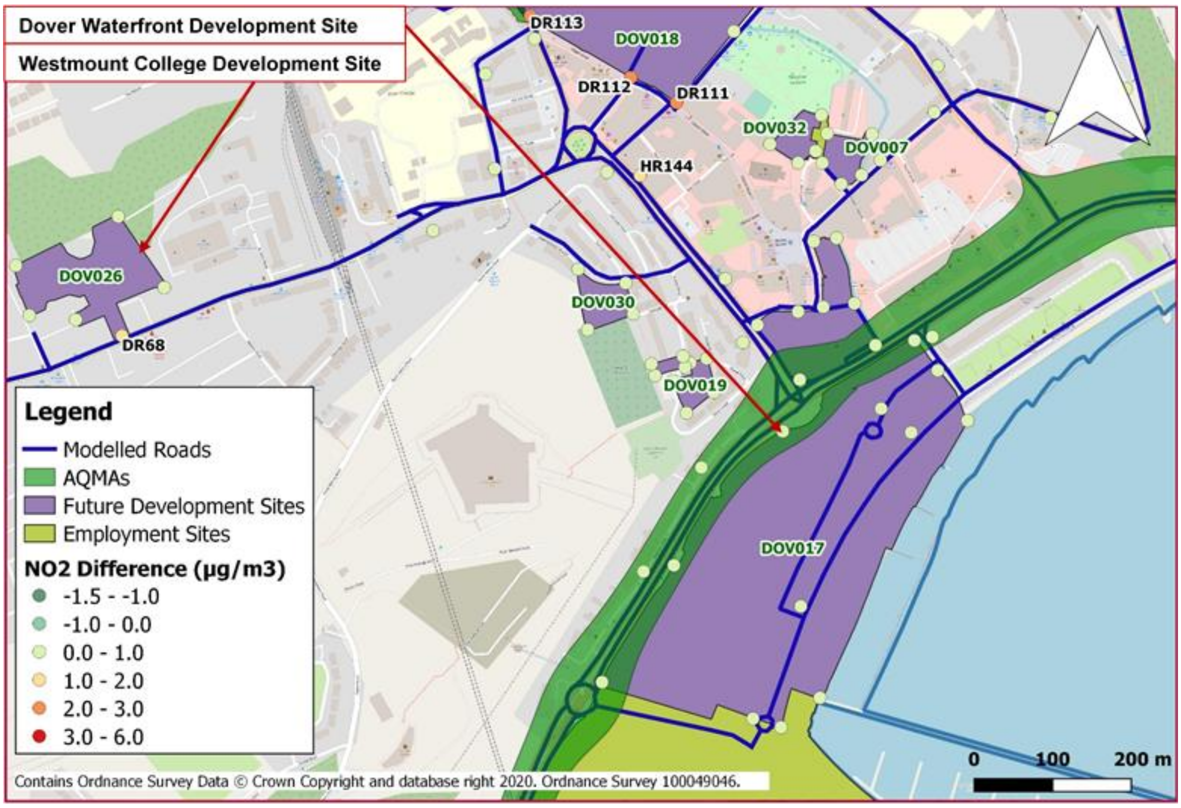


Figure 5-8 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 scenarios at the Mid-Town Development Site



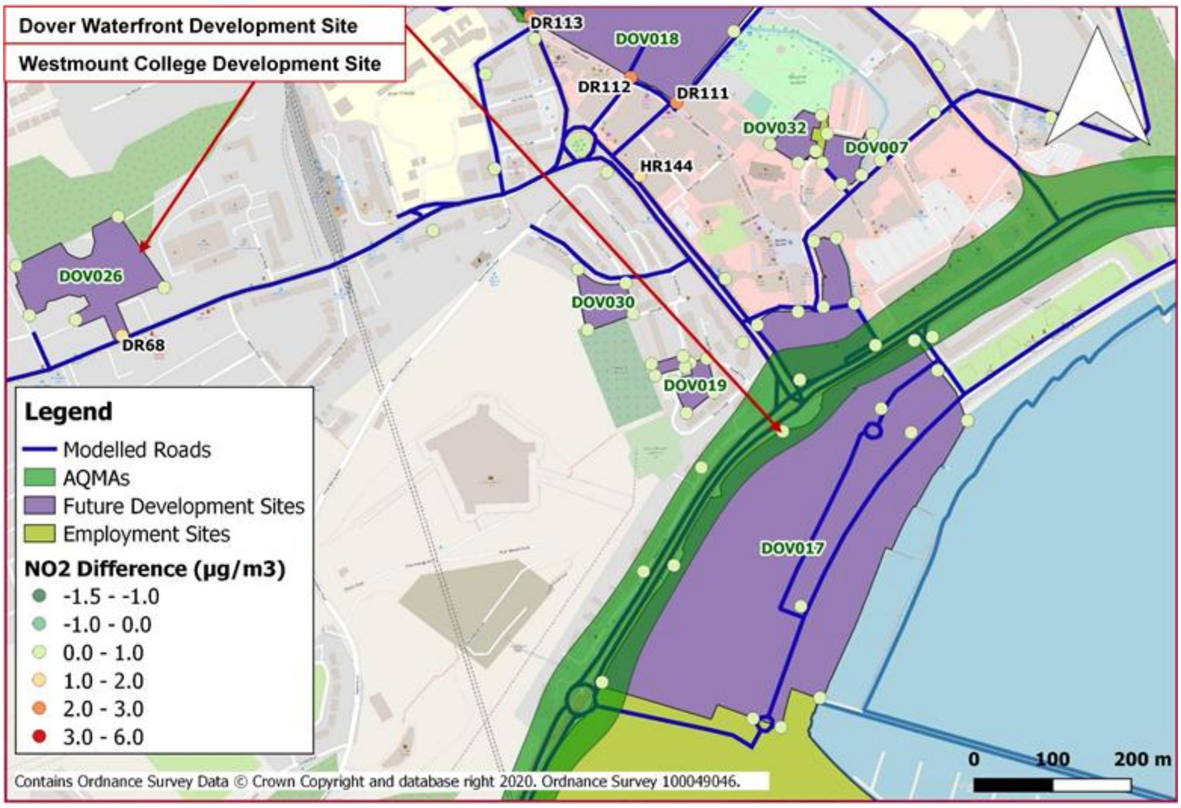
Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-9 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 scenarios at the Dover Waterfront and Westmount College Development Site



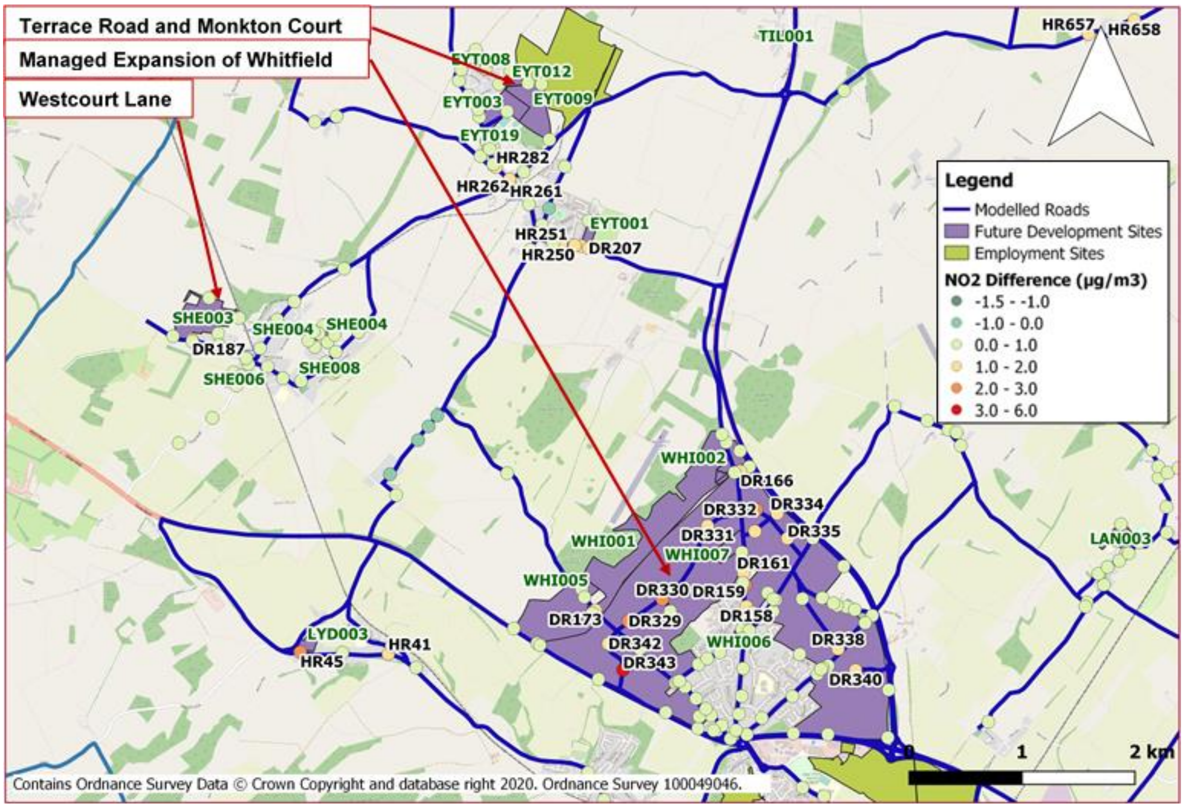
Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-10 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 Scenarios at Development Sites in Dover Centre



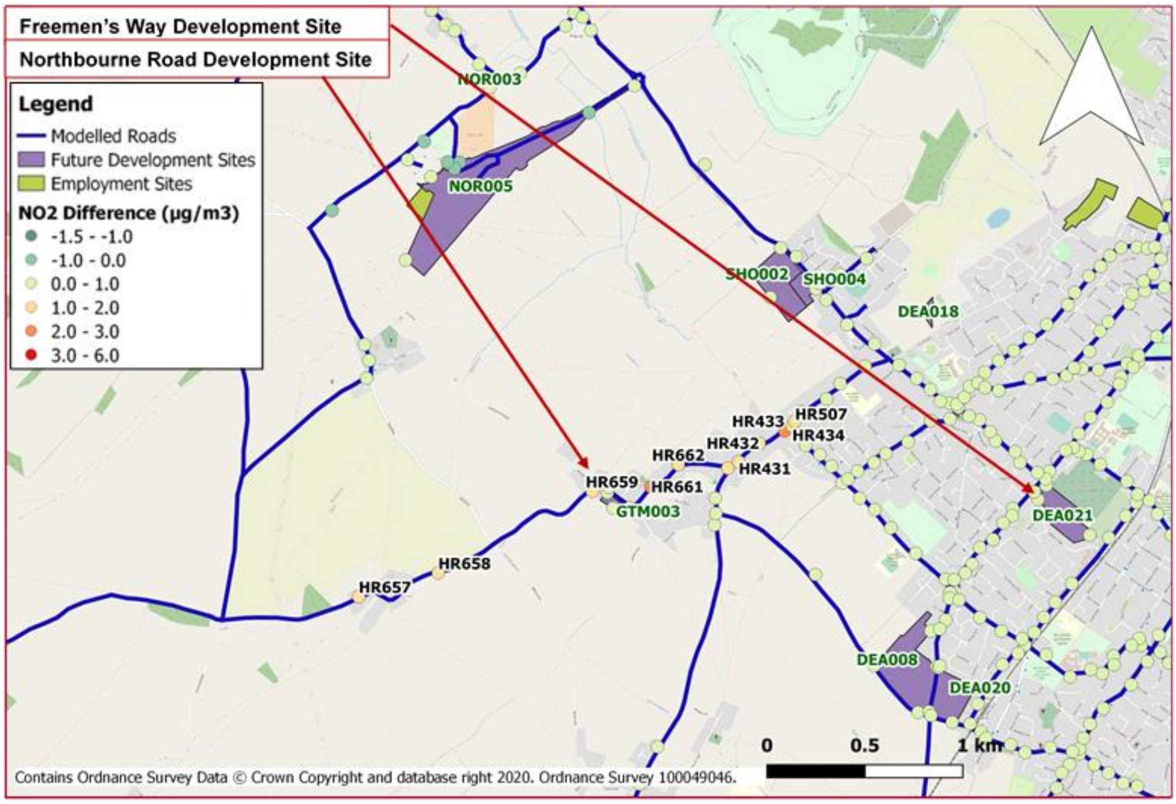
Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-11 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 scenarios at Development Sites in Whitfield



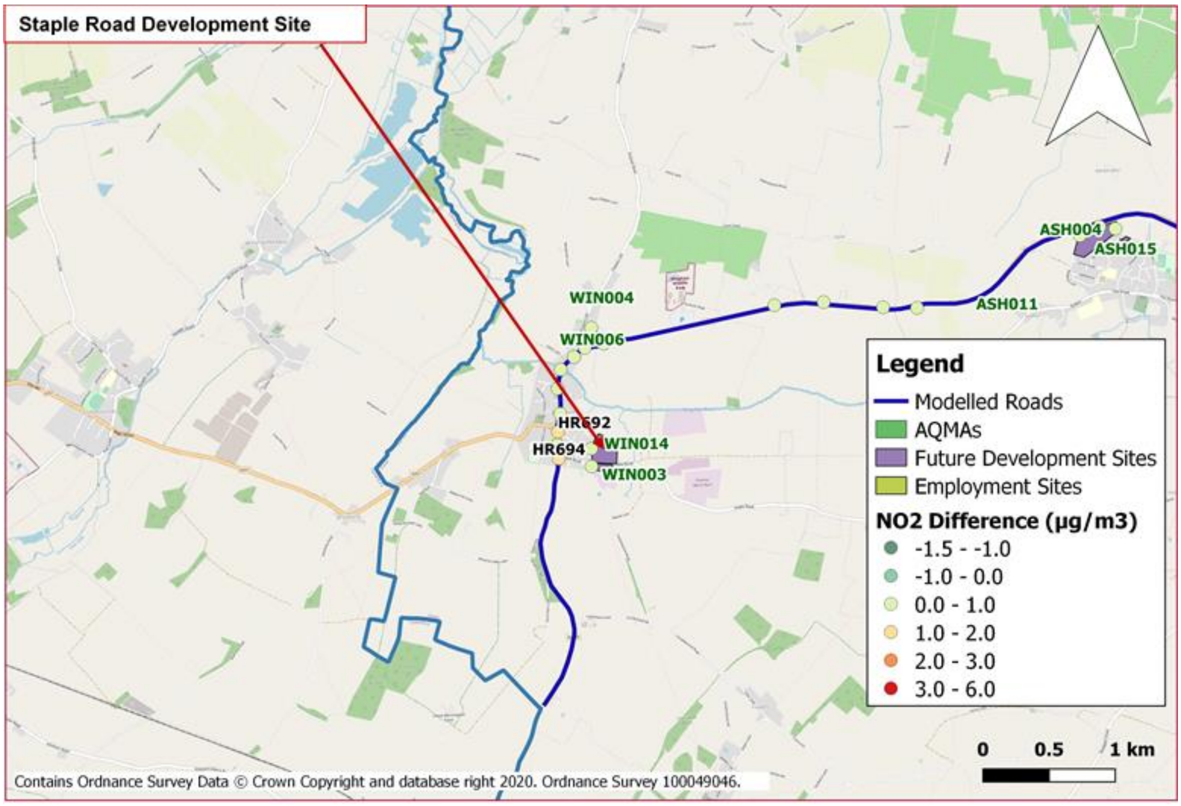
Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-12 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 scenarios at Development Sites in Deal



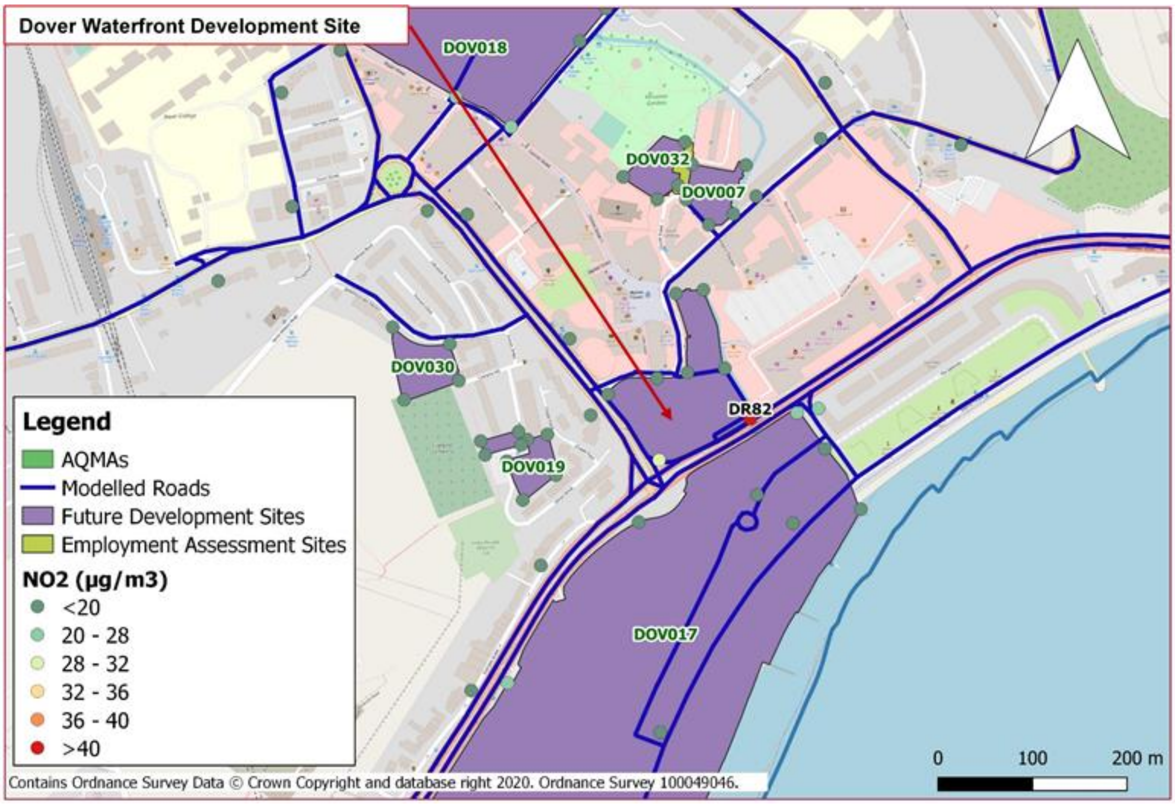
Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-13 - Difference in NO_2 Annual Mean Concentrations between DM 2040 and DS 2040 scenarios at Staple Road Development Site at Staple Road



Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

Figure 5-14 - 2040 Do Something NO_2 Annual Mean Concentrations at the Dover Waterfront Development Site, showing DR82 exceedance location



HELAA development site IDs labelled in green. Exceedance locations labelled with receptor ID.

5.2 Assessment of Particulate Matter (PM_{10})

5.2.1 Baseline Concentrations – 2019 and 2040

The baseline modelled concentrations of PM_{10} in 2019 and 2040 were all well below the AQS annual mean objective of 40µg/m^3 at all receptors, see Figure 5-15 and Figure 5-16.

The maximum predicted annual mean PM_{10} concentration at existing receptor locations was reported at HR498 for both the 2019 Baseline scenario and the 2040 Do Minimum scenario. This monitoring site is located in the Upper Deal area and is located on London Road at the junction with Manor Road (see Figure 5-4 for location). The predicted concentration at this location is 25.2µg/m^3 in 2019 and 25.4µg/m^3 in 2040, representing 63% and 64% of the AQS objective respectively. The maximum predicted annual mean PM_{10} concentration at development receptors for both the 2019 Baseline scenario and the 2040 Do Minimum scenario was at Receptor DR82 which is related to the Dover Waterfront development (see Figure 5-5 for location) and is close to the junction of Townwall Street and York Street, with a predicted concentration of 29.5µg/m^3 in 2019 and 28.5µg/m^3 in 2040. This represents 74% of the 40µg/m^3 annual mean AQS objective 2019 and 71% of the objective in 2040. However, this receptor is associated with a future development, therefore is not representative of long-term public exposure in 2019 or in the 2040 scenario where development has not been completed.

Figure 5-15 - Baseline 2019 PM_{10} Annual Mean Concentrations at Existing Receptor Locations

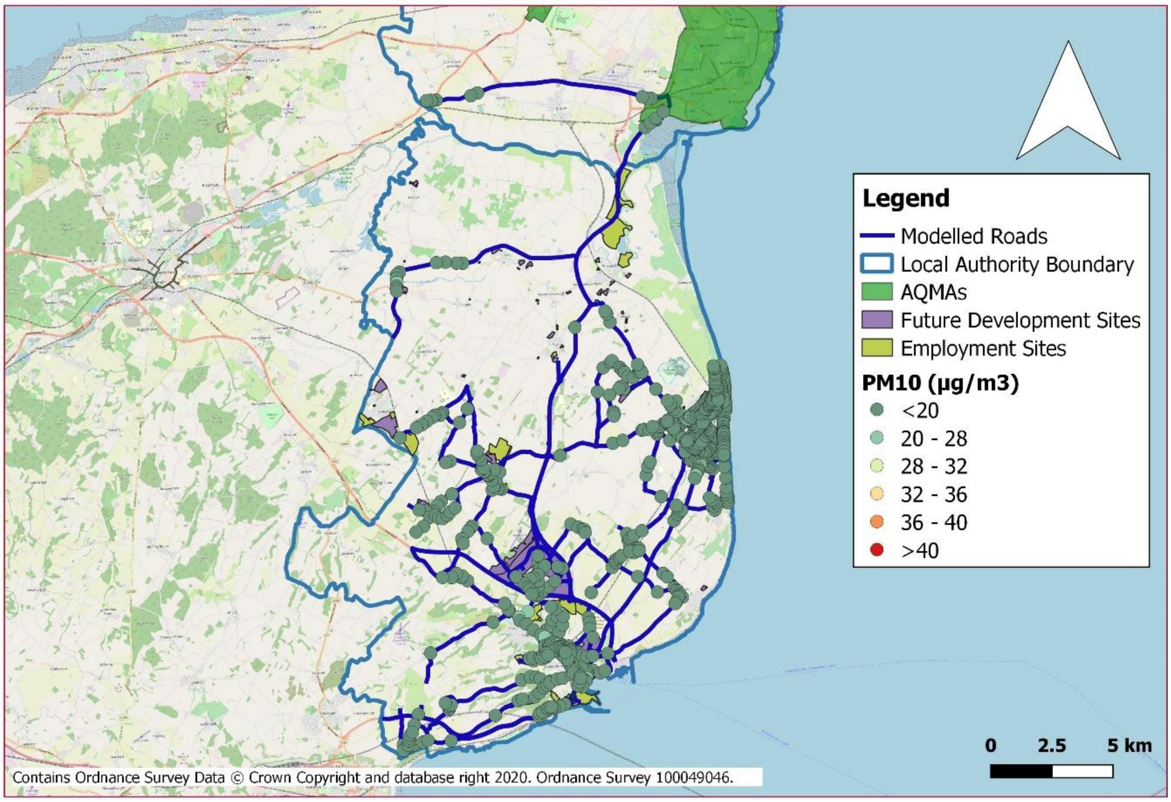
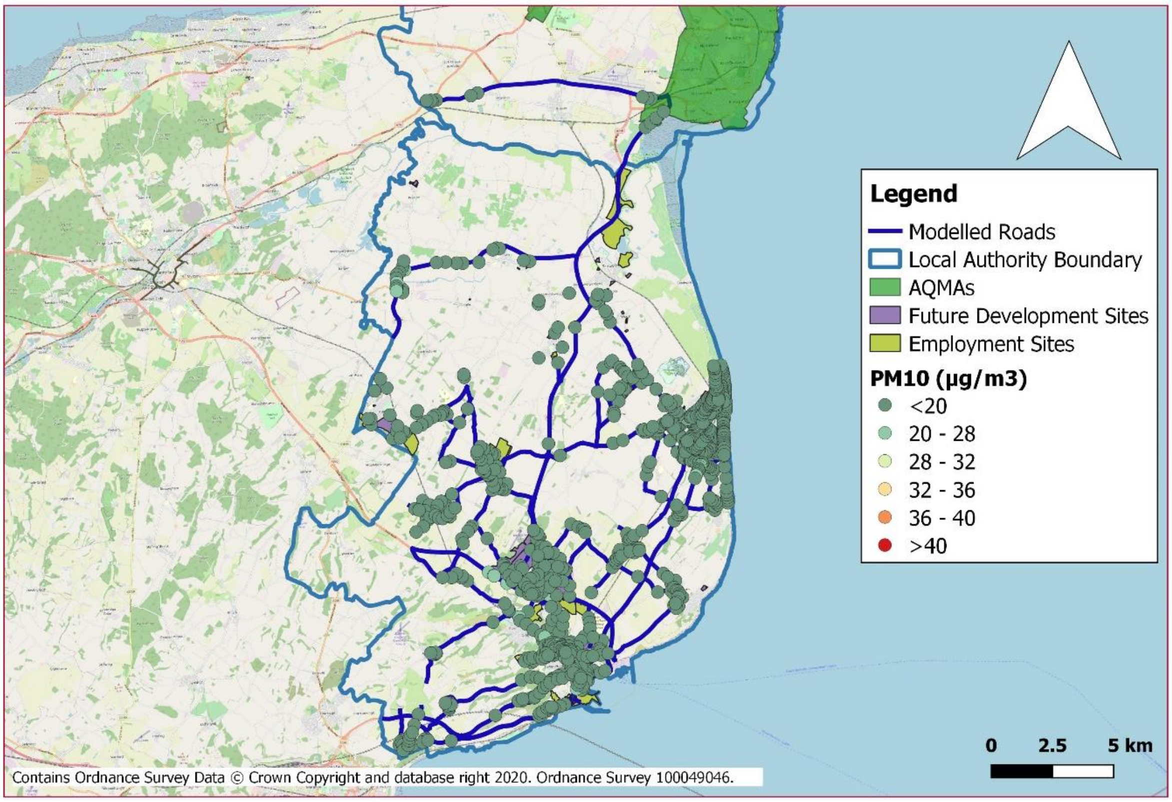


Figure 5-16 - Do Minimum 2040 PM_{10} Annual Mean Concentrations at all Receptor Locations



5.2.2 Impact of the Local Development Plan

The 2040 Do Something (DS) scenario represents the future development scenario, i.e. assuming that the Development Plan proceeds alongside any other known growth across the region. The modelled concentrations of PM_{10} in the 2040 DS scenario were all well below the objective at all receptors. The patterns of the impact from the proposed developments, in terms of positive and negative impacts, are the same for PM_{10} as they are for NO_2, as illustrated in Figure 5-7, although the magnitudes of change are smaller (Figure 5-17). The areas associated with the greatest change in concentrations are illustrated in Figure 5-18 and Figure 5-19.

Table 5-2 presents the annual mean PM_{10} concentrations predicted at existing residential and future development receptor locations for 2019 B, 2040 DM and 2040 DS scenarios, and a comparison against the 40µg/m^3 annual mean AQS objective. Due to the high number of receptors, data is not shown for the 1,022 receptor locations classified as having a "Negligible" impact, as per the criteria set out in EPUK and IAQM planning guidance[25]. There are six receptor locations that have been classified as "Slight" and one location that has been classified at "Moderate" in terms of the IAQM/EPUK impact descriptor. These locations are associated with the same developments as those impacted by NO_2, outlined in Section 5.1.2. The location that reported "Moderate" impacts, DR343, was associated with the newly planned road in the Managed Expansion of Whitfield development (Figure 5-18).

The maximum predicted annual mean PM_{10} concentration for the 2040 DS scenario was at Receptor DR82 which is associated with the Dover Waterfront development, with a predicted concentration of 29.1µg/m^3. This represents 73% of the 40µg/m^3 annual mean AQS objective; however due to the percentage change from the DM to DS scenario being 1.4%, the impact at this receptor has been classified at Negligible[25].

The greatest increase in PM_{10} concentrations between the two scenarios, with a predicted increase of 3.9µg/m^3, was reported at receptor DR343 (see Figure 5-18), located in the Managed Expansion of Whitfield development. It is worth noting that this receptor is located on a new planned road associated with the development, therefore this road does not have any traffic flows in the 2040 DM scenario. Furthermore, the predicted total annual mean PM_{10} concentration at this location in the 2040 DS scenario is 18.5µg/m^3, which is well below the objective of 40µg/m^3.

Table 5-3 shows the number of predicted exceedances of the 24-hour PM_{10} 50µg/m^3 AQS objective predicted at the existing residential (HR) and future development (DR) receptor locations. Due to the number of receptors modelled, only the receptors with an increase of greater than 1µg/m^3 between the two future scenarios (DM and DS) have been presented in Table **5-3.** The greatest number of exceedances of the 24-hour PM_{10} AQS objective were also predicted at DR82, predicting 24 exceedances in the 2040 DS scenario, compared with 22 in the 2040 DM scenario. There were no receptor locations that that surpassed the 35 allowed exceedances of the objective.

Table 5-2 outlines the developments that have been associated with slight or moderate impacts caused by the proposed Local Development Plan. All other proposed HELAA development sites have been associated with negligible impacts. All receptor locations are reporting PM_{10} concentrations well below the AQS Objective in the 2040 DS scenario, assuming that the Local Development Plan proceeds. Therefore, with the proposed Local Development Plan in place, there will be good air quality conditions across Dover District and no adverse impacts of the Development Plan have been reported in Thanet District.

Provided that the mitigation methods outlined in Section 8 are followed for all proposed developments, with particular attention paid to those developments outlined in Table 5-2, the impact from the Local Development Plan in terms of PM_{10} is deemed to be **not significant**.

[25] EPUK and IAQM Guidance, January 2017: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

Table 5-2 – Predicted Annual Mean PM_{10} Concentrations (excluding receptors with negligible impacts)

ID	Annual mean PM_{10} (µg/m^3)				% Change relative to AQS Objective	% DC OF AQS	IAQM/EPUK Impact Descriptor	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	AQS Objective	2019 B	2040 DM	2040 DS					
Development Receptors									
DR111	40	20.6	21.3	23.6	6%	59%	Slight (A)	Mid Town	DOV018
DR159	40	19.5	17.3	19.6	6%	49%	Slight (A)	Expansion of Whitfield	WHI008
DR329	40	15.2	14.2	16.7	6%	42%	Slight (A)	Expansion of Whitfield*	WHI008
DR330	40	15.1	14.1	17.2	8%	43%	Slight (A)	Expansion of Whitfield*	WHI008
DR332	40	15.8	14.8	17.1	6%	43%	Slight (A)	Expansion of Whitfield*	WHI008
DR343	40	15.6	14.6	18.5	10%	46%	Moderate (A)	Expansion of Whitfield*	WHI008
Existing Receptors									
HR661	40	17.9	18.6	21.0	6%	53%	Slight (A)	Footpath Field, Staple Rd	WIN014 / WIN003

(A) Adverse impact (B) Beneficial impact
* Receptor located on a new planned development road, therefore there are no traffic flows in a DM scenario, leading to a large percentage change

Table 5-3 – Predicted Number of Exceedances of 24-hour PM_{10} 50µg/m³ AQS objective (excluding receptor locations where the magnitude of change was below 1µg/m³)

ID	Number of Exceedances				Magnitude Change (µg/m³)	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	Number of allowed exceedances of PM_{10} 50µg/m³ AQS Objective	2019 B	2040 DM	2040 DS			
Development Receptors							
DR111	35	4	5	9	4.3	Mid Town	DOV018
DR112	35	5	8	12	4.5	Mid Town	DOV018
DR113	35	7	8	12	3.4	Mid Town	DOV018
DR114	35	9	10	14	4.1	Mid Town	DOV018
DR159	35	3	1	3	2.1	Expansion of Whitfield	WHI008
DR160	35	2	1	2	1.5	Expansion of Whitfield	WHI008
DR166	35	2	1	2	1.1	Expansion of Whitfield	WHI008
DR176	35	7	6	7	1	Northwest of Whitfield housing land allocation	WHI001
DR177	35	8	7	8	1.1	Expansion of Whitfield	WHI008
DR178	35	6	6	6	1	Expansion of Whitfield	WHI008
DR187	35	1	1	2	1.1	Westcourt Lane	SHE003
DR308	35	6	6	8	1.2	Ringwould Alpines	RIN004 / RIN002
DR309	35	7	7	9	1.4	Ringwould Alpines	RIN004 / RIN002
DR343	35	0	0	2	1.8	Expansion of Whitfield*	WHI008

ID	Number of Exceedances				Magnitude Change (µg/m³)	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	Number of allowed exceedances of PM_{10} 50µg/m³ AQS Objective	2019 B	2040 DM	2040 DS			
DR68	35	8	8	10	2.3	Westmount College	DOV026
DR82	35	26	22	24	1.8	Dover Waterfront	DOV017
Existing Receptors							
HR146	35	3	3	4	1	Mid Town	DOV018
HR197	35	6	5	6	1.6	Buckland Mill	DOV023
HR250	35	1	0	2	1.1	Monkton Court Lane	EYT001
HR251	35	1	1	2	1.4	Monkton Court Lane	EYT001
HR334	35	2	1	2	1	*High St.*	STM007/STM008
HR373	35	5	6	8	1.2	*Dover Road*	DEA008 / DEA020 / WAL002
HR416	35	8	8	10	1.5	*Dover Road*	DEA008 / DEA020 / WAL002
HR431	35	1	1	2	1.4	*Mongeham Rd*	GTM003 / SHO002 / SHO004
HR433	35	1	1	3	1.8	*Mongeham Rd*	GTM003 / SHO002 / SHO004
HR490	35	6	6	7	1.2	*Manor Rd*	DEA018 / SHO002 / SHO004
HR498	35	13	13	15	2	*London Rd*	DEA018 / SHO002 / SHO004

ID	Number of Exceedances				Magnitude Change (µg/m^3)	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	Number of allowed exceedances of PM_{10} 50µg/m^3 AQS Objective	2019 B	2040 DM	2040 DS			
HR500	35	9	9	10	1.2	*London Rd*	DEA018 / SHO002 / SHO004
HR501	35	7	7	8	1	*London Rd*	DEA018 / SHO002 / SHO004
HR502	35	8	9	10	1.2	*London Rd*	DEA018 / SHO002 / SHO004
HR508	35	9	9	11	1.7	*London Rd*	DEA018 / SHO002 / SHO004
HR509	35	6	5	6	1	*London Rd*	DEA018 / SHO002 / SHO004
HR525	35	5	5	6	1	*London Rd*	DEA018 / SHO002 / SHO004
HR657	35	1	1	2	1.2	Northbourne Rd, Great Mongeham	GTM003
HR658	35	1	1	2	1.1	Northbourne Rd, Great Mongeham	GTM003
HR661	35	1	2	5	2.9	Northbourne Rd, Great Mongeham	GTM003
HR691	35	7	12	13	1.4	Footpath Field, Staple Rd	WIN014 / WIN003
HR692	35	2	4	6	2.5	Footpath Field, Staple Rd	WIN014 / WIN003

ID	Number of Exceedances				Magnitude Change (µg/m^3)	Associated HELAA Development Site (*or Location if not applicable*)	Associated HELAA Development Site Code
	Number of allowed exceedances of PM_{10} 50µg/m^3 AQS Objective	2019 B	2040 DM	2040 DS			
HR694	35	2	5	9	3.5	Footpath Field, Staple Rd	WIN014 / WIN003
HR72	35	6	4	6	1.9	*Buckland Avenue*	DOV023 / DOV022 A B C
HR74	35	6	5	8	2.4	*Buckland Avenue*	DOV023 / DOV022 A B C
HR79	35	3	2	3	1	*London Rd*	DOV023 / DOV022 A B C
HR89	35	4	3	5	1.8	*Barton Rd*	DOV009 / GUS002

Where a receptor is not linked to a single HELAA Development site, the location of the receptor is given *in italics* instead and closest development site codes are provided
* Receptor located on a new planned development road, therefore there are no traffic flows in a DM scenario, leading to a large percentage change

Figure 5-17 - Difference in PM_{10} Annual Mean Concentrations between Do Minimum and Do Something 2040 scenarios at all Receptor Locations

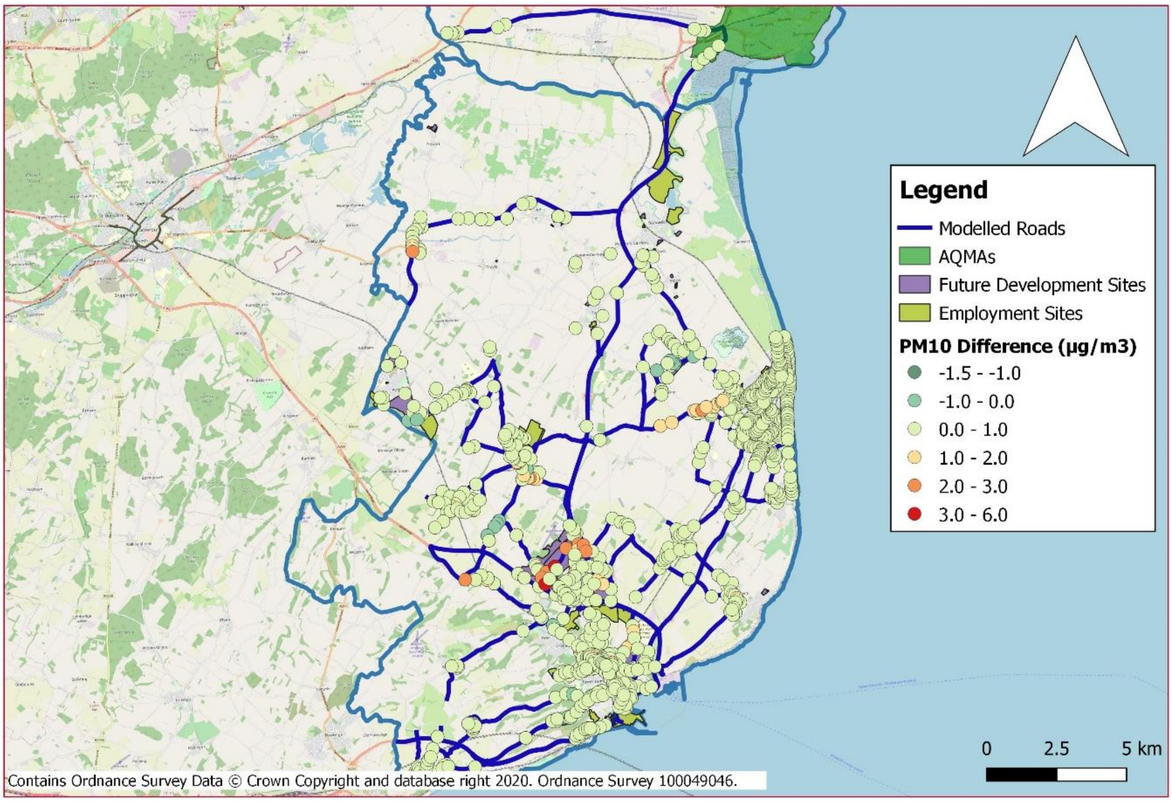
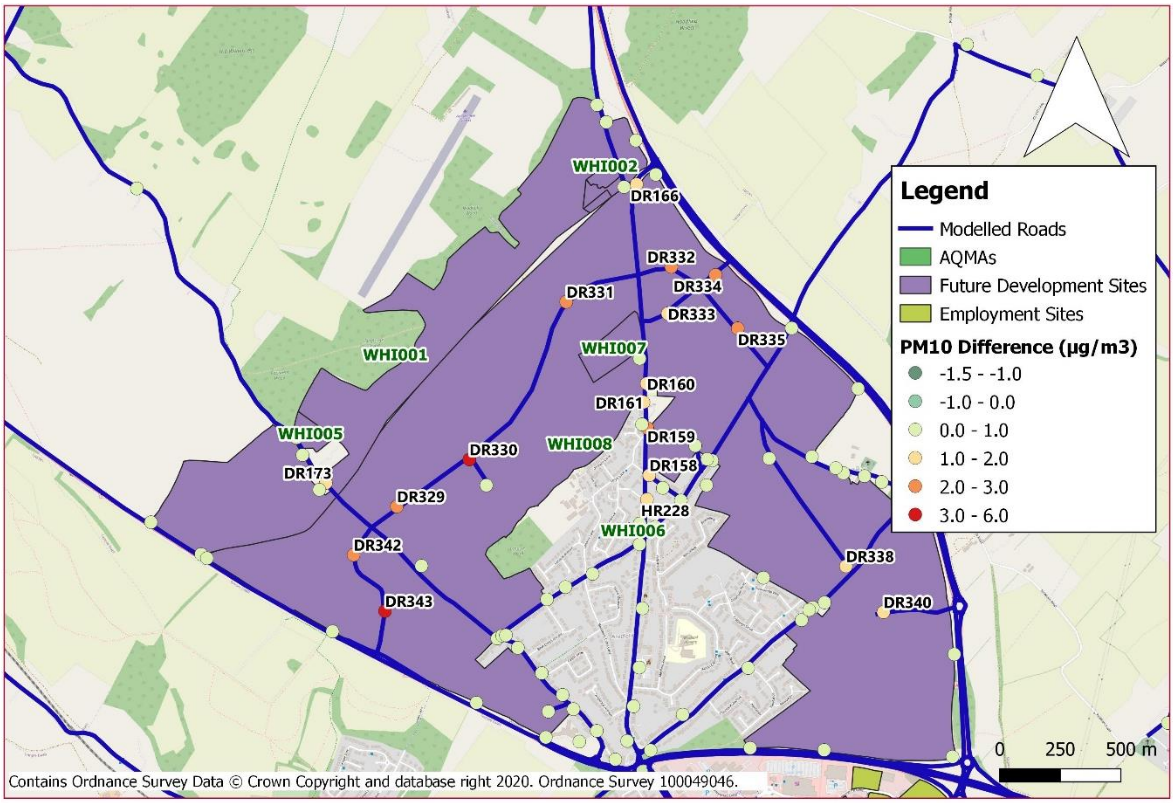
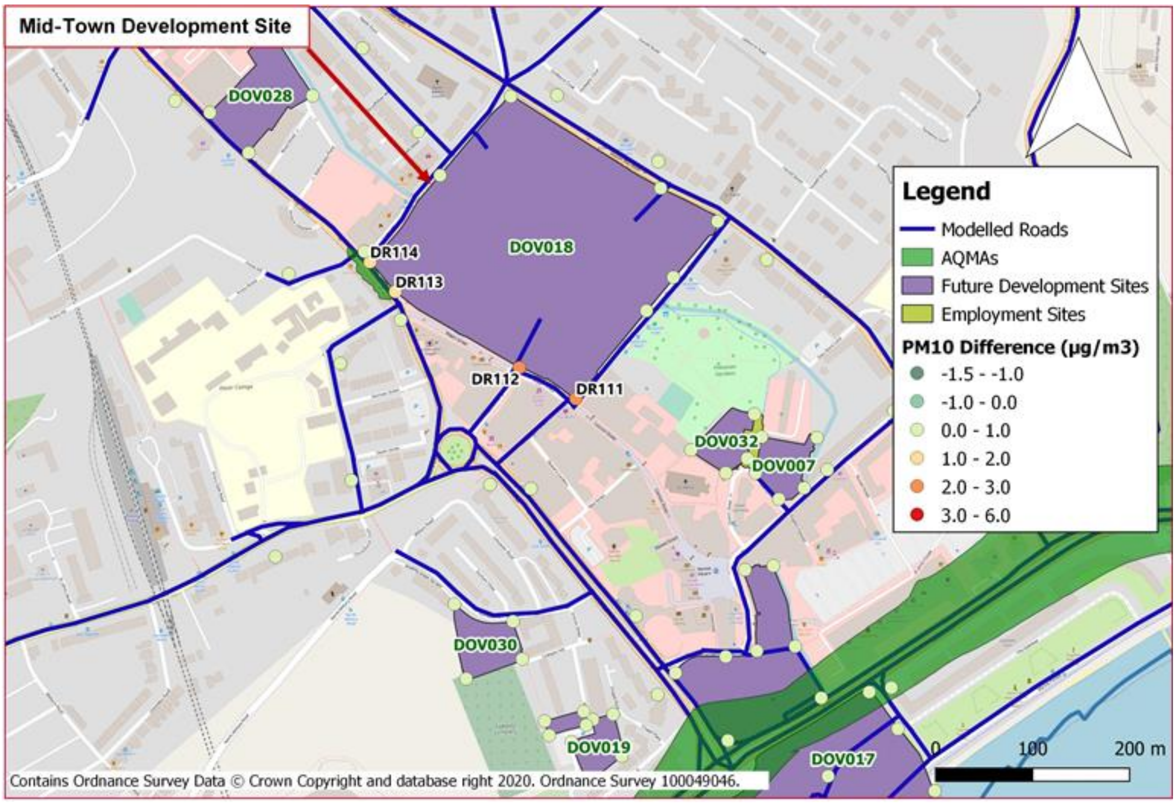


Figure 5-18 - Difference in PM_{10} Annual Mean Concentrations between Do Minimum and Do Something 2040 scenarios at Whitfield Developments



Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m[3]. HELAA development site IDs labelled in green.

Figure 5-19 - Difference in PM_{10} Annual Mean Concentrations between Do Minimum and Do Something 2040 scenarios at the Mid-Town Development Site



Receptor IDs shown at locations where the NO_2 concentration increase was more than 1.0 µg/m^3. HELAA development site IDs labelled in green.

6. Assessment of Ecological Receptors

The following section considers emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. The results of the dispersion modelling are provided below, for those ecological receptor locations detailed and illustrated previously (Figure 4-1 and Table 4-1). It should be noted that the ecological receptor points are those within the designated sites that are closest to the road and so are likely to demonstrate the maximum impacts. It is likely that deposition rates will be at a lower level across the rest of the site area.

6.1 NO_x Impacts at Ecological Receptors

Table 6-1 details the results of the impact assessment for NO_x for the Do Minimum (DM) scenario; Table 6-2 details the results of the impact assessment for NO_x for the Do Something (DS) scenario.

Table 6-1 - NO_x Impacts at Ecological Receptors for the Do Minimum (2040) Scenario

Receptor ID	Annual Mean				
	AQS µg m^{-3}	PC µg m^{-3}	Background	PEC µg m^{-3}	% PEC OF AQS
ER1	30	2.4	12.9	15.2	51
ER5	30	1.8	12.9	14.6	49
ER8	30	0.7	8.9	9.6	32
ER9	30	1.3	8.6	9.8	33
ER10	30	0.8	8.4	9.2	31
ER13	30	9.5	8.4	17.9	60
ER14	30	5.2	8.2	13.5	45
ER15	30	0.8	8.2	9.0	30
ER18	30	0.8	8.4	9.1	30
ER22	30	0.7	8.4	9.1	30
ER24	30	1.6	8.2	9.9	33
ER29	30	4.0	8.2	12.2	41
ER30	30	14.8	8.1	22.9	76
ER31	30	6.7	8.1	14.8	49
ER33	30	15.5	8.1	23.6	79
ER37	30	0.4	8.1	8.5	28
ER38	30	0.5	8.1	8.6	29
ER40	30	0.3	8.3	8.6	29
ER41	30	0.6	8.3	8.8	29
ER43	30	4.5	10.2	14.7	49
ER45	30	13.2	8.5	21.7	72
ER46	30	39.1	8.6	47.7	159
ER48	30	9.8	9.1	19.0	63

AQS = Air Quality Standard ; EAL = Environmental Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)

Table 6-2 - NO_x Impacts at Ecological Receptors for the Do Something (2040) Scenario

Receptor ID	Annual Mean				
	AQS µg m^{-3}	PC µg m^{-3}	Background	PEC µg m^{-3}	% PEC OF AQS
ER1	30	2.9	12.9	15.7	52
ER5	30	2.4	12.9	15.3	51

Receptor ID	Annual Mean				
	AQS µg m^{-3}	PC µg m^{-3}	Background	PEC µg m^{-3}	% PEC OF AQS
ER8	30	0.9	8.9	9.8	33
ER9	30	1.5	8.6	10.0	33
ER10	30	1.1	8.4	9.5	32
ER13	30	7.0	8.4	15.4	51
ER14	30	4.0	8.2	12.2	41
ER15	30	0.8	8.2	9.0	30
ER18	30	0.8	8.4	9.2	31
ER22	30	0.7	8.4	9.2	31
ER24	30	1.5	8.2	9.7	32
ER29	30	4.9	8.2	13.2	44
ER30	30	15.6	8.1	23.7	79
ER31	30	7.1	8.1	15.2	51
ER33	30	16.3	8.1	24.4	81
ER37	30	0.5	8.1	8.6	29
ER38	30	0.5	8.1	8.6	29
ER40	30	0.3	8.3	8.6	29
ER41	30	0.6	8.3	8.9	30
ER43	30	4.5	10.2	14.8	49
ER45	30	13.3	8.5	21.9	73
ER46	30	39.6	8.6	48.1	160
ER48	30	10.0	9.1	19.1	64

AQS = Air Quality Standard ; EAL = Environmental Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)

Table 6-2 indicates that NO_x PECs are above the relevant AQS respective assessment metric at one receptor location, ER46. However, this exceedances was also predicted at the same location in the Do Minimum scenario, and the process contribution attributed to the Local Development Plan is below 1µg m^{-3} at all receptor locations. NO_x impacts on ecological receptors from the road contribution can therefore be regarded as **not significant**.

6.2 Nitrogen Deposition Rates at Ecological Receptors

Table 6-3 details the results of the deposition analysis for nitrogen at ecological receptors.

Table 6-3 - Nitrogen Deposition Rates at Ecological Receptors

Receptor ID	CL (kg N ha^{-1} yr^{-1})	PC (kg N ha^{-1} yr^{-1})	%PC of CL_{min} (%)	Background Deposition rate (kg N ha^{-1} yr^{-1})	PEDR (kg N ha^{-1} yr^{-1})
ER1	15-25	0.01	0.08	15.3	15.3
ER5	15-25	0.02	0.11	15.3	15.3
ER8	15-25	<0.01	0.03	16.5	16.5
ER9	15-25	<0.01	0.03	18.3	18.3
ER10	15-25	0.01	0.05	18.3	18.3
ER13	15-25	-0.06	-0.39	18.3	18.3
ER14	15-25	-0.03	-0.20	18.3	18.3
ER15	15-25	<0.01	<0.01	18.3	18.3
ER18	15-25	<0.01	0.01	18.3	18.3

Receptor ID	CL (kg N ha^{-1} yr^{-1})	PC (kg N ha^{-1} yr^{-1})	%PC of CL_{min} (%)	Background Deposition rate (kg N ha^{-1} yr^{-1})	PEDR (kg N ha^{-1} yr^{-1})
ER22	5-10	<0.01	0.03	13.3	13.3
ER24	5-10	<0.01	-0.05	16.2	16.2
ER29	5-10	0.02	0.45	16.2	16.3
ER30	5-10	0.02	0.37	16.2	16.3
ER31	5-10	0.01	0.18	16.2	16.2
ER33	5-10	0.02	0.36	16.2	16.3
ER37	5-10	<0.01	0.02	16.2	16.2
ER38	5-10	<0.01	0.02	16.2	16.2
ER40	8-10	<0.01	0.01	13.3	13.3
ER41	8-10	<0.01	0.01	13.3	13.3
ER43	5-10	<0.01	0.04	13.2	13.2
ER45	5-10	<0.01	0.08	13.2	13.2
ER46	5-10	0.01	0.19	13.2	13.2
ER48	5-10	<0.01	0.05	13.2	13.2
CL = Critical load – *the CL selected for each designated site relates to its most N-sensitive habitat (or a similar surrogate) listed on the site citation for which data on Critical Loads are available and is also based on a precautionary approach using professional judgement.* PC = Process contribution PEDR = Predicted environmental deposition rate (= PC + background)					

Negative Process Contribution (PC) values represent a reduction in the contribution towards nitrogen deposition between the DM and DS scenarios, likely due to changes in road layouts associated with the new developments. ER13, ER14 and ER24 are seeing a reduction in the process contribution from the modelled roads in the 2040 DS scenario. Despite the exceedance of the nitrogen deposition critical load at all ecological receptor locations, the PC towards nutrient nitrogen deposition is less than 1% of the minimum critical load at all sites. Furthermore, the background rate alone exceeds the critical load all locations. Nutrient nitrogen deposition from the road contribution can therefore be regarded as **not significant**.

6.3 Acid Deposition Rates at Ecological Receptors

Table 6-4 details the results of the nitric acid deposition at ecological receptors

Table 6-4 - Nitric Acid Deposition Rates at Ecological Receptors

Receptor ID	CL (kg eq ha^{-1} yr^{-1})	N PC (kg eq ha^{-1} yr^{-1})	%N PC of CL_{min}	N PEDR (keq ha^{-1} y^{-1})
ER1	0.9	<0.01	0.3	1.1
ER5	0.9	<0.01	0.5	1.1
ER8	0.9	<0.01	0.1	1.2
ER9	0.9	<0.01	0.2	1.3
ER10	0.9	<0.01	0.2	1.3
ER13	0.9	-0.01	-2.0	1.3
ER14	0.9	-0.01	-0.8	1.3
ER15	0.9	<0.01	0.0	1.3
ER18	0.9	<0.01	0.0	1.3
ER22	0.2	<0.01	0.0	1.0
ER24	0.2	<0.01	-0.1	1.2
ER29	0.2	0.01	0.7	1.2

Receptor ID	CL (kg eq ha^{-1} yr^{-1})	N PC (kg eq ha^{-1} yr^{-1})	%N PC of CL_{min}	N PEDR (keq ha^{-1} y^{-1})
ER30	0.3	<0.01	0.5	1.2
ER31	0.3	<0.01	0.3	1.2
ER33	0.3	<0.01	0.5	1.2
ER37	0.3	<0.01	0.0	1.2
ER38	0.3	<0.01	0.0	1.2
ER40	n/a	<0.01	0.0	1.0
ER41	n/a	<0.01	0.0	1.0
ER43	0.3	<0.01	0.1	0.9
ER45	0.3	<0.01	0.1	0.9
ER46	0.3	<0.01	0.3	0.9
ER48	0.3	<0.01	0.1	0.9

CL = Critical load – *the CL selected for each designated site relates to its most N-sensitive habitat (or a similar surrogate) listed on the site citation for which data on Critical Loads are available and is also based on a precautionary approach using professional judgement.*
PC = Process contribution
PEDR = Predicted environmental deposition rate (= PC + background)
N/A = No CL exists for these habitats

Negative Process Contribution (PC) values represent a reduction in the contribution towards nitrogen deposition between the DM and DS scenarios, likely due changes in road layouts associated with the new developments. As with nitrogen deposition, ER13, ER14 and ER24 are seeing a reduction in the process contribution from the modelled roads in the 2040 DS scenario. Despite exceedances of the minimum critical load, the PC towards the nitrogen component of acid deposition is less than 1% of the minimum critical load at all ecological sites considered, and the background rate alone exceeds the critical load for all sites. The nitrogen component of acid deposition from the road contribution can therefore be regarded as **not significant**.

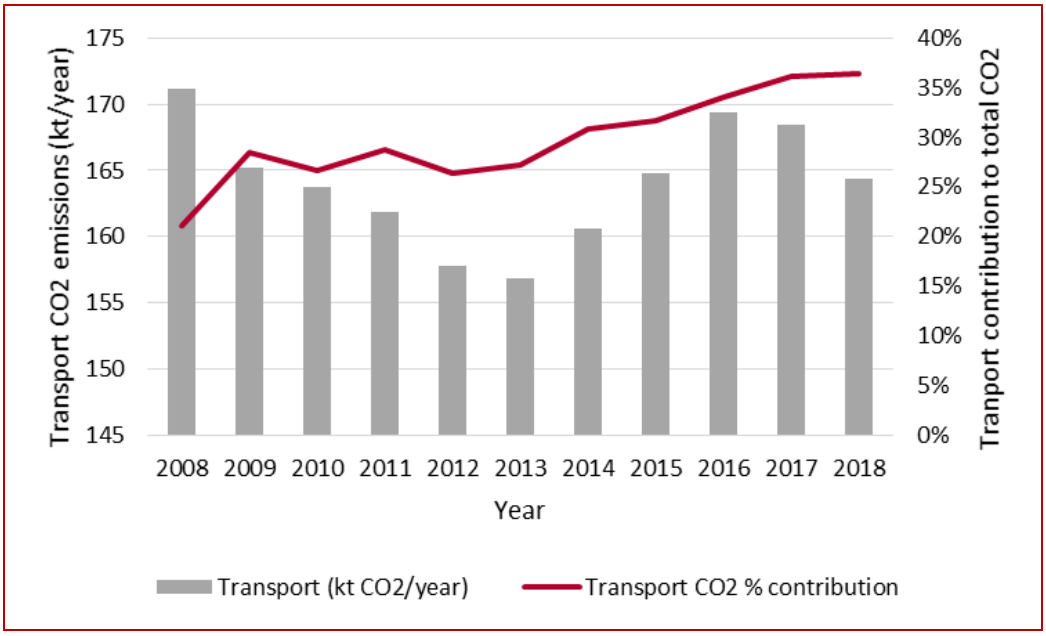
7. Climate Change Emissions

CO_2, alongside other greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O), trap heat from the sun that is radiated from the Earth's surface. Human activities, such as from burning fossil fuels, has increased the presence of the greenhouse gases and contributed to an enhanced greenhouse effect, increasing temperatures and contributing to climate change. The Intergovernmental Panel on Climate Change (IPCC) predicts that by 2100 the average global temperature will increase by between 1.4°C and 5.8°C above 1990 temperatures. Even if excess greenhouse gases ceased today, the climate would continue to change for another 30–40 years as it adjusts slowly to the increased gases of recent decades. Changes to the earth's climate will affect all aspects of life including food sources, wildlife and sea levels and it is considered the greatest environmental challenge facing the world today[26].

CO_2 is the UK's most prevalent greenhouse gas, estimated in 2018 to make up 81% of the UK's total greenhouse gas emissions, with 28% of the UK's total CO_2 emissions from the transport sector[27]. The UK Government's 2018 Greenhouse Gas Emissions report estimates that 2018 UK CO_2 emissions have reduced nationally by 2.2% in comparison to 2017.

According to the UK local authority and regional carbon dioxide emissions (2005-2018)[28], Dover District Council's estimate for transport CO_2 emissions in 2018 was 164.4 kilotonnes (kt), accounting for 36.4% of the 451.6kt total CO_2 estimated for Dover in 2018. Estimated CO_2 emissions from transport within Dover declined between 2008-2013 followed by an increase in emissions between 2013-2016. Since 2016, the emission trend has been decreasing, however despite this; the contribution of the transport sector to overall CO_2 emissions across the District indicates a gradual increase over the 10-year period (Figure 6-1).

Figure 6-1 – CO_2 percentage and kt/year Emissions as Transport Source in Dover District Council



[26] https://uk-air.defra.gov.uk/assets/documents/ozone-uv/Tackling_Climate_Change_defra.pdf

[27] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf

[28] https://www.gov.uk/government/collections/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics

7.1 Modelled CO_2 Emissions

In order to predict CO_2 emissions, the EFT, as detailed in Section 4.2 was utilised. The EFT is capable of predicting annual CO_2 tailpipe emissions associated with traffic flows that have been entered into the tool. The annual link emissions option is selected to generate emissions in tonnes/year for each road link. Emission factors for CO_2 are those published by the Department for Transport in June 2009. The emission factors have been combined with new information on Fleet Composition on different road types collected as part of the National Atmospheric Emissions Inventory and information from Transport for London, prepared as part of the London Mayor's Transport Strategy, to allow total emission from a particular road link to be calculated.

It should be noted that there are limitations in the ability for the EFT to estimate CO_2 emissions. As the emission factors utilised are from 2009, there is likely to be some uncertainty with regards to the present day forecasts. At the time of preparing the tool, this was the most up to date information available. In comparison, the UK local authority and regional carbon dioxide emissions national statistics publication, as presented above, combines data from the UK's Greenhouse Gas Inventory with data from a number of other sources, including local energy consumption statistics, to produce a nationally consistent set of carbon dioxide emission estimates at local authority level from 2005 to 2018. A comparison of both these sources is beneficial to attempt to ascertain a more detailed interpretation of how CO_2 emissions are generated within the local authority.

Table 7-1 below details the estimated contribution of CO_2 emissions associated with the modelled area within Dover. It can be seen that in total, the modelled network in Dover contributes to approximately 150.3t/year of CO_2 in 2019, which is 91% of the total contribution of CO_2 from transport emissions in 2018 (latest available estimate). This high percentage contribution was expected as the modelled domain includes all major roads within the District, with the remaining CO_2 contributions from the transport sector originating from roads outside of the model domain and other transport such as diesel railways.

When comparing the two 2040 modelled scenarios, there is an increase of 15.9kt CO_2/year under the DS scenario when compared to the DM scenario, equating to an increase of 10%. This suggests that the planned local development across the region will have an impact on the district's CO_2 contribution from the transport sector. In order to influence overall CO_2 emissions within the borough, a borough wide approach is required that targets all areas of the borough rather than just those areas considered to be hot spot areas for poor air quality.

Table 7-1 – Baseline 2019 Modelled CO_2 Concentration Compared to Local Authority Estimate Values for 2018

Model Scenario	Modelled CO_2 (kt/year)	Dover 2018 Total Transport CO_2 (kt/year)	Contribution to 2018 CO_2 Transport Emissions	Dover 2018 All Sources CO_2 (kt/year)	% Contribution Grand Total 2018 CO_2 Emissions
Baseline - 2019	150.3	164.4	91%	451.6	33%

Table 7-2 - Comparison of Modelled CO_2 Emissions between Scenarios

Model Scenario	Modelled CO_2 (kt/year)	Difference between DM2040 and DS2040 (kt CO_2/year)	Percentage increase (%)
Do Minimum - 2040	167.2	**+15.9**	10%
Do Something - 2040	183.1		

8. Recommended Mitigation Measures

As identified in Section 5, the implementation of the Local Development Plan is not predicted to significantly impact air quality or increase the number of sensitive receptors which are exposed to poor air quality. However, multiple receptors have been highlighted as being subjected to either a slight or moderate impact associated with implementation of the Local Development Plan. Therefore it is important for the Local Development Plan to not be a part of a wider cumulative impact or creeping baseline.

The Kent and Medway Air Quality Planning Guidance outlines a number of mitigation measures in terms of the operational phase of a development. The mitigation options selected for a development should be relevant and appropriate to:

- Any local policies including Air Quality Action Plans, which may determine the mitigation priorities that the local authority may wish to be incorporated within a particular scheme
- Any local air quality concerns; to assist in the mitigation of potential cumulative air pollution impacts of the development on the local community; and
- The type, size and activity of the development.

Standard mitigation plus the following mitigation measures should be considered:

Residential:

- Travel plan (where required) including mechanisms for discouraging high emission vehicle use and encouraging the uptake of low emission fuels and technologies
- A Welcome Pack available to all new residents online and as a booklet, containing information and incentives to encourage the use of sustainable transport modes from new occupiers
- Eco-driver training and provision of eco-driver aid to all residents
- EV recharging infrastructure within the development (wall mounted or free standing in-garage or off-street points)
- Car club provision within development or support given to local car club/eV car clubs
- Designation of parking spaces for low emission vehicles
- Improved cycle paths to link cycle network
- Adequate provision of secure cycle storage
- Using green infrastructure, in particular trees* to absorb dust and other pollutants

Commercial/Industrial:

- As above plus: -
- Differential parking charges depending on vehicle emissions
- Public transport subsidy for employees
- All commercial vehicles should comply with either current or previous European Emission Standard
- Fleet operations should provide a strategy for considering reduced emissions, low emission fuels and technologies
- Use of ultra low emission service vehicles
- Support local walking and cycling initiatives
- On-street EV recharging
- Contributing funding to measures, including those identified in air quality action plans and low emission strategies, designed to offset the impact on air quality arising from new development

Additional mitigation:

- Contribution to low emission vehicle refuelling infrastructure
- Low emission bus service provision or waste collection services

- Bike/e-bike hire schemes
- Contribution to renewable fuel and energy generation projects
- Incentives for the take-up of low emission technologies and fuels

*For guidance on selecting the best air quality species please refer to the Urban Air Quality 2012 Woodland Trust document

The above lists are not exhaustive and further options may be suggested where the Council feels it is appropriate, depending on the scale of development and air quality issues within an area. The developer may also suggest alternative mitigation options not listed above provided that they clearly show the air quality benefits

9. Conclusions

Bureau Veritas UK Ltd has been commissioned by Dover District Council to complete an Air Quality Assessment to supplement the Council's New Local Plan for future development across the district over the next 20 years. The Local Plan covers the proposed development across Dover District, the modelling assessment has therefore included all major roads and roads that are relevant to the proposed development sites. Additionally, the model domain was extended into Thanet, to ensure that proposed development was not adversely affecting air quality in the neighbouring Local Authority.

This assessment has been completed based upon the requirements outlined by the Council, and following the methodology for the assessment of operational phase air quality impacts using detailed dispersion modelling as outlined within the guidance issued by EPUK and IAQM and the Kent and Medway Air Quality Panning Guidance document.

The assessment of air quality effects in relation to the operation of the developments outlined in the Local Plan has been undertaken qualitatively in accordance with the impact designations presented within the EPUK/IAQM Guidance. The assessment considered ambient NO_2 and PM_{10} concentrations to which existing and new receptors may be exposed to if the Local Plan were to proceed. This was based on a review of current site layout plans, pollutant concentrations and the predicted traffic generated from the development, supported by the relevant guidance.

Baseline modelling was completed for 2019 in order to calculate a verification factor to apply to the future year modelling. The 2019 model highlighted an area of exceedance in the Deal / Walmer area, illustrated in Figure 5-4, which is not within a declared AQMA. At present, there is currently monitoring by a nearby primary school but no monitoring taking place closer to the junction where the exceedances are reported. There is inherent uncertainty in dispersion modelling and we recommend that monitoring site(s) be deployed in this area to confirm the results and inform future planning decisions. As a conservative approach, it may also be worth considering modelling an interim year prior to 2040 that includes developments that will be completed prior to the final year set out in the Local Plan.

From the modelling completed it has been shown that the Local Development Plan has a negligible effect upon annual mean concentrations of NO_2 and PM_{10} at most receptor locations. However, there were some receptor locations that have been associated with slight or moderate effects caused by the following developments:

NO_2:

- Mid Town – DOV018 (slight)
- Managed Expansion of Whitfield – WHI008 (slight)
- Dover Waterfront – DOV017 (moderate)

PM_{10}:

- Mid Town – DOV018 (slight)
- Managed Expansion of Whitfield – WHI008 (moderate)
- Footpath field, Staple Rd – WIN014 / WIN003 (slight)

Mitigation measures in line with the Kent and Medway guidance should be implemented to ensure that the predicted impact from the development does not lead to an adverse effect on air quality in the region.

It should be noted that although there were significant increases at receptors associated with the above developments, only one exceedance of the NO_2 AQS objective was reported at the worst-case receptor location associated with the Dover Waterfront development (DR82). This exceedance was also reported in the 2040 DM modelling scenario, i.e. assuming that the Local Plan was not implemented, and the increase in NO_2 concentration attributed to the development at this location was only 0.5µg/m^3. No exceedances of the AQS objective for PM_{10} was reported for all receptor locations. Further consideration should be given to the planned use of the Dover Waterfront development to avoid introducing new receptors to an area of poor air quality. Therefore, provided the mitigation measures are followed, the impact on local air quality conditions arising from increased traffic flows as a result of the implementation of the Local Development Plan can be described as **not significant** with regards to human receptors.

The assessment also considered the contribution towards CO_2 emissions in Dover as a result of the implementation of the Local Development Plan. There is a predicted increase of 15.9kt CO_2/year under the DS scenario when compared to the DM scenario, equating to an increase of 10%. This suggests that the planned local development across the region will have an impact on the district's CO_2 contribution from the transport sector. In order to reduce overall CO_2 emissions within the borough, a borough wide approach is required that targets all areas of the borough rather than transport emissions alone.

The assessment has also considered emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. When considering nutrient nitrogen deposition, NO_x PECs are above the relevant AQS respective assessment metric at one receptor location, ER46 (located within Thanet Coast & Sandwich Bay) however, the process contribution attributed to the Local Development Plan is below 1µg m^{-3} at all receptor locations. NO_x impacts on ecological receptors from the road contribution can therefore be regarded as **not significant**. Regarding the nitrogen deposition rates and acid deposition rates, there are exceedances of the CL_{min} at all sites. However, in each case the background deposition rate alone exceeds the CL_{min} prior to the addition of the road contribution. Each of the exceedances are therefore primarily attributed to the background deposition rate. The nitrogen component of acid deposition from the road contribution can therefore be regarded as **not significant**.

Appendices

Appendix A – Background to Air Quality

Emissions from road traffic contribute significantly to ambient pollutant concentrations in urban areas. The main constituents of vehicle exhaust emissions, produced by fuel combustion are carbon dioxide (CO_2) and water vapour (H_2O). However, combustion engines are not 100% efficient and partial combustion of fuel results in emissions of a number of other pollutants, including carbon monoxide (CO), particulate matter (PM), Volatile Organic Compounds (VOCs) and hydrocarbons (HC). For HC, the pollutants of most concern are 1,3 - butadiene (C_4H_6) and benzene (C_6H_6). In addition, some of the nitrogen (N) in the air is oxidised under the high temperature and pressure during combustion; resulting in emissions of oxides of nitrogen (NO_x). NO_x emissions from vehicles predominately consist of nitrogen oxide (NO), but also contain nitrogen dioxide (NO_2). Once emitted, NO can be oxidised in the atmosphere to produce further NO_2.

The quantities of each pollutant emitted depend upon a number of parameters; including the type and quantity of fuel used, the engine size, the vehicle speed, and the type of emissions abatement equipment fitted. Once emitted, these pollutants disperse in the air. Where there is no additional source of emission, pollutant concentrations generally decrease with distance from roads, until concentrations reach those of the background.

This air quality assessment focuses on NO_2 and PM_{10} (PM of aerodynamic diameter less than 10µm) as these pollutants are least likely to meet their respective Air Quality Strategy (AQS) objectives near roads. This has been confirmed over recent years by the outcome of the Local Air Quality Management (LAQM) regime. The most recent statistics[29] regarding Air Quality Management Areas (AQMAs) show that approximately 650 AQMAs are declared in the UK. The majority of existing AQMAs have been declared in relation to road traffic emissions.

In line with these results, the reports produced by the Council under the LAQM regime have confirmed that road traffic within their administrative area is the main issue in relation to air quality.

An overview of these two pollutants, describing briefly the sources and processes influencing the ambient concentrations, is presented below.

Particulate Matter (PM_{10})

Particulate matter is a mixture of solid and liquid particles suspended in the air. There are a number of ways in which airborne PM may be categorised. The most widely used categorisation is based on the size of particles such as $PM_{2.5}$, particles of aerodynamic diameter less than 2.5µm (micrometre = 10^{-6} metre), and PM_{10}, particles of aerodynamic diameter less than 10µm. Generically, particulate residing in low altitude air is referred to as Total Suspended Particulate (TSP) and comprises coarse and fine material including dust.

Particulate matter comprises a wide range of materials arising from a variety of sources. Examples of anthropogenic sources are carbon (C) particles from incomplete combustion, bonfire ash, recondensed metallic vapours and secondary particles (or aerosols) formed by chemical reactions in the atmosphere. As well as being emitted directly from combustion sources, man-made particles can arise from mining, quarrying, demolition and construction operations, from brake and tyre wear in motor vehicles and from road dust resuspension from moving traffic or strong winds. Natural sources of PM include wind-blown sand and dust, forest fires, sea salt and biological particles such as pollen and fungal spores.

The health impacts from PM depend upon size and chemical composition of the particles. For the purposes of the AQS objectives, PM_{10} or $PM_{2.5}$ is solely defined on size rather than chemical composition. This enables a uniform method of measurement and comparison. The short and long-term exposure to PM has been associated with increased risk of lung and heart diseases.PM may also carry surface-absorbed carcinogenic compounds. Smaller PM have a greater likelihood of penetrating the respiratory tract and reaching the lung to blood interface and causing the above adverse health effects.

[29] Statistics from the UK AIR website available at https://uk-air.defra.gov.uk/aqma/summary – Figures as of November 2019

In the UK, emissions of PM_{10} have declined significantly since 1980, and were estimated to be 114kt (kilotonne) in 2010[30]. Residential / public electricity and heat production and road transport are the largest sources of PM_{10} emissions. The road transport sector contributed 22% (25kt) of PM_{10} emissions in 2010. The main source within road transport is brake and tyre wear.

It is important to note that these estimates only refer to primary emissions, that is, the emissions directly resulting from sources and processes and do not include secondary particles. These secondary particles, which result from the interaction of various gaseous components in the air such as ammonia (NH_3), sulphur dioxide (SO_2) and NO_x, can come from further afield and impact on the air quality in the UK and vice versa.

Nitrogen Oxides (NO_x)

NO and NO_2, collectively known as NO_x, are produced during the high temperature combustion processes involving the oxidation of N. Initially, NO_x are mainly emitted as NO, which then undergoes further oxidation in the atmosphere, particularly with ozone (O_3), to produce secondary NO_2. Production of secondary NO_2 could also be favoured due to a class of compounds, VOCs, typically present in urban environments, and under certain meteorological conditions, such as hot sunny days and stagnant anti-cyclonic winter conditions.

Of NO_x, it is NO_2 that is associated with health impacts. Exposure to NO_2 can bring about reversible effects on lung function and airway responsiveness. It may also increase reactivity to natural allergens, and exposure to NO_2 puts children at increased risk of respiratory infection and may lead to poorer lung function in later life.

In the UK, emissions of NO_x have decreased by 62% between 1990 and 2010. For 2010, NO_x (as NO_2) emissions were estimated to be 1,106kt. The transport sector remained the largest source of NO_x emissions with road transport contribution 34% to NO_x emissions in 2010.

Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is a colourless, tasteless, odourless gas that is naturally present in the Earth's atmosphere. It is produced naturally by living organisms such as humans, animals, plants and microbes, and plays an important role in various processes that are essential for life. CO_2, alongside other greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O), have contributed the most to an enhanced greenhouse effect, increasing temperatures and contributing to climate change. CO_2 concentrations for example, have increased 30% globally since the mid-18th Century[26].

Unlike road source NO_2 and Particulate emissions, human health is not directly impacted from CO_2 vehicular emissions; however, rising CO_2 concentrations are known to greatly impact human life through its wider contribution to climate change.

[30] National Atmospheric Emissions Inventory (NAEI) Summary Emission Estimate Datasets 2010. March 2012

Appendix B – Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in the Defra's LAQM.TG(16) guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the proposed development site. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- Monitoring data, including locations; and
- Overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

Model setup parameters and input data were checked prior to running the models in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- Traffic data;
- Distance between sources and monitoring as represented in the model;
- Speed estimates on roads;
- Background monitoring and background estimates; and
- Checks on the monitoring data

NO_2 Verification Calculations

The verification of the modelling output was performed in accordance with the guidance provided in Chapter 7 of LAQM.TG(16).

Monitoring data provided by the Council, as presented in Section 3.2 has been used from the most recent available year of 2019. Two monitoring locations were excluded from the verification process, DV30, located on High St, due to low data capture (50%) and the urban background site DV04, located on Green Lane in Buckland Valley, due to the distance from modelled roads. Therefore, eleven passive NO_2 monitoring locations were used in the verification process; locations are illustrated in Figure A-1.

As per Section 3.2.2, background NO_x and NO_2 concentrations were obtained from the relevant Defra background maps for 2019. Table A-1 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2019, in order to determine if verification and adjustment was required.

Figure A-1 - Location of monitoring sites across Dover District Council that were used in the Verification Calculations

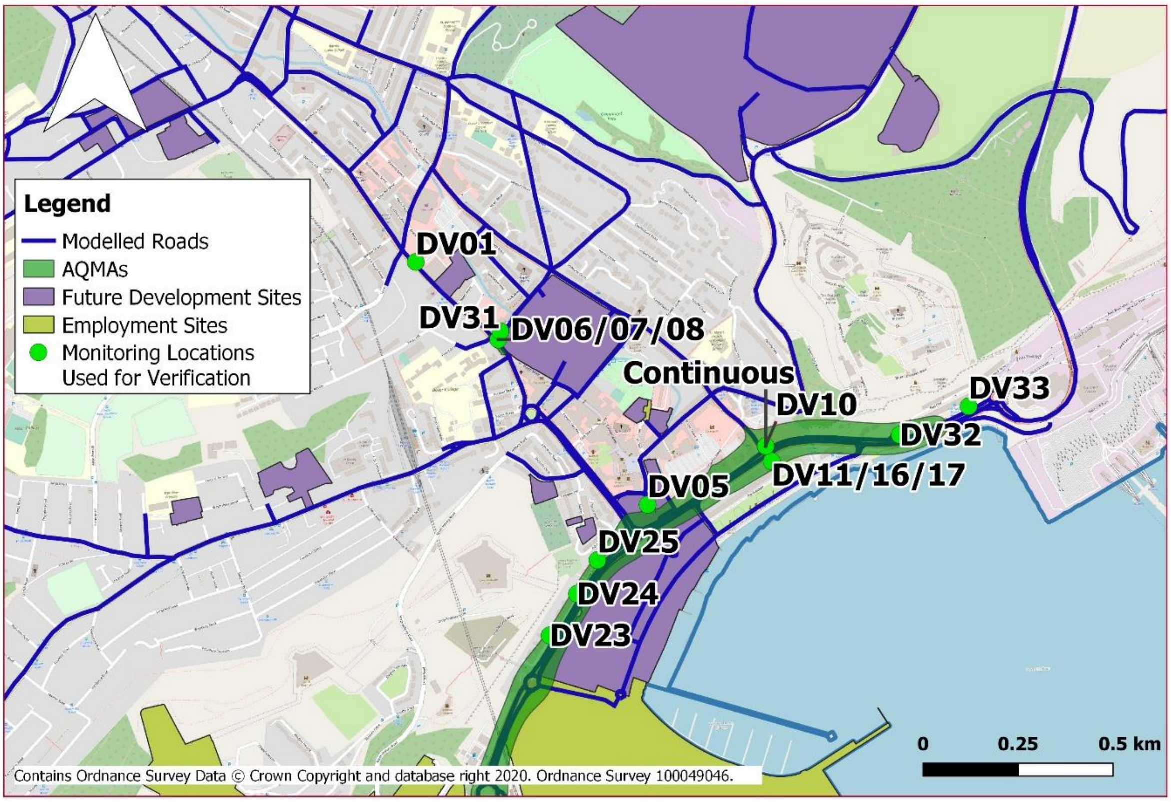


Table A-1 – Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Site Location	Background NO_2 (µg/m^3)	Monitored total NO_2 (µg/m^3)	Unverified Modelled total NO_2 (µg/m^3)	% Difference (modelled vs. monitored)
DV23	126 Snargate St	12.5	31.2	18.00	-42.27
DV24	148 Snargate St	12.4	33.7	17.75	-47.37
DV25	167 Snargate St	12.4	29.3	16.96	-42.06
DV05	Bench St	12.4	24.4	16.79	-31.10
DV11/16/17	The Gateway	13.0	28.1	19.43	-30.83
DV10	Townwall St	13.0	35.9	22.46	-37.36
DV32	1 Marine Parade	13.0	31.7	21.26	-32.93
DV33	24 Marine Parade	13.0	35.9	20.84	-41.90
DV06/07/08	Town Hall	12.4	39.8	22.81	-42.67
DV01	95 High St	12.4	30.8	17.60	-42.83
DV31	3 Ladywell	12.4	31.5	19.67	-37.51

The model was under predicting at the majority of locations, all model inputs were checked to be accurate and no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations was greater than ±25% at all locations, with all locations under predicting, meaning adjustment of the results was necessary. The relevant data was then gathered to allow the adjustment factor to be calculated.

Model adjustment needs to be undertaken for roads NO_x and not NO_2. For the diffusion tube monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2; these calculations were undertaken using the NO_x to NO_2 Calculator (version 8.1) spreadsheet tool available from the LAQM website[31].

Table A-2 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x. Figure A-2 provides a comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x, and the equation of the trend line based on linear regression through zero. The Total Monitored NO_x concentration has been derived by back-calculating NO_x from the NO_x/NO_2 empirical relationship using the spreadsheet tool available from Defra's website. The equation of the trend lines presented in Figure A-2 gives an adjustment factor for the modelled results of 2.932.

[31] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

Table A-2 – Data Required for Adjustment Factor Calculation

Site ID	Monitored total NO_2 (µg/m³)	Monitored total NO_x (µg/m³)	Background NO_2 (µg/m³)	Background NO_x (µg/m³)	Monitored road contribution NO_2 (total - background) (µg/m³)	Monitored road contribution NO_x (total - background) (µg/m³)	Modelled road contribution NO_x (excludes background) (µg/m³)
DV23	31.2	53.7	12.5	17.0	18.7	36.7	10.2
DV24	33.7	59.1	12.4	16.8	21.3	42.3	9.9
DV25	29.3	49.6	12.4	16.8	16.8	32.8	8.3
DV05	24.4	39.6	12.4	16.8	11.9	22.7	8.0
DV11/16/17	28.1	47.0	13.0	17.7	15.1	29.2	12.0
DV10	35.9	63.6	13.0	17.7	22.8	45.9	17.9
DV32	31.7	54.6	13.0	17.7	18.7	36.8	15.5
DV33	35.9	63.6	13.0	17.7	22.9	45.9	14.7
DV06/07/08	39.8	72.8	12.4	16.8	27.3	56.0	19.6
DV01	30.8	52.8	12.4	16.8	18.3	36.0	9.6
DV31	31.5	54.3	12.4	16.8	19.0	37.5	13.5

Figure A-2 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x

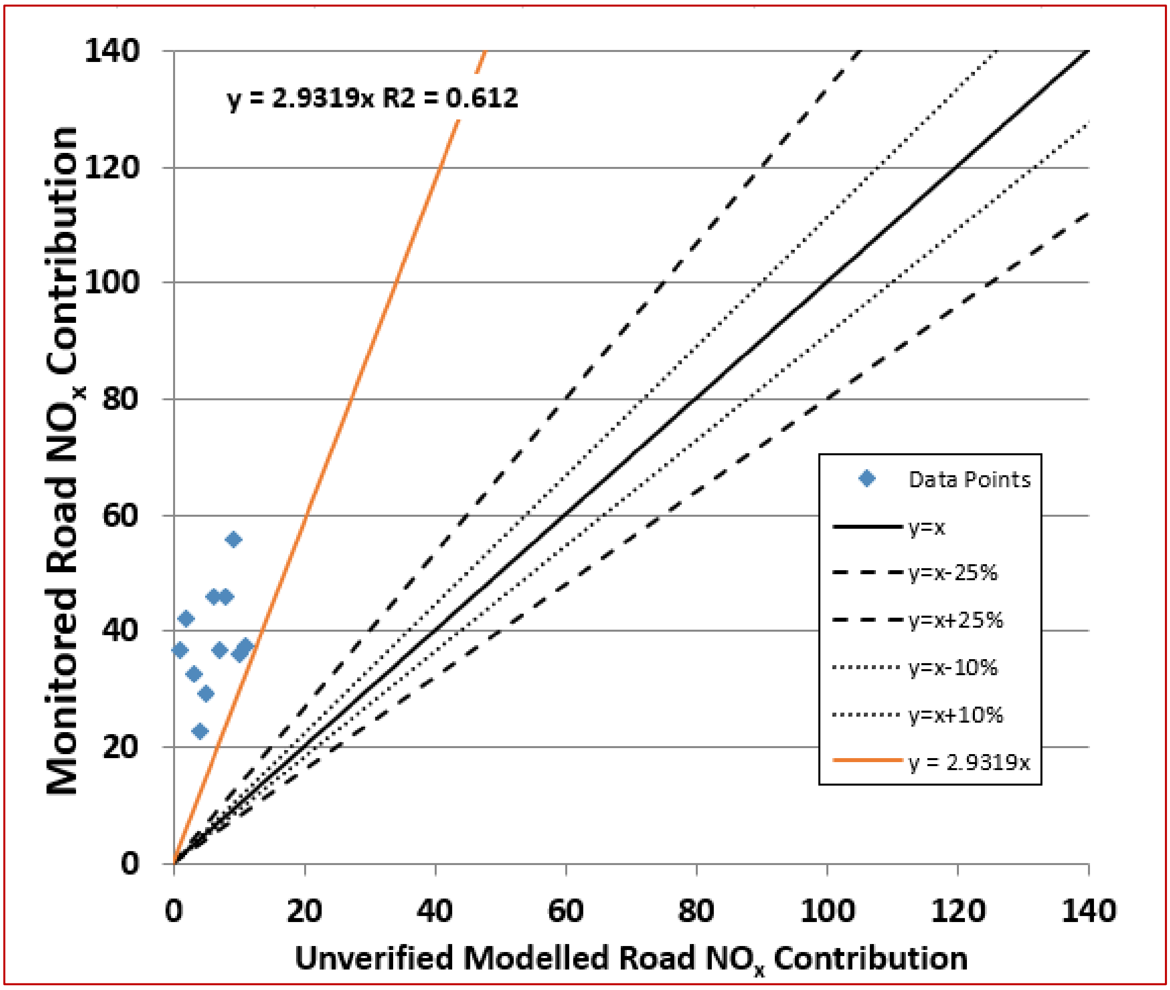


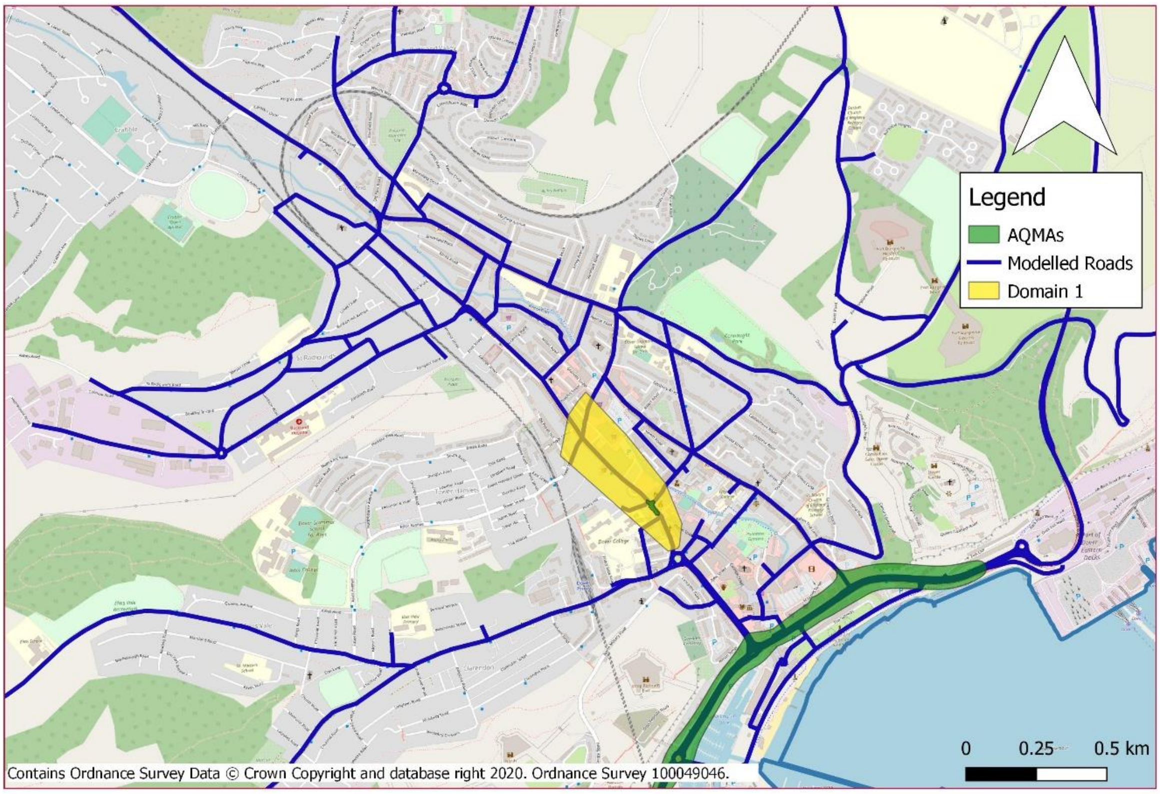
Table A-3 shows the ratios between monitored and modelled NO_2 for each monitoring location based on the above adjustment factor. Using a factor of 2.932, although all of the results are within 25% of the monitored value, the threshold deemed acceptable in TG.16, there are significant variations between the adjustment ratios across the verification points. Ideally, concentrations should be within ±10%, but 6 sites were outside of this range. Therefore, it was deemed 2.932 was not a suitable verification factor.

Table A-3 – Adjustment Factor and Comparison of Verified Results Against Monitoring Results

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m^3)	Adjusted modelled total NO_x (including background NO_x) (µg/m^3)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m^3)	Monitored total NO_2 (µg/m^3)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV23	3.59	2.932	29.96	46.91	27.96	31.18	-10.33
DV24	4.30		28.89	45.71	27.39	33.73	-18.79
DV25	3.93		24.48	41.29	25.23	29.27	-13.81
DV05	2.83		23.55	40.36	24.77	24.37	1.65
DV11/16/17	2.44		35.11	52.86	30.90	28.09	10.01
DV10	2.57		52.38	70.13	38.74	35.86	8.04
DV32	2.37		45.48	63.23	35.68	31.70	12.56
DV33	3.12		43.08	60.83	34.59	35.87	-3.56
DV06/07/08	2.85		57.57	74.38	40.48	39.79	1.74
DV01	3.76		28.05	44.87	26.99	30.78	-12.32
DV31	2.77		39.62	56.44	32.48	31.48	3.18

In order to provide more confidence in the model predictions, the model was split into two verification domains, the High Street / Ladywell area (Domain 1), that incorporates the High St / Ladywell AQMA and consists of multiple street canyons, as illustrated in Figure A-3. Domain 2 consists of the remainder of the modelled area.

Figure A-2 - Inner Verification Area: Domain 1



Splitting the modelled area into two domains results in a decrease in the model verification factor for Domain 1, and increased alignment between monitored and modelled values, as shown in Table A-4 and Figure A-3. The equation of the new trend line presented gives a decreased adjustment factor for the modelled results in Domain 1 of 2.955.

Table A-4 - Adjustment Factor and Comparison of Verified Results Against Monitoring Results in Domain 1

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m^3)	Adjusted modelled total NO_x (including background NO_x) (µg/m^3)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m^3)	Monitored total NO_2 (µg/m^3)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV06/07/08	2.85	2.955	58.02	74.84	40.68	39.79	2.25
DV31	2.77		39.93	56.75	32.62	31.48	3.63
DV01	3.76		28.27	45.09	27.09	30.78	-12.00

Figure A-3 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 1

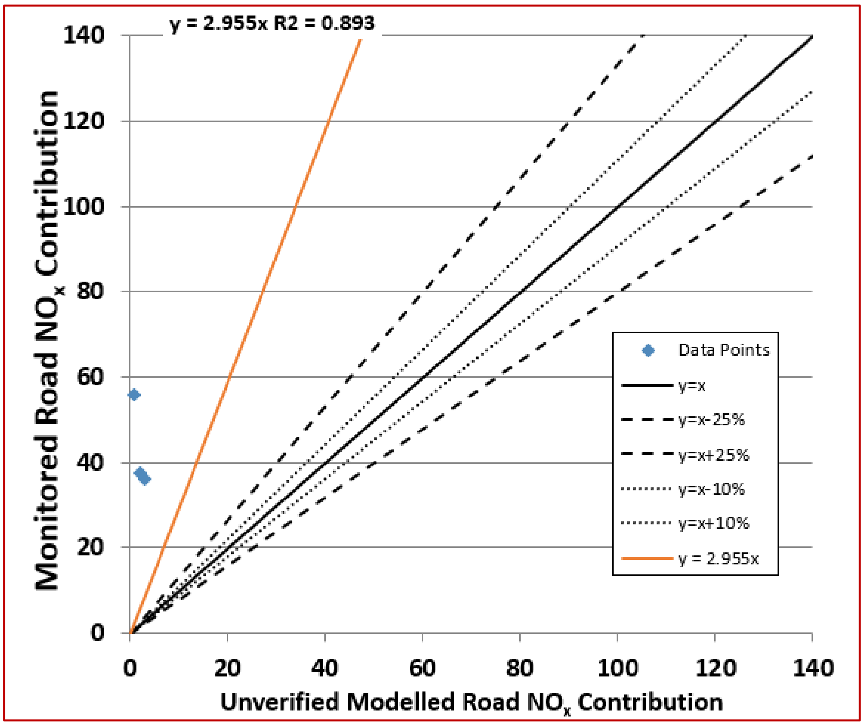
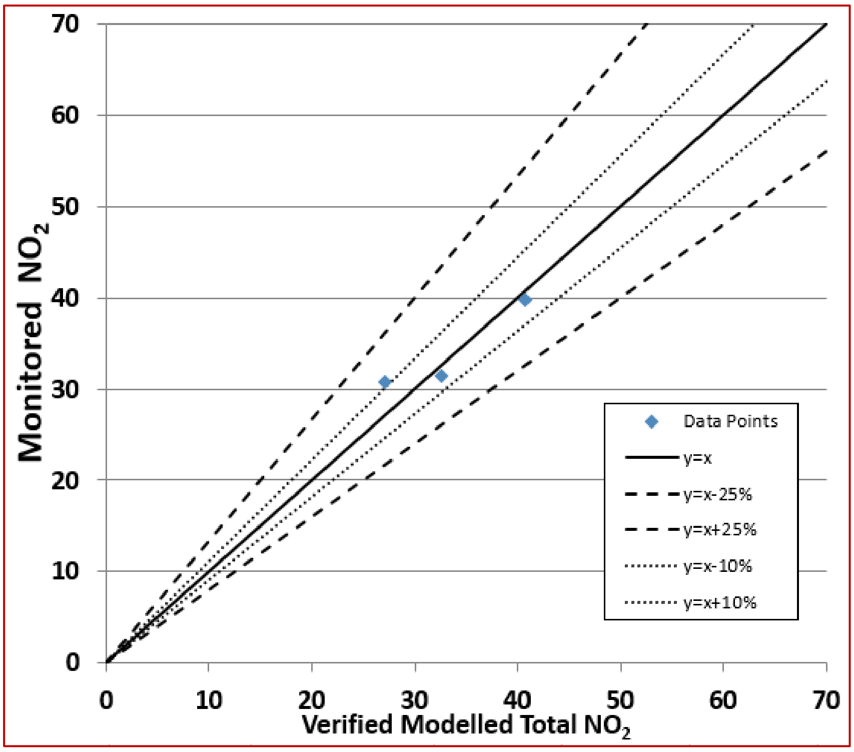


Figure A-4 - Comparison of the Modelled NO_2 versus Monitored NO_2 in Domain 1



The adjustment factor of 2.955 was applied to the road-NO_x concentrations predicted by the model in Domain 1 to arrive at the final NO_2 concentrations. The sites then show strong agreement between the ratios of monitored and modelled NO_2, all within ±25%, as shown in Figure A-4. A factor of 2.955 in Domain 1 also reduces the Root Mean Square Error (RMSE) from a value of 14.2 to 2.3, which less than the guidance value of 4µg/m³ as stated within LAQM.TG(16).

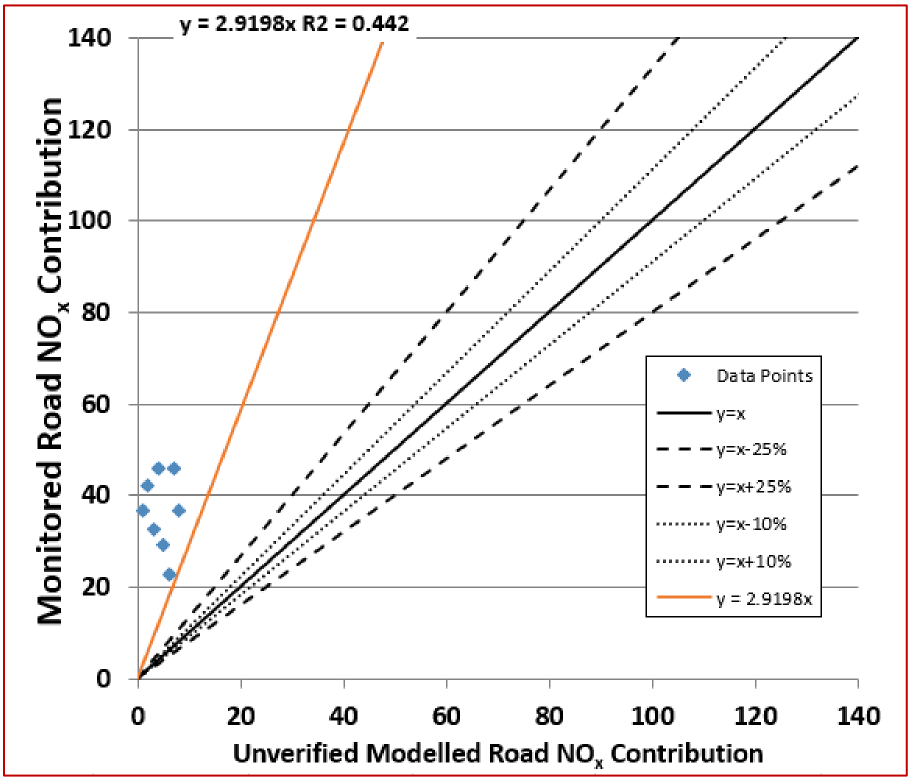
All NO_2 results residing within Domain 1 presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 2.955.

For Domain 2, splitting the modelled area results in an increase in the model verification factor, and increased alignment between monitored and modelled values, as shown in Table A-5 and Figure A-5. The equation of the new trend line presented gives an increased adjustment factor for the modelled results in Domain 2 of 2.920.

Table A-5 - Adjustment Factor and Comparison of Verified Results Against Monitoring Results in Domain 2

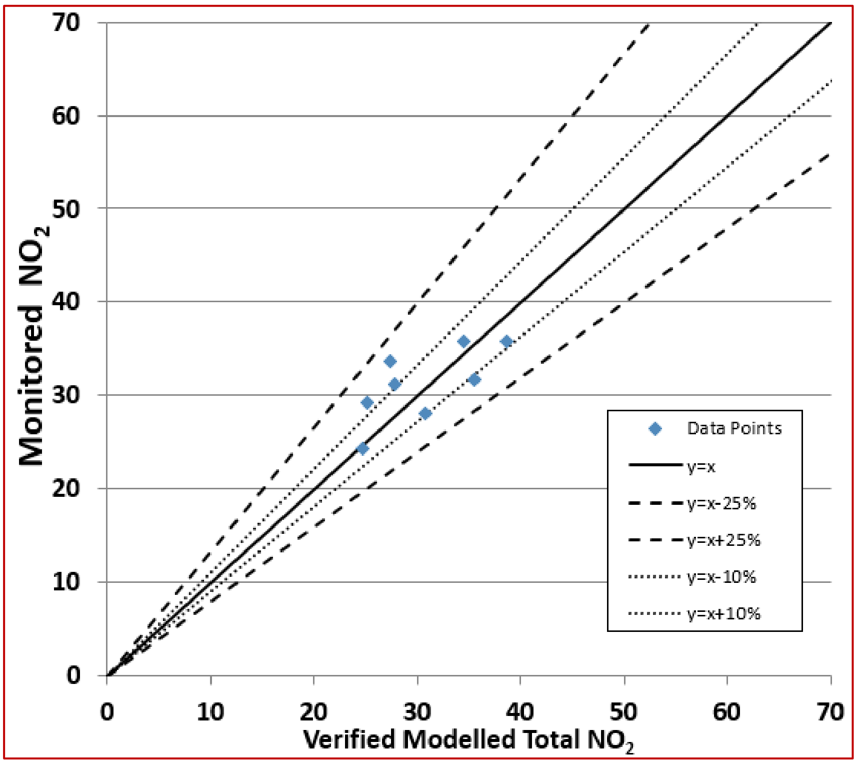
Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m³)	Adjusted modelled total NO_x (including background NO_x) (µg/m³)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m³)	Monitored total NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV23	3.59	2.920	29.84	46.79	27.90	31.18	-10.52
DV24	4.30		28.77	45.59	27.34	33.73	-18.94
DV25	3.93		24.38	41.19	25.18	29.27	-13.98
DV33	3.12		42.90	60.65	34.51	35.87	-3.78
DV11/16/17	2.44		34.97	52.72	30.83	28.09	9.76
DV05	2.83		23.45	40.26	24.72	24.37	1.44
DV10	2.57		52.16	69.91	38.65	35.86	7.79
DV32	2.37		45.29	63.04	35.59	31.70	12.28

Figure A-5 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 2



The adjustment factor of 2.920 was applied to the road-NO_x concentrations predicted by the model in Domain 2 to arrive at the final NO_2 concentrations. The sites then show strong agreement between the ratios of monitored and modelled NO_2, all within ±25%, as shown in Figure A-6. A factor of 2.920 in Domain 2 also reduces the Root Mean Square Error (RMSE) from a value of 12.4 to 3.5, which less than the guidance value of 4µg/m^3 as stated within LAQM.TG(16).

Figure A-6 - Comparison of the Modelled NO_2 versus Monitored NO_2 in Domain 2



All NO_2 results in Domain 2 presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 2.920.

LAQM.TG(16) states that:

"In order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within 25% of the monitored concentrations, ideally within 10%."

Following verification within each Domain, the sites show good agreement between the ratios of monitored and modelled NO_2, It can be seen that all of the verification points lie within ±25%, and the majority lie close to the ±10% tolerance as detailed in LAQM.TG(16).

PM_{10} Verification Calculations

The verification of the modelling output was performed in accordance with the methodology provided in Chapter 7 of LAQM.TG(16).

For the verification and adjustment of PM_{10}, the LAQM monitoring data was used, as presented in Table 3-1. Data capture for 2019 was very good at 97%. Table A-6 below shows the relevant data required to calculate the model adjustment based on the ratio of modelled and monitored road source contribution to PM_{10}.

Table A-6 – PM_{10} Verification Calculations

Site	Monitored 2019 PM_{10} (µg/m^3)	Corrected Background 2019 PM_{10} (µg/m^3)	Monitored Road Contribution (µg/m^3)	Modelled Road Contribution (µg/m^3)	Verification Factor
Dover Centre	21.6	13.9	7.73	1.43	5.420

Following the verification of PM_{10} modelled results, all results presented within the assessment for all receptors are those calculated following the process of model verification using the adjustment factor of 5.420 for PM_{10}.