BNE17

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Member of the SNC-Lavalin Group

HCC Air Quality Framework

Phase 1 (Manual)

Hampshire County Council

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Chapters 1-10

Notice

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1. Case for action

Over recent years increasing scientific evidence has emerged regarding the serious impact poor air quality can have on human health, particularly upon vulnerable groups or those with protected characteristics. This has led to an increasing awareness of the dangers of air pollution amongst the public and politicians.

Road transport is understood to contribute significantly to local air pollution and the County Council, as both local Highway Authority and Public Health authority, acknowledges the scale and breadth of the human health implications of poor air quality and the well-evidenced links to early mortality.

The county of Hampshire is a two-tier administrative area, in which statutory duties and powers are split between local authorities. These separate public sector organisations are accountable for inextricably linked responsibilities such as transport, environmental health protection and public health. This in turn leads to discreet technical specialism within different authorities, which can make agreeing and coordinating action challenging.

In 2017 the UK government published its national plan for tackling roadside concentrations of nitrogen dioxide (NO_2), with the goal of bringing locations across the country identified by national modelling to within legal limits 'in the shortest possible time', for which the County Council received a Ministerial Direction to take action in several locations, in support of local Environmental Health authorities.

This work was unprecedented in its urgency, technical requirements, and legal tests, largely due to the context of successive legal challenges brought against central government and the anticipated ongoing breach of legal limits across the country.

1.1. National Policy Context

Central government have published three national policy documents which signpost long-term strategies with steps to improve air quality and shift travel behaviour:

'Road to Zero' sets out proposed next steps to deliver cleaner road transport and support delivery of the national Industrial Strategy. This policy document proposes all new cars and vans must be zero emission by 2040 and that by 2050 almost every car and van on the road should be zero emission. In 2020 government announced plans to bring forward the 2040 target to 2035.

Government's 2017 'Cycling & Walking Investment Strategy' sets out the policy goal for doubling cycling activity by 2025 and for cycling and walking to become the natural choices for shorter journeys in every urban and rural community in England.

These aspirations are also a key part of Government's 'Clean Growth Strategy'.

In addition to this, the Department for Transport is expected to publish its Transport Decarbonisation Plan in Spring 2021, which will likely be of relevance relevant to tackling emissions harmful to human health.

1.2. Local Policy Context

Turning to local government, as both public health and highway authority the desired outcomes of Hampshire's corporate priorities are set out in 'Serving Hampshire – Strategic plan for 2017–2021' of which air quality is of either primary or secondary relevance:

- Outcome 1: Hampshire maintains strong and sustainable economic growth and prosperity (Secondary)
- Outcome 2: People in Hampshire live safe, healthy and independent lives (Primary)
- Outcome 3: People in Hampshire enjoy a rich and diverse environment (Primary)
- Outcome 4: People in Hampshire enjoy being part of strong, inclusive communities (Primary)

Hampshire's duties as Highway Authority in relation to air quality and transport are set out in the existing Local Transport Plan (LTP), last revised in 2013. Vehicle emissions will be at the forefront of the next Local Transport Plan, which is in the early stages of development at the time of writing.

1.3. Developing an evidence base

As a result of the high-profile, nitrogen dioxide national plan work, (combined with the increasing scientific evidence of harm, shifting national policy, growing public awareness and reciprocal political scrutiny), a joint report by the Director of Economy, Transport & Environment and the Director of Public Health in November 2018 secured Cabinet approval for the County Council to undertake a "coordination role" on air quality issues within Hampshire as outlined, where this is related to core functions as both highway and public health authority.

Neither transport or air pollution adhere to administrative boundaries and the County Council is well placed to both develop a strategic overview and help coordinate action to tackle transport emission across the Hampshire geography, including working closely with the neighbouring unitary authorities of Southampton and Portsmouth.

To make effective transport policy, strategy and planning decisions equitably across the widest geographic area and grow operational knowledge, a County Council-owned road transport & emissions evidence base is required. This initial document has been developed as an information resource for County Council officers, Members and Hampshire residents.

It utilises existing air quality and transport data to provide a baseline 'snapshot' of current road transport emissions across Hampshire and applies established, nationally recognised guidance and methodologies to report anticipated future improvements.

This evidence base also considers the disproportionate burden of poor air quality impacts on vulnerable groups, those with protected characteristics or areas of higher deprivation, where future action could be prioritised where need is evidenced to be greatest.

Given the weight of growing scientific evidence, the County Council is committed to ensuring health and environmental impacts of transport emissions from local roads are appropriately considered in discharging its duties to manage and maintain a safe and well-functioning transport network. This position has been reinforced by the County Council's declaration of a Climate Change Emergency.

2. National Trends: Emissions and Air Pollutants

2.1. What are the air pollutants with legal ceiling limits?

2.1.1. Air Quality Legislation

Air quality legislation covers both emission of pollutants to air and ambient concentrations of pollutants in the air and is based on EU Directives transposed into UK law. The data presented here is correct and in line with legislation as at February 2020.

Internationally agreed limits ('ceilings') are currently applicable for emissions of nitrogen oxides, ammonia, non-methane volatile organic compounds, and sulphur dioxide - as detailed in the National Emission Ceilings Regulations 2018 (SI 2018/129).

2.1.2. Pollutant Emissions

Emissions of pollutants and commitments to reduce them are covered by the National Emission Ceilings Regulations 2018 (SI 2018/129). These Regulations transpose the requirements of the EU National Emission Ceilings Directive 2016/2284/EU into UK law. The Directive is periodically updated to continuously move emissions reductions forward.

The Regulations have been subsequently amended by the Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 (SI 2019/74) to enable the Regulations to operate within the UK legal framework after the UK's withdrawal from the EU.

The Regulations cover national emission reduction commitments from 2020 and from 2030 for five air pollutants: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$).

The reduction limits applied to the UK are as follows:

- SO_2 reduction compared with 2005
  - For years 2020 to 2029 – 59%
  - From 2030 – 88%
- NO_X reduction compared with 2005
  - For years 2020 to 2029 – 55%
  - From 2030 – 73%
- NMVOC reduction compared with 2005
  - For years 2020 to 2029 – 32%
  - From 2030 – 39%
- NH_3 reduction compared with 2005
  - For years 2020 to 2029 – 8%
  - From 2030 – 16%
- $PM_{2.5}$ reduction compared with 2005
  - For years 2020 to 2029 – 30%
  - From 2030 – 46%

Reducing total emissions will help to protect human health and the environment. To date the UK is compliant with its 2010 national emission ceilings for air pollutants as defined in EU Directive 2001/81/EC[1](see section 2.2.1).

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0081&from=EN

2.1.3. Pollutant Concentrations

Air pollutant concentrations are regulated in the UK by the Air Quality Standards Regulations (SI 2010 No. 1001)[2] which implement the EU Directive on ambient air quality and cleaner air for Europe (2008/50/EC). As the Directive has been transposed into UK law, it will remain in force following the EU Exit. The Regulations set limit values, target values, and alert thresholds[3] for the protection of human health, and an exposure reduction target for $PM_{2.5}$. There are also critical levels set for the protection of vegetation. Statutory responsibility for achieving EU limit values rests with the Secretary of State.

In addition, national air quality objectives are regulated by the Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment) Regulations 2002 (SI 2002 No. 3043)[4,5]. Local authorities have a duty to work towards achieving national air quality objectives.

Fundamentally air quality standards must be met by the compliance date, while air quality objectives are an intent.

2.1.4. National Air Quality Strategy

The Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland[6] (UK AQS) sets out the national air quality standards and objectives for a number of local air pollutants.

Standards - are set by expert organisations with regard to scientific and medical evidence on the effects of the particular pollutant on health and define the level of pollution below which health effects are expected to be minimum or low risk even for the most sensitive members of the population.

Objectives - are targets for air pollution levels to be achieved by a specified timescale, which take account of the costs and benefits of achieving the standard, either without exception or, for certain short-term averaging period standards, with a permitted number of exceedances. Local authorities have a responsibility (under Part IV of the Environment Act 1995) to review and assess local pollution levels against these objectives.

It should be noted that the national air quality objectives for human health only apply in locations likely to have 'relevant exposure' i.e. where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. The AQS also includes objectives for the protection of vegetation and ecosystems.

In January 2019, the UK Government published a Clean Air Strategy[7] which sets out actions to improve air quality by reducing pollution from a wide range of sources. Within the strategy, the Government proposes a target to reduce the population exposed to concentrations of $PM_{2.5}$ above 10 µg/m^3 by 2025 – a draft approach is expected by Autumn 2020

The national air quality objectives and the EU limit and target values for the protection of human health and vegetation and ecosystems are presented in Table 2-1 and Table 2-2.

Further information on legislation and policies, particularly at a regional and local level, is described in Chapter 3 Air Quality & Legislation.

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[2] The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made

[3] 'limit value' is the level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period and not to be exceeded once attained.
'target value' is the level fixed with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained where possible over a given period.
'alert threshold' is a level beyond which there is a risk to human health from brief exposure for the population as a whole and at which immediate steps are to be taken by the Member States.

[4] The Air Quality (England) Regulations 2000: http://www.legislation.gov.uk/uksi/2000/928/contents/made

[5] The Air Quality (England) (Amendment) Regulations 2002: http://www.legislation.gov.uk/uksi/2002/3043/contents/made

[6] Department for Environment, Food and Rural Affairs (Defra), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1

[7] Department for Environment, Food and Rural Affairs, 2019, Clean Air Strategy. [Online]. Available: https://www.gov.uk/government/publications/clean-air-strategy-2019 [Accessed February 2020].

Table 2-1 - National air quality objectives and EU limit and target values for the protection of human health[8]

Pollutant	Applies	Objective	Concentration measured as	Date to be achieved by (and maintained thereafter)	European Obligations	Date to be achieved (by and maintained thereafter)
Particles (PM_{10})	UK	50 µg/m³ not to be exceeded more than 35 times a year	24 hour mean	31 December 2004	50 µg/m³ not to be exceeded more than 35 times a year	1 January 2005
	UK	40 µg/m³	annual mean	31 December 2004	40 µg/m³	1 January 2005
	Indicative 2010 objectives for PM_{10} (from the 2000 strategy and Addendum) have been replaced by an exposure reduction approach for $PM_{2.5}$ (except in Scotland – see below)					
	Scotland	50 µg/m³ not to be exceeded more than 7 times a year	24 hour mean	31 December 2010	50 µg/m³ not to be exceeded more than 35 times a year	1 January 2005
	Scotland	18 µg/m³	annual mean	31 December 2010	40 µg/m³	1 January 2005
Particles ($PM_{2.5}$) Exposure Reduction	UK (except Scotland)	25 µg/m³	annual mean	2020	Target value - 25 µg/m³	2010
	Scotland	10 µg/m³		31 December 2020	Limit value - 25 µg/m³	1 January 2015
	UK urban areas	Target of 15% reduction in concentrations at urban background		Between 2010 and 2020	Target of 20% reduction in concentrations at urban background.	Between 2010 and 2020

[8] Defra, The air quality strategy for England, Scotland, Wales and Northern Ireland: Volume 1, March 2011, https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf. Accessed Jan 2020

Nitrogen dioxide	UK	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31 December 2005	200 µg/m^3 not to be exceeded more than 18 times a year	1 January 2010
	UK	40 µg/m^3	annual mean	31 December 2005	40 µg/m^3	1 January 2010
Ozone	UK	100 µg/m^3 not to be exceeded more than 10 times a year	8 hour mean	31 December 2005	Target of 120 µg/m^3 not to be exceeded by more than 25 times a year averaged over 3 years	31 December 2010
Sulphur dioxide	UK	266 µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31 December 2005	-	-
	UK	350 µg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31 December 2004	350 µg/m^3 not to be exceeded more than 24 times a year	1 January 2005
	UK	125 µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31 December 2004	125 µg/m^3 not to be exceeded more than 3 times a year	1 January 2005
Polycyclic Aromatic Hydrocarbons	UK	0.25 ng/m^3 B[a]P	as annual average	31 December 2012	1.0 ng/m^3	31 December 2012
Benzene	UK	16.25 µg/m^3	running annual mean	31 December 2003	-	-
	England and Wales	5 µg/m^3	annual average	31 December 2010	5 µg/m^3	1 January 2010

	Scotland, Northern Ireland	3.25 µg/m³	running annual mean	31 December 2010	-	-
1,3-butadiene	UK	2.25 µg/m³	running annual mean	31 December 2003	-	-
Carbon monoxide	UK	10 mg/m³	maximum daily running 8 hour mean/in Scotland as running 8 hour mean	31 December 2003	10 mg/m³	1 January 2005
Lead	UK	0.5 µg/m³	annual mean	31 December 2004	0.5 µg/m³	1 January 2005
	UK	0.25 µg/m³	annual mean	31 December 2008	-	-

Table 2-2 - National air quality objectives and European Directive limit and target values for the protection of vegetation and ecosystems[8]

Pollutant	Applies	Objective	Concentration measured as	Date to be achieved by (and maintained thereafter)	European Obligations	Date to be achieved by (and maintained thereafter)
Nitrogen oxides	UK	30 µg/m^3	annual mean	31 December 2000	30 µg/m^3	19 July 2001
Sulphur dioxide	UK	20 µg/m^3	annual mean	31 December 2000	20 µg/m^3	19 July 2001
	UK	20 µg/m^3	winter average	31 December 2000	20 µg/m^3	19 July 2001
Ozone: protection of vegetation and ecosystems	UK	Target value of 18,000 µg/m^3 based on AOT40[9] to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	Average over 5 years	1 January 2010	Target value of 18,000 µg/m^3 based on AOT40 to be calculated from 1 hour values from May to July, and to be achieved, so far as possible, by 2010	1 January 2010

[9] AOT40 = Accumulated Ozone over Threshold of 40 ppb

2.1.5. What are the WHO criteria?

The WHO air quality defined criteria (known as “guidelines”[10]) are designed to offer guidance in reducing the health impacts of air pollution.

They are aimed at an international audience and have been adopted by national, and unions of, Governments and international organisations.

They are health-based targets, acknowledging that some pollutants, namely particulate matter and sulphur dioxide, do not have objective based safe concentration limits. For these pollutants interim targets are proposed to encourage a constant reduction of public exposure.

The stated WHO guidelines, as published in 2005 are presented in Table 2-3 below alongside the values for the objectives adopted within the UK Air Quality Strategy.

Table 2-3 – WHO Guidelines

Pollutant	Measured as	WHO Target Value (µg/m³)				UK AQS
		Interim Target 1 (IT-1)	Interim Target 2 (IT-2)	Interim Target 3 (IT-3)	Air Quality Guideline (AQG)	
PM_{10}	Annual Mean	70	50	30	20	40
	24 hour mean	150	100	75	50	50 (35 exceedances)
$PM_{2.5}$	Annual Mean	35	25	15	10	25
	24 hour mean	75	50	37.5	25	No objective set
Ozone	8 hour mean	240	160	-	100	100 (10 exceedances)
NO_2	Annual Mean	-	-	-	40	40
	1 hour Mean	-	-	-	200	200 (18 exceedances)
SO_2	24 hour mean	125	50	-	20	125 (35 exceedances)
	1 hour Mean	-	-	-	500	350 (24 exceedances)

2.1.6. Greenhouse gases legal limits and legislation

Greenhouse gas emissions are legislated under the Climate Change Act 2008. Greenhouse gases are not harmful to human health or to the environment but are important for their contribution to climate change. The Climate Change Act 2008 set a target for the year 2050 for an 80% reduction of greenhouse gas emissions from a baseline of 1990.

In 2019 the Climate Change Act was amended to change the target to a more ambitious 100% reduction from 1990 levels (The Climate Change Act 2008 (2050 Target Amendment) Order 2019 (SI 2019/1056). The Secretary of State has a duty to ensure that this target is met.

[10] WHO (2005) Air quality guidelines – global update 2005. Available online: https://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/. Accessed Jan 2020.

The Climate Change Act requires the government to set legally-binding ‘carbon budgets’ to act as stepping stones towards the 2050 target. A carbon budget is a cap on the amount of greenhouse gases emitted in the UK over a five-year period.

Of all the greenhouse gases, carbon dioxide is the largest contributor to global warming, which is why it tends to have the most focus (see Section 2.2.4). It is not the most intense greenhouse gas though (global warming potential).

The Greenhouse Gas Emissions Trading Scheme Regulations (SI 2012/3038) implements the EU Directive 2003/87EC to establish a scheme to allow greenhouse gas emission allowance trading with other countries within the EU, the EU Emissions Trading System (EU ETS). This system assists with meeting emissions reductions targets, and in the UK the carbon budgets. It largely covers industrial activities.

The UK‑EU Withdrawal Agreement ensures that relevant EU legislation, including that relating to the EU ETS is transposed into national law for the immediate future (up to January 2021). The UK government issued a consultation on the Future of UK Carbon Pricing in May 2019 regarding a future system once the UK leaves the EU.

Leaving the EU will not affect commitments under the Climate Change Act and the UK will also remain a Party to international climate change agreements, including the Paris Agreement.

2.2. National pollutant trends

Air pollutants are emitted from sources such as vehicle exhausts and industrial processes (emissions). The extent to which air pollution is harmful to human health and the environment depends on the location of the emission source relative to exposure, how the pollutants travel through the atmosphere (see chapter 7) and the concentration of pollutant at the point of exposure. Concentrations are thus the amount of emitted pollutant contained in a volume air (suspended in a form that humans can breath in). The key to health impact is thus how much pollutant is emitted and how well and how quickly that pollutant is mixed with ambient air.

2.2.1. Emissions

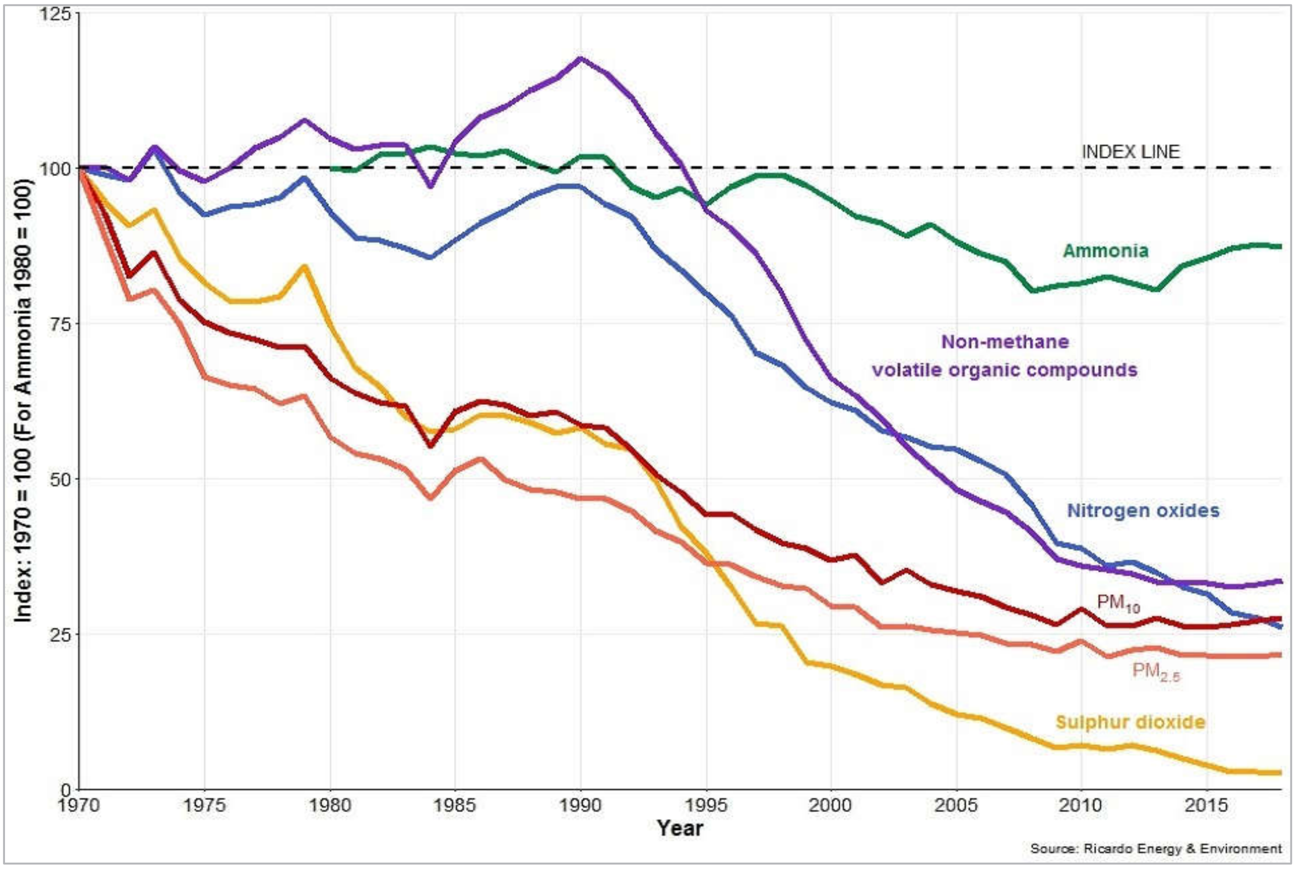
The UK continues to meet current EU emission ceilings levels under the National Emission Ceilings Regulations 2018[11]. A long term decrease in emissions has been achieved for the 5 pollutants covered by the National Emissions Ceilings Directive (ammonia, nitrogen oxides, non-methane volatile organic compounds, fine particulate matter ($PM_{2.5}$) and sulphur dioxide). This trend of reduction is illustrated in Figure 2-1 below which shows total annual UK emissions between 1970 and 2018, indexed to a 1970 (or 1980 for ammonia) base year[11].

The most significant reductions are for sulphur dioxide, although substantial reductions in fine particulate matter, NOx and NMVOCs have also been observed. Reductions have been achieved through a range of policy and legislative actions and technological advances including improvements or changes to fuel use, transport efficiency and changing transportation habits.

Emissions of ammonia have not declined at the same rate as the other pollutants, largely because of increases from certain aspects of the agricultural sector, such as increases in the use of nitrogen fertilizers and from dairy cattle.

[11] Defra, Emissions of air pollutants in the UK, 1970 to 2018, February 2020, https://www.gov.uk/government/statistics/emissions-of-air-pollutants. Accessed February 2020.

Figure 2-1 - Trends in annual emissions in the UK: 1970 –2018[11]



2.2.2. Air Quality Trends (Concentrations)

Defra's analysis of Air Pollution in the UK 2018[12] demonstrates a marked improvement in air quality such that current concentrations of many air pollutants are now at the lowest they have been since widespread monitoring began. This has been largely driven by environmental legislation and technological advances.

Trends in pollutant emissions and ambient concentrations are generally linked, such that a reduction in emissions results in a reduction in concentrations. However, depending on the pollutant, the two are not directly proportional.

The trends in concentrations vary through space and time. Throughout the UK, there has been a general improvement in all pollutant concentrations, however this has not always resulted in the same rate of reduction at all site types, with roadside sites sometimes showing more improvement than at background or rural sites. In some locations, the rate of decline has not been as fast as expected or there has actually been an increase in concentrations. This is particularly true for NO_2 concentrations in urban areas, often as a result of local factors, such as traffic congestion in urban areas, coupled with a high uptake of diesel vehicles in these locations.

2.2.3. Trends of Air Pollution within Ecosystems

Trends of air pollution within ecosystems are provided in Trends Report 2019: Trends in critical load and critical levels exceedances in the UK[13]. See Chapter 5 for further information on the effects of air pollution on ecosystems.

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[12] Defra, Air Pollution in the UK 2018, September 2019, https://uk-air.defra.gov.uk/library/annualreport/. Accessed Feb 2020.

[13] Defra, Trends Report 2019: Trends in critical load and critical levels exceedances in the UK, December 2019. https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1908280952_Trends_Report_2019.pdf. Accessed Feb 2020.

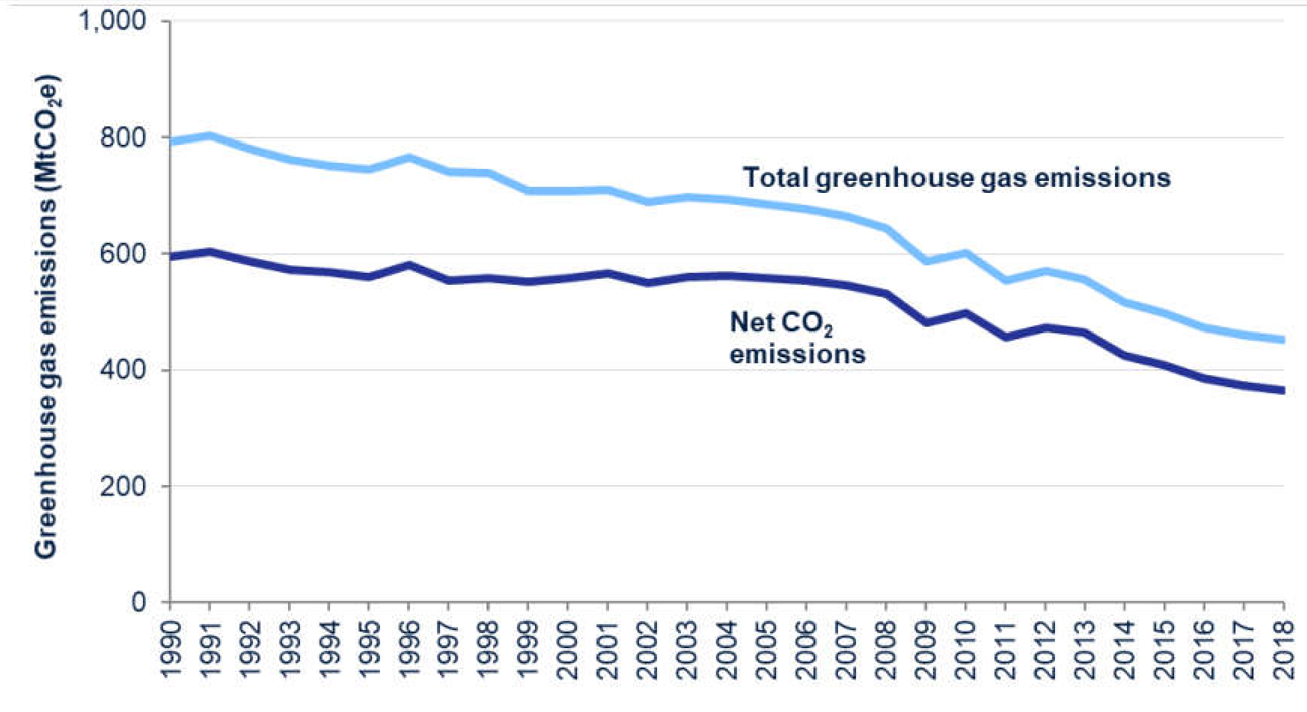
There has been a general decrease in the area of habitats in exceedance of critical loads for both nitrogen and acid deposition between 1996 and 2016. The rate of the decrease has been faster for those areas sensitive to acid deposition, as a result of a larger decrease in sulphur emissions.

There has not, however, been a clear trend for areas in exceedance of the ammonia critical levels between 2010 and 2015. There was an increase in the area exceeding the critical level for plants by 0.5%, but a decrease in the area exceeding the critical level set to protect lichens and mosses.

2.2.4. Greenhouse Gases

The UK trend in greenhouse gas emissions has shown a decrease since the 1990 baseline. In 2018 the transport sector accounted for 28% of total UK greenhouse gas emissions, making it the largest emitting sector[14]. Figure 2-2 shows the trend in greenhouse gas emissions since 1990.

Figure 2-2 - Total UK greenhouse gas emissions, 1990-2018 ($MtCO_2e$)[14]

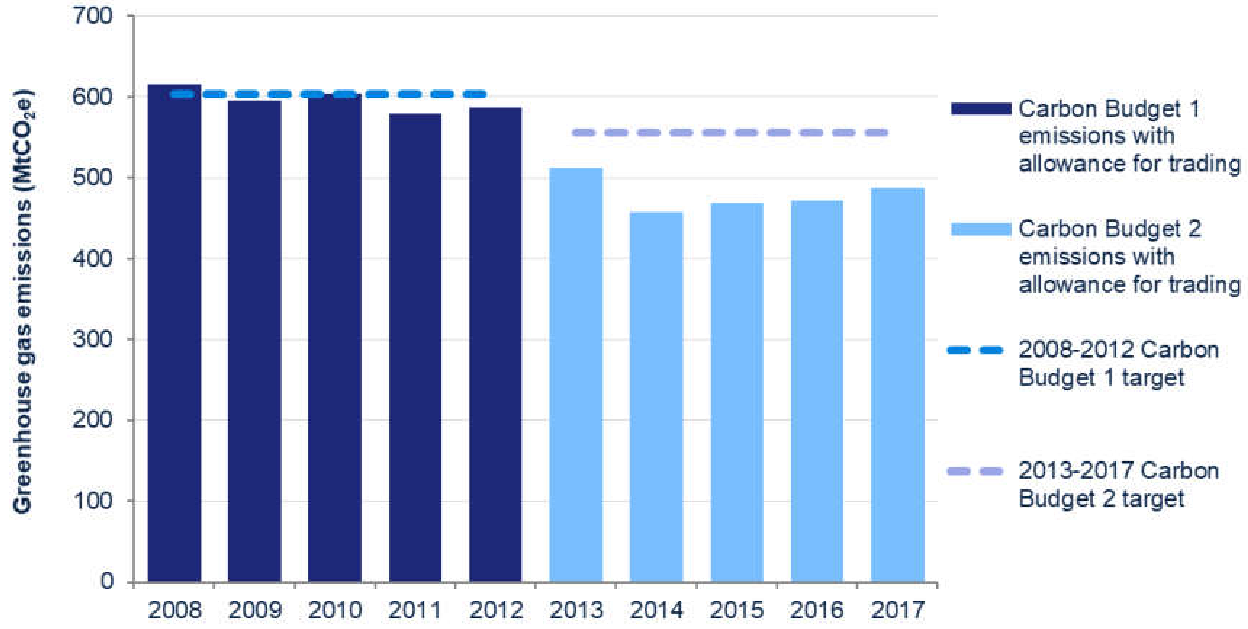


Source: Table 1, Final UK greenhouse gas emissions national statistics 1990-2018 Excel data tables

In 2018 total greenhouse gas emission were approximately 40% of 1990 levels. Figure 2-3 demonstrates that the UK had met the carbon budget targets for both 2008-2012 and 2013-2017.

[14] Defra, Final UK greenhouse gas emissions national statistics: 1990 to 2018, February 2020, https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018. Accessed February 2020.

Figure 2-3 - UK's progress towards meeting carbon budget targets ($MtCO_2e$)[14]



Source: Table 9, Final UK greenhouse gas emissions national statistics 1990-2018 Excel data tables

2.3. Road Transport Emissions Sources

2.3.1. Source Apportionment

There are two sources of local air quality-related emissions from road transport: those which are emitted from the combustion of fossil fuels through the vehicle exhaust, and those which are emitted from the deterioration of brakes, tyres and the road surface whilst driving, known as non- exhaust emissions (NEE) (shown in Figure 2.5).

The key pollutants from road traffic which are included in the National Atmospheric Emissions Inventory (NAEI)[15] include:

- Benzo(a)pyrene (B[a]p);
- Carbon Monoxide (CO);
- Ammonia (NH_3);
- Nitrogen oxides (NOx);
- Fine Particulate Matter (PM_{10} and $PM_{2.5}$);
- Lead (Pb);
- Sulphur dioxide (SO_2);
- Volatile organic compounds (VOCs); and
- Dioxins.

The greatest emissions (by weight) from road transport are NOx, CO and VOCs; quantities of B[a]p and dioxins are negligible when compared to other pollutants. Gaseous pollutants are primarily sourced from internal combustion, whereas particulate matter is additionally produced by wear of brakes and tyres and abrasion of the road surface itself.

[15] NAEI, UK National Atmospheric Emissions Inventory for 2017 Interactive Map, https://naei.beis.gov.uk/emissionsapp/. Accessed February 2020.

Figure 2-4 - Sources of vehicular emissions[16]

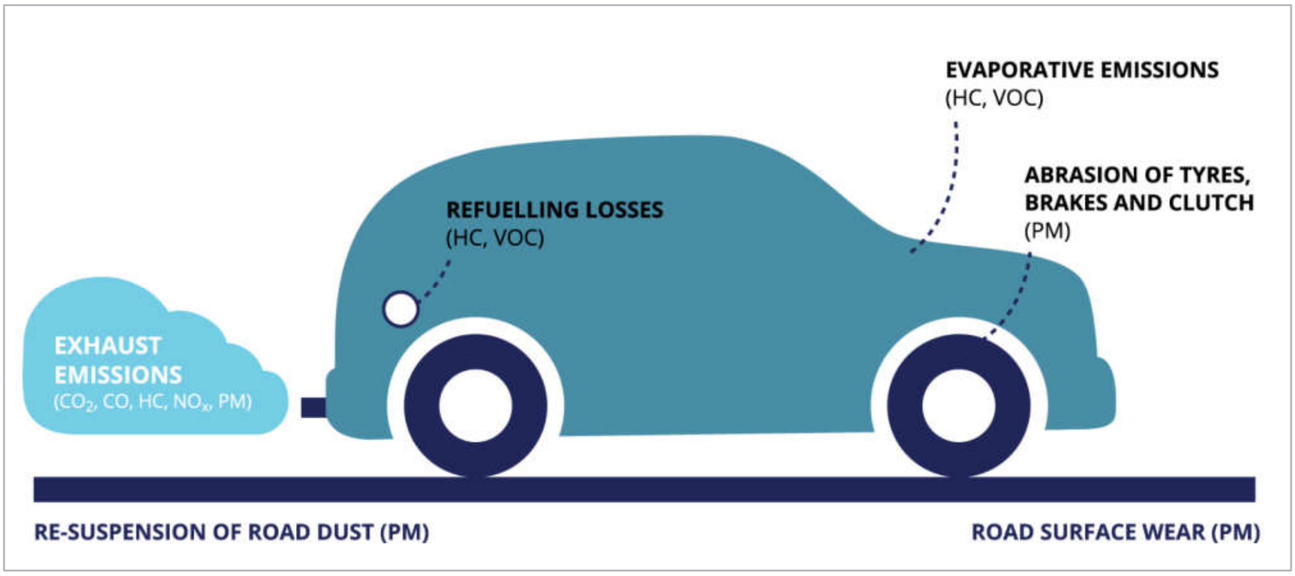


Figure 2-5 and Figure 2-6 show the total emissions of pollutants from road transport and their relative sources in England in 2017 as compiled by NAEI. They demonstrate that:

- The largest emissions from road transport are CO and NOx with smaller emissions of PM_{10}, $PM_{2.5}$ and VOCs.
- Petrol combustion accounts for the greatest percentage of CO, NH_3 and VOC emissions.
- Diesel combustion accounts for the greatest proportion of NOx, $PM_{2.5}$ and SO_2 emissions.
- non- exhaust emissions (NEE) from tyre wear and brake wear account for significant proportions of PM_{10}, $PM_{2.5}$ and Pb emissions with road abrasion also contributing to PM_{10} and $PM_{2.5}$ emissions.

[16] European Environment Agency (EEA). Different types of emissions from vehicles. https://www.eea.europa.eu/media/infographics/different-types-of-emissions-from-vehicles/view. Accessed May 2020.

Figure 2-5 - Total emissions of pollutants from road transport in England in 2017 as compiled by NAEI[15]

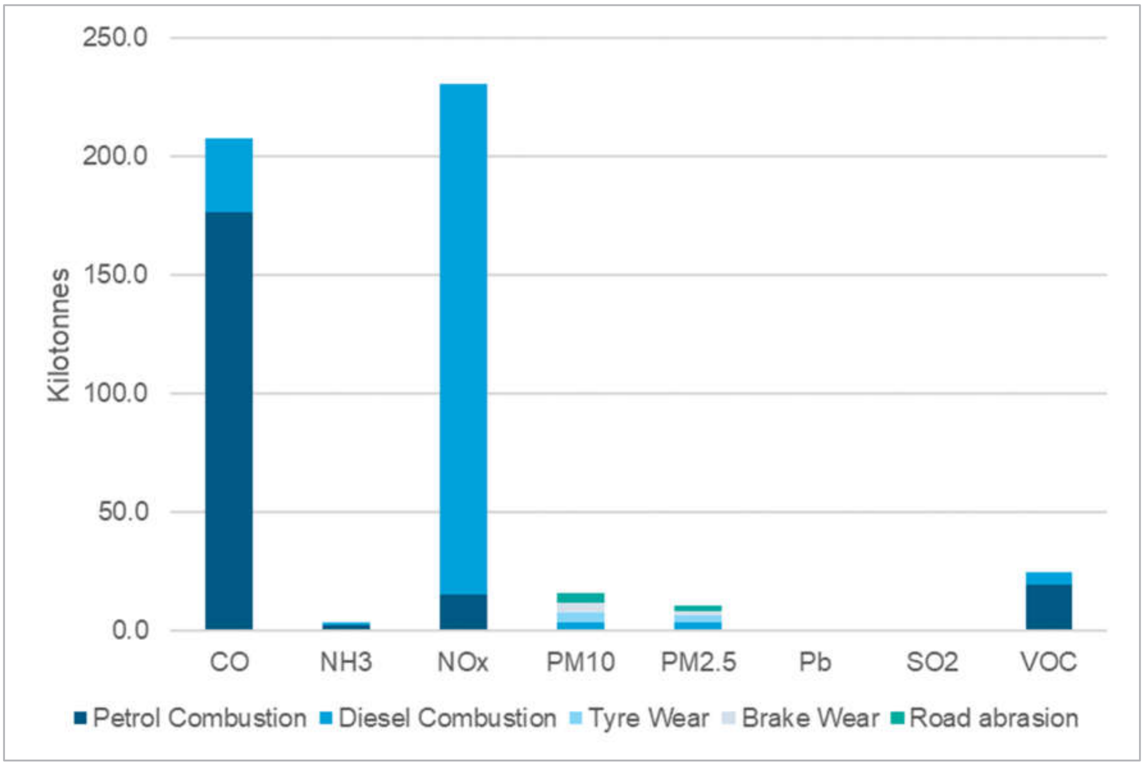
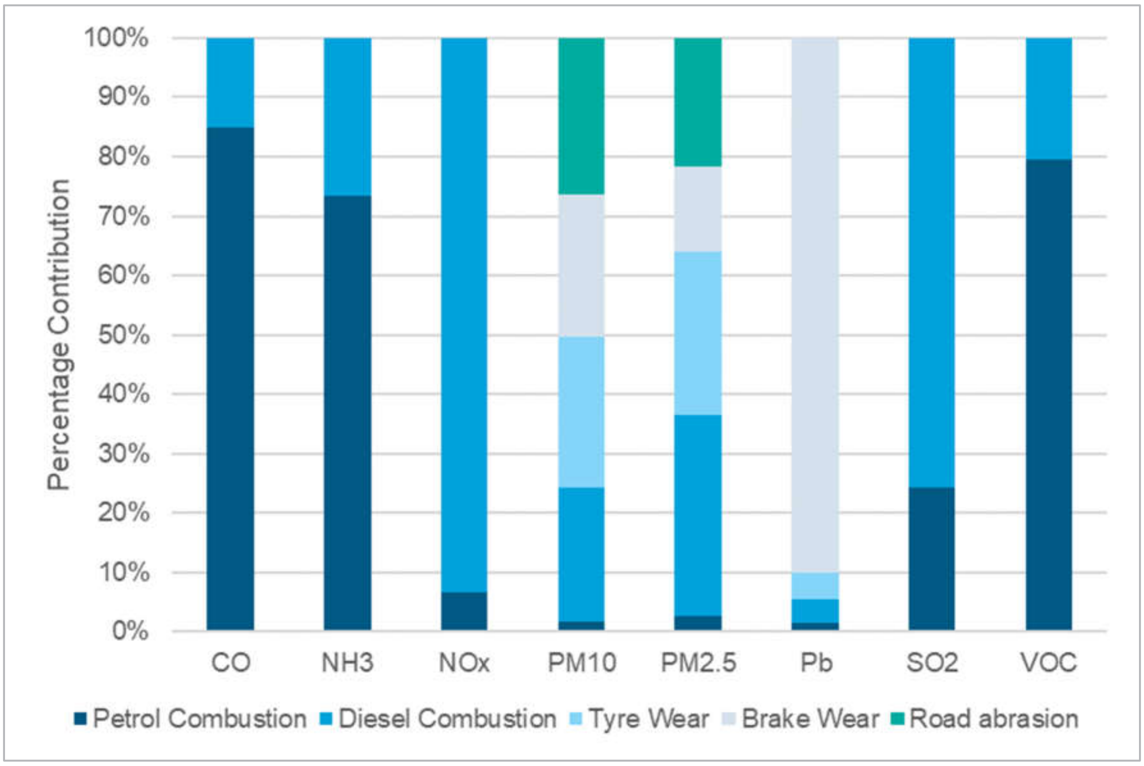


Figure 2-6 - Relative sources of pollutants from road transport in England in 2017 as compiled by NAEI[15]



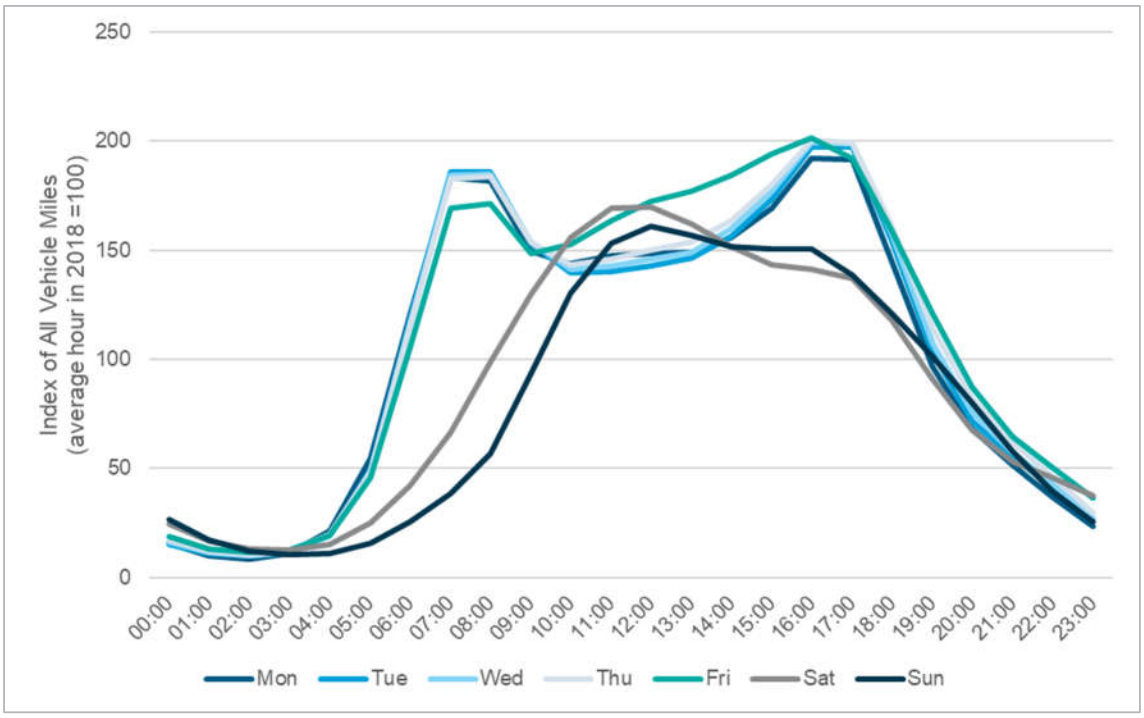
2.3.2. Profile of Road Transport Emissions

The magnitude of road transport emission is dependent on the type and age of vehicle, the number of miles driven, the driving style and fuel efficiency of the engine/chassis combination. As such, the key criterion for determining local pollution impacts is the volume of vehicle movements on a specific road link however, traffic flows, speeds and fleet composition can be highly variable, varying on an hourly, daily or seasonal basis.

Typically, on most roads, there is an AM and PM peak in traffic on weekdays which corresponds with the morning and evening rush hours to start and leave work. During the weekend, the peak tends to occur later in the day and for a longer period (essentially the afternoon). This pattern is shown in Figure 2-7. Weekend profiles can vary a lot by location - reflecting events (e.g. markets, sports matches, tourist events etc).

In areas of heavy congestion, the peak period can extend further into the day, a phenomenon known as "peak spreading", when there is little difference between the AM and PM peaks and the inter peak period during the rest of the working day.

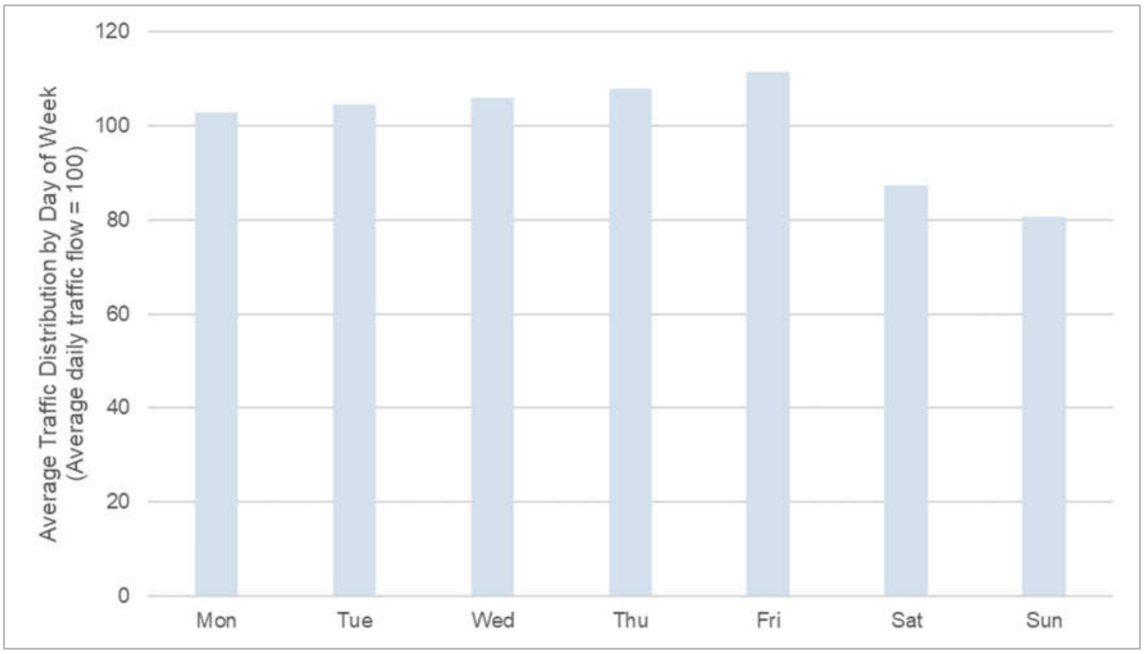
Figure 2-7 – 2018 Average Department for Transport (DfT) Diurnal Traffic Flows by Day[17]



Traffic flows can also vary by day of the week. As shown in Figure 2-8, traffic flows typically increase slightly over the course of the working week from Monday to Friday before reducing considerably at the weekends. Friday is the busiest day on average, and the Friday evening peak is often used as the worst-case period in impact assessments.

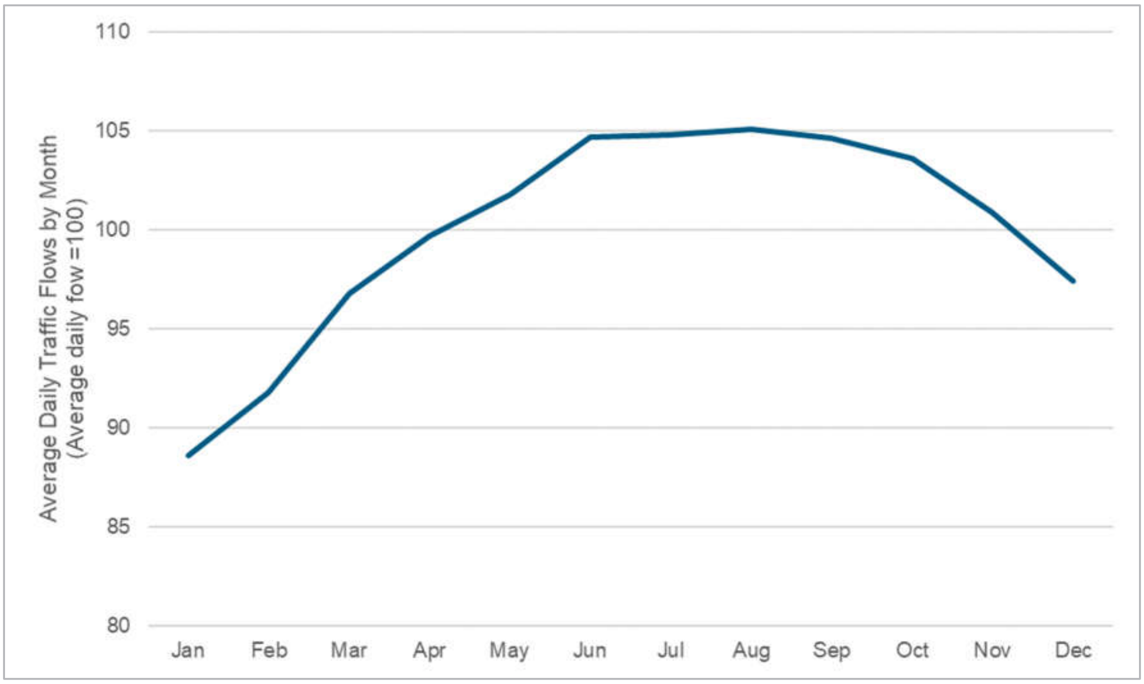
[17] DfT. Road traffic estimates in Great Britain: 2018, May 2019, https://www.gov.uk/government/statistics/road-traffic-estimates-in-great-britain-2018. Accessed Feb 2020.

Figure 2-8 - 2018 Average Department for Transport (DfT) Traffic Flows by Day Across an Average Week[17]



Traffic flows also vary by month of the year. As shown in Figure 2-9, daily traffic flows are typically lowest in January, and highest in the summer months, where flows peak in August before declining to December. Average months in any given year tend to be April and November.

Figure 2-9 - 2018 Average Department for Transport (DfT) Traffic Flows by Month[17]

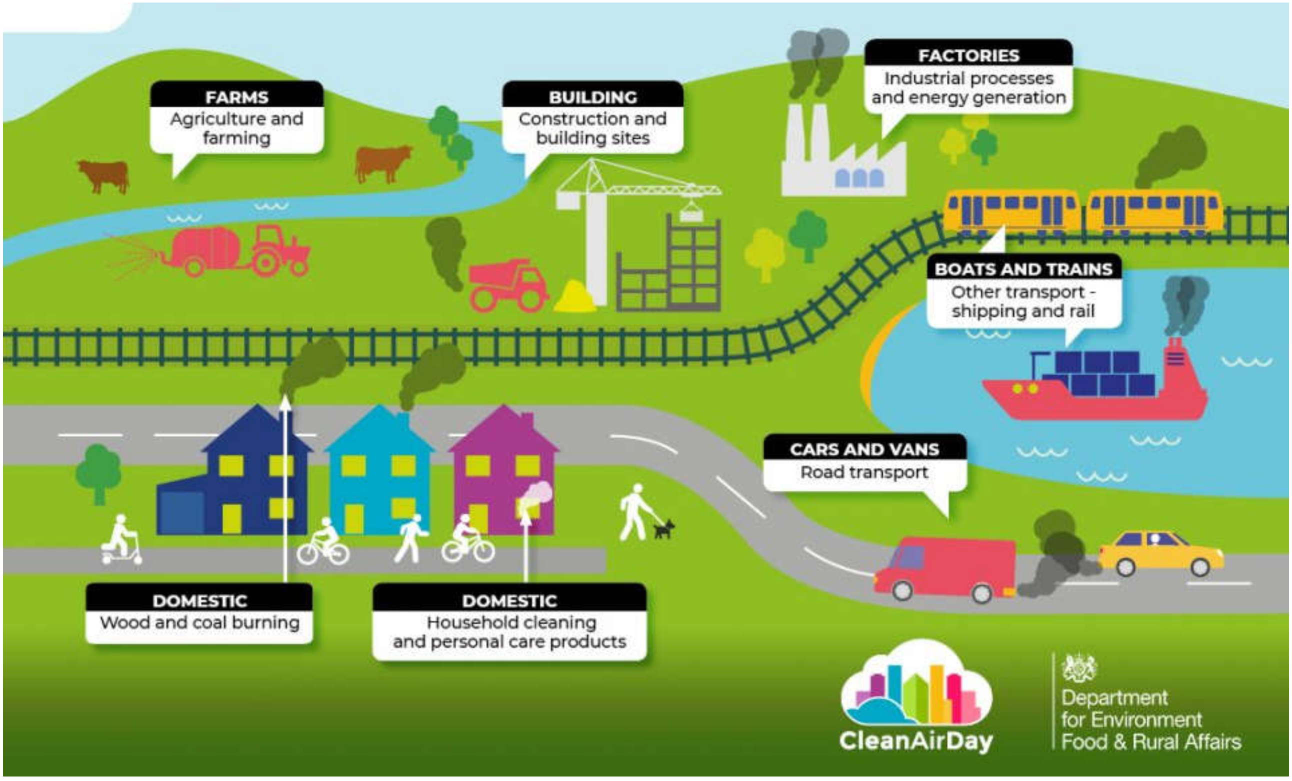


2.4. What are the primary sources of each of pollutants & which are predominantly road transport emissions?

2.4.1. General sources

The image below shows the primary sources of air pollutants. Emissions mainly result from combustion activities although for specific pollutants non-combustion sources can also be significant.

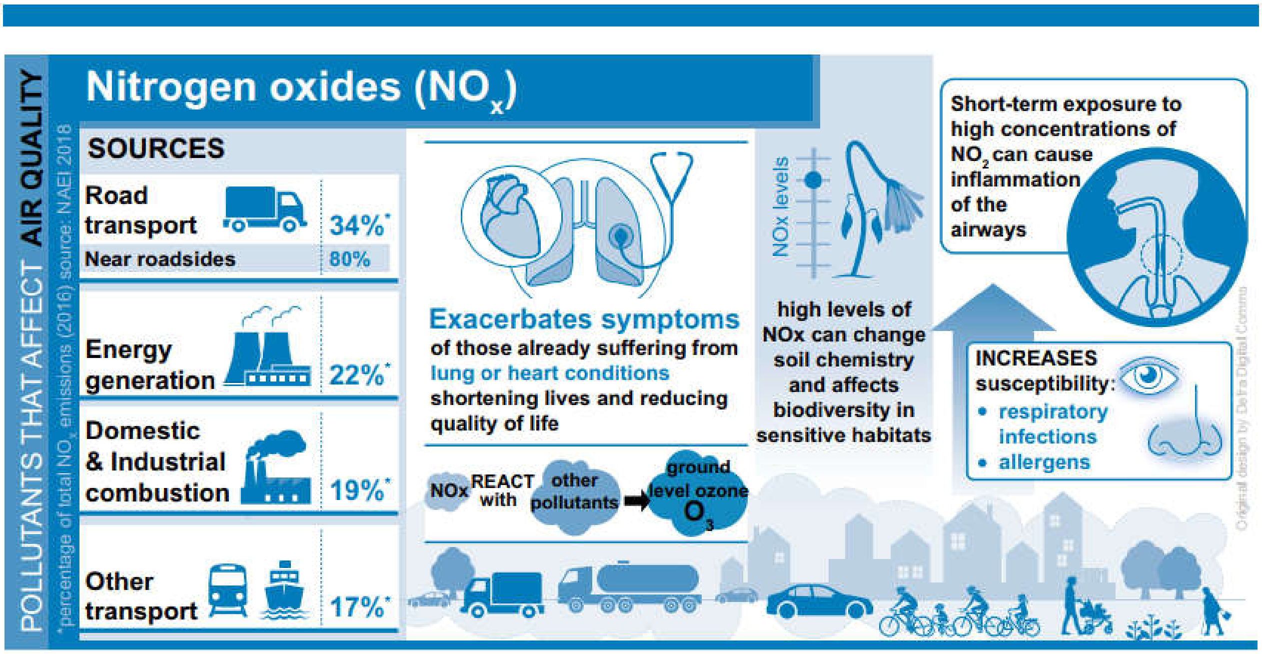
Figure 2-10 - Sources of air pollution[18]



[18] Global Action Plan and Defra, "Where does air pollution come from?", https://www.cleanairhub.org.uk/where-does-air-pollution-come-from. Accessed February 2020.

2.4.2. By Pollutant - Nitrogen oxides (NOx)

Figure 2-11 - Nitrogen oxides sources, impacts and effects[7]



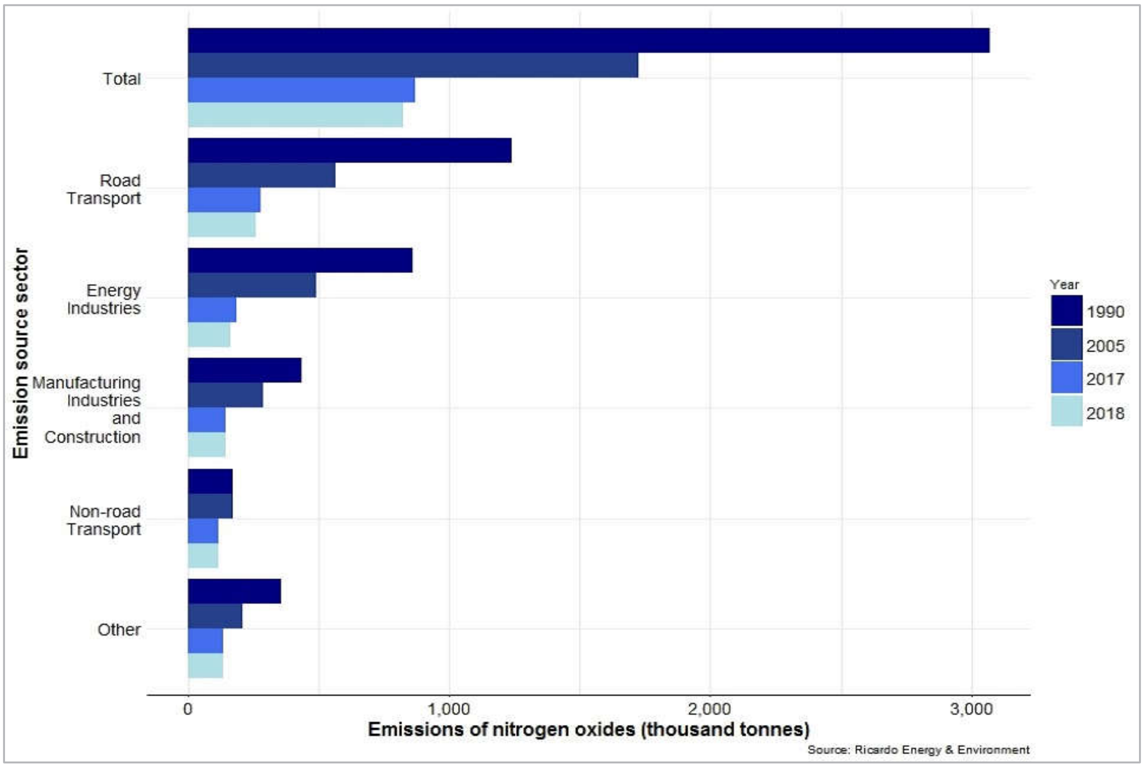
2.4.2.1. Sources and emissions

Nitrogen oxides (NOx) are a group of gases that are predominantly formed during the combustion of fossil fuels. The majority of NOx is emitted in the form of nitric oxide (NO) which forms NO_2 when it reacts to with oxygen or ozone in the air.

The main sources of NOx are road transport (34%), energy generation (22%) and domestic and industrial combustion (19%). 'Other' transport sources include rail and shipping (17%).

Further information on the sources of nitrogen oxides and the relative proportion of emissions 1990-2018 is shown in Figure 2-12.

Figure 2-12 – UK Emissions of Nitrogen Oxides[11]



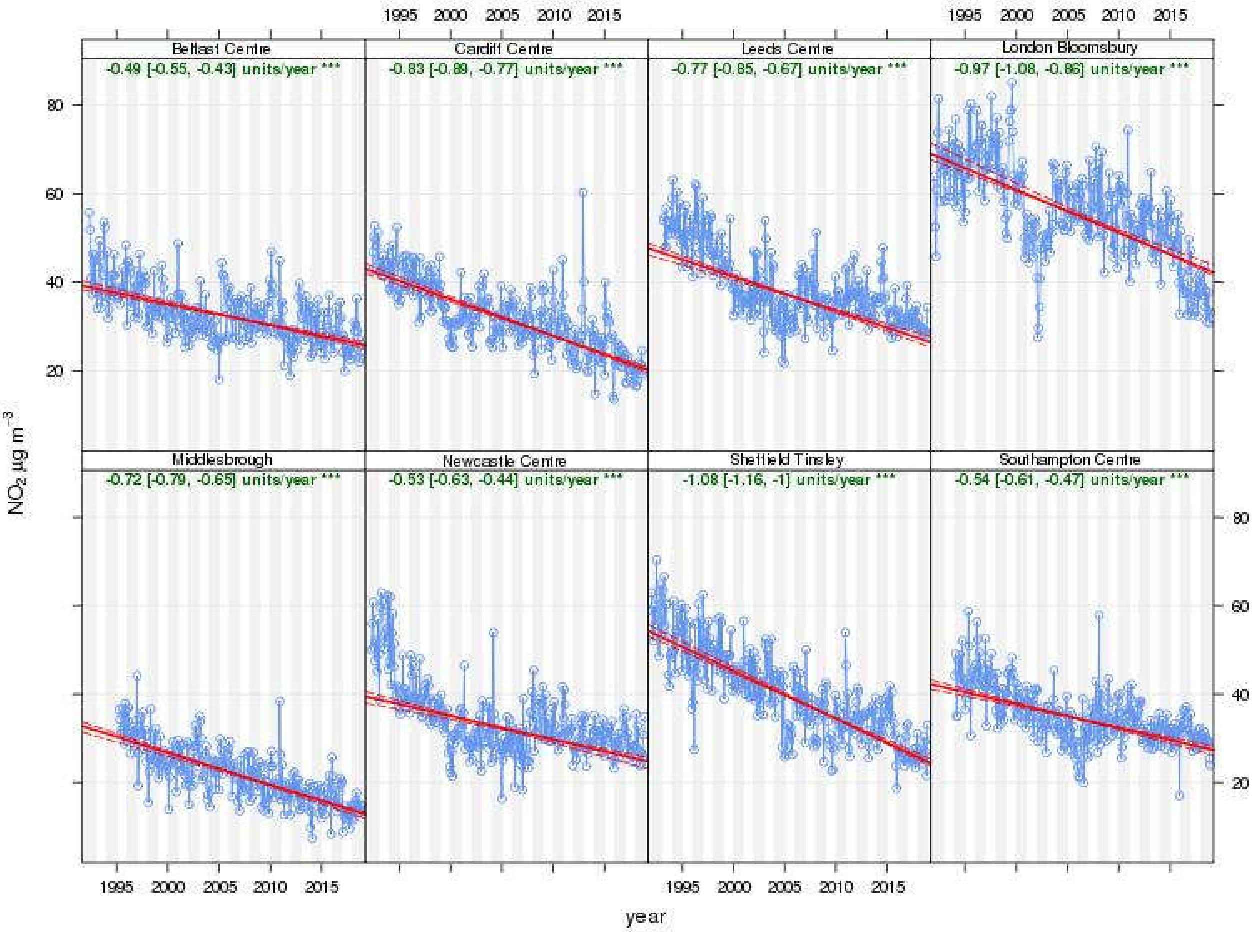
2.4.2.2. Concentrations

NOx concentrations are not generally reported but are recorded as NO_2 for consistency with AQS objectives. Annual mean concentrations of NO_2 adjacent to busy roads frequently exceed the AQS objective of 40 µg/m^3. Concentrations at urban background locations are lower, typically in the region of 10-30 µg/m^3 outside of London.

2.4.2.3. Trends

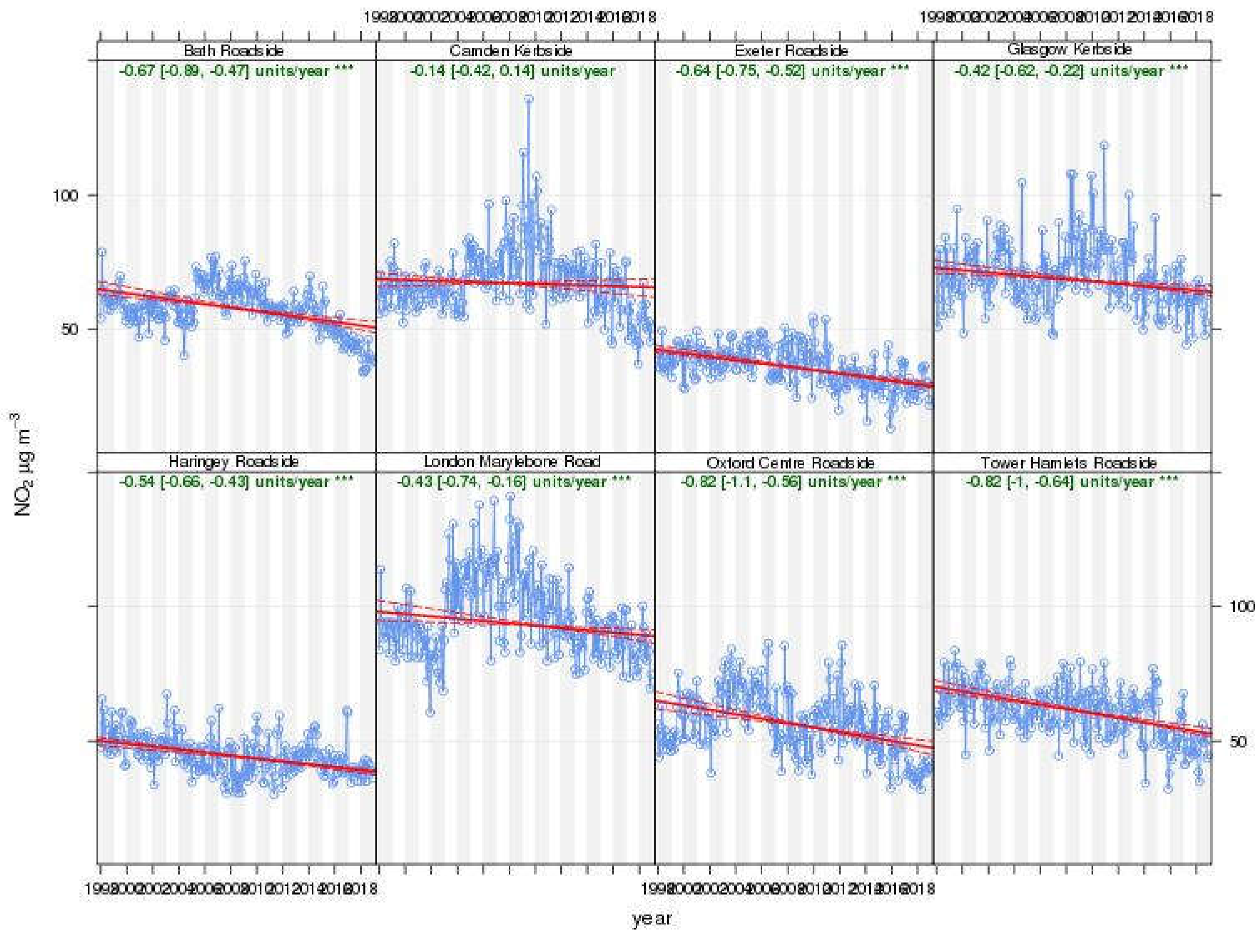
Reductions in roadside NO_2 concentrations due to progressively more stringent European vehicle emission standards have not always materialised to the expected extent, particularly in the period 2007-2015. This was as a combined result of the increased uptake in diesel cars (to help tackle climate change), and, according to Defra[12] the failure of Euro vehicle emission standards for diesel vehicles to deliver the anticipated reductions in NO_X emissions – principally associated with an increase in “primary NO_2” (directly emitted from the exhaust through the use of emission reduction devices). Figure 2-13 shows how ambient concentrations of nitrogen dioxide have decreased since 1992 using a time series chart of annual mean NO_2 concentration for eight urban non-roadside sites. There has been a general downward trend in ambient concentrations at the urban non-roadside monitoring sites.

Figure 2-13 - De-seasonalised Trends in NO_2 Concentrations at Urban Non-Roadside sites[12]



For urban traffic sites, the pattern of trends is less consistent, due to local factors (congestion, urban canyons) and the influence of diesel vehicles as shown in the figure below.

Figure 2-14 - De-seasonalised Trends in NO_2 Concentrations at Urban Roadside sites[12]

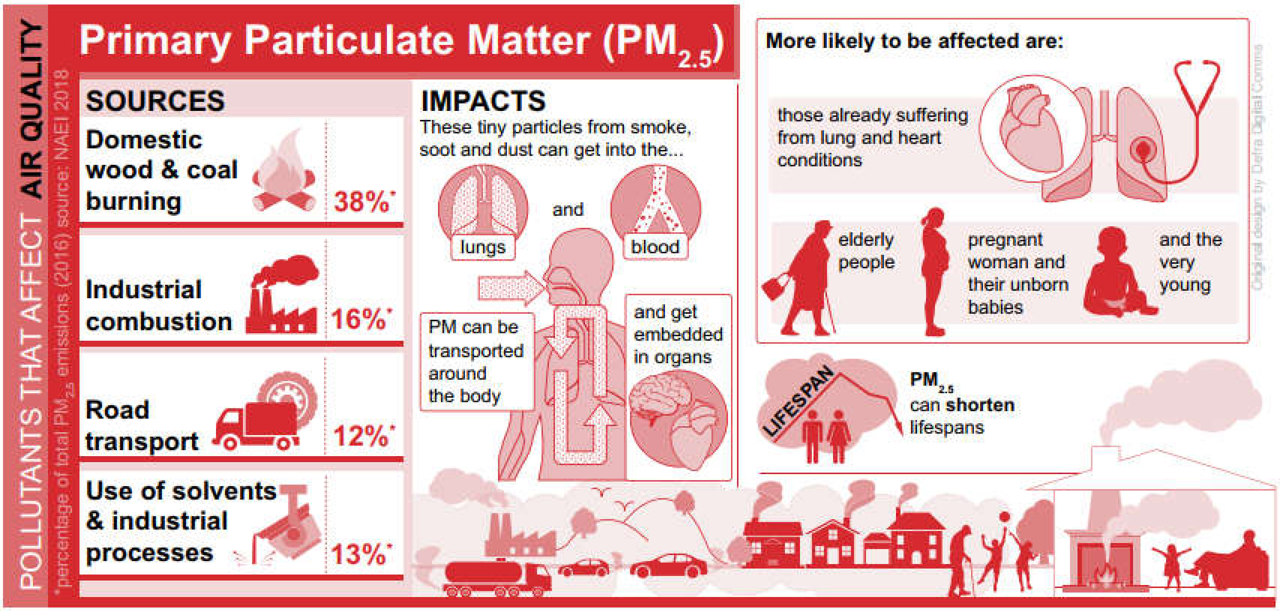


Nationally nitrogen oxide emissions (NOx) have been falling year on year with emissions in 2018 falling to their lowest level since 1970. The decrease has been driven by a decline in coal use in power stations and more stringent vehicle emissions technology.

Annual NOx emissions from road transport have fallen by 79 per cent between 1990 and 2018, and other forms of transport have reduced annual emissions by 32 per cent over the same period.

2.4.3. By Pollutant - Fine particulate matter ($PM_{2.5}$)

Figure 2-15 - $PM_{2.5}$ sources, impacts and effects[7]

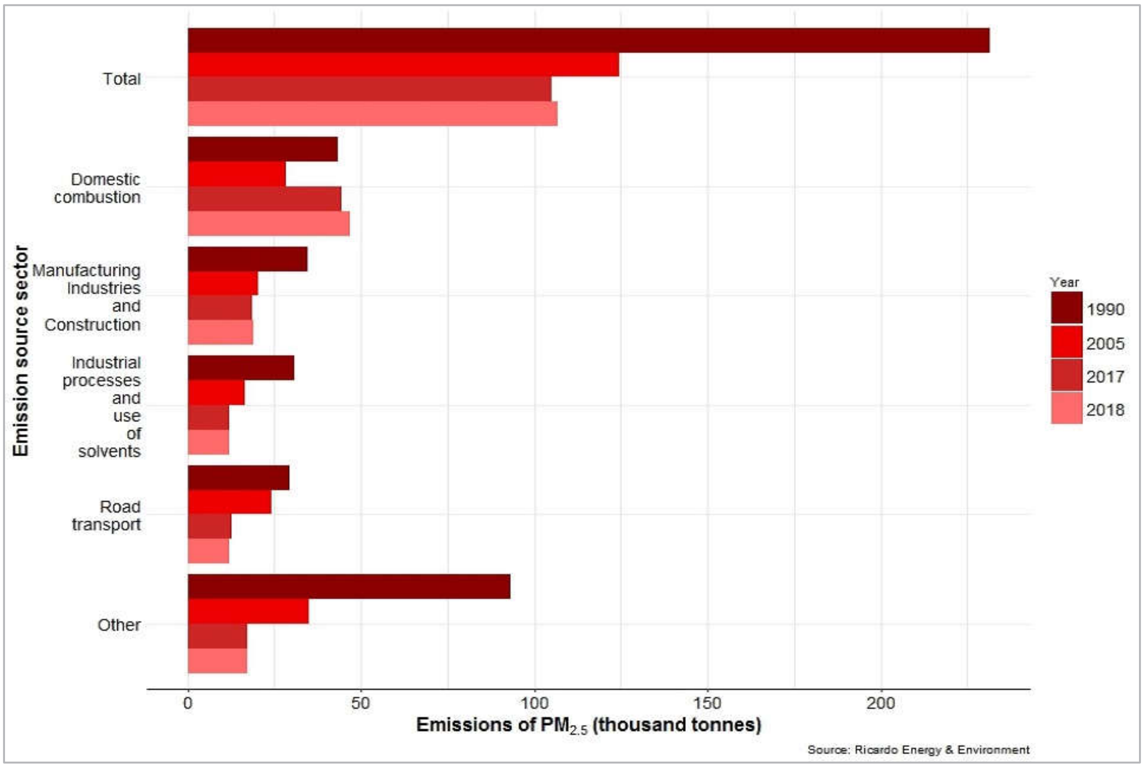


2.4.3.1. Sources and emissions

- Particulate matter (PM) is emitted from natural sources such as pollen, sea spray and desert dust, and also from man-made sources such as domestic fires, vehicle exhausts, dust from tyres and brakes, and from industry. Particles emitted directly from these sources are called primary PM.
- Secondary particles are formed in the atmosphere through chemical reactions with other gases (such as Ammonia).
- Around 15% of UK PM comes from naturally occurring sources, up to a third from other European countries and around half from UK human-made sources.
- 38% of UK primary PM emissions come from burning wood and coal in domestic open fires and solid fuel stoves, 12% comes from road transport (e.g. fuel related emissions and tyre and brake wear) and a further 13% comes from solvent use and industrial processes (e.g. steel making, brick making, quarries, construction).
- The majority of PM emissions from combustion from road vehicles comes from diesel as opposed to petrol vehicles (see Figure 2-7).
- Industrial combustion and processes are another major source of particulate matter although emissions from this source have decreased as demand for manufacturing of chemicals and steel has declined.

Further information on the sources of $PM_{2.5}$ and the relative proportion of emissions 1990-2018 is shown in Figure 2-16.

Figure 2-16 – UK Emissions of $PM_{2.5}$[11]



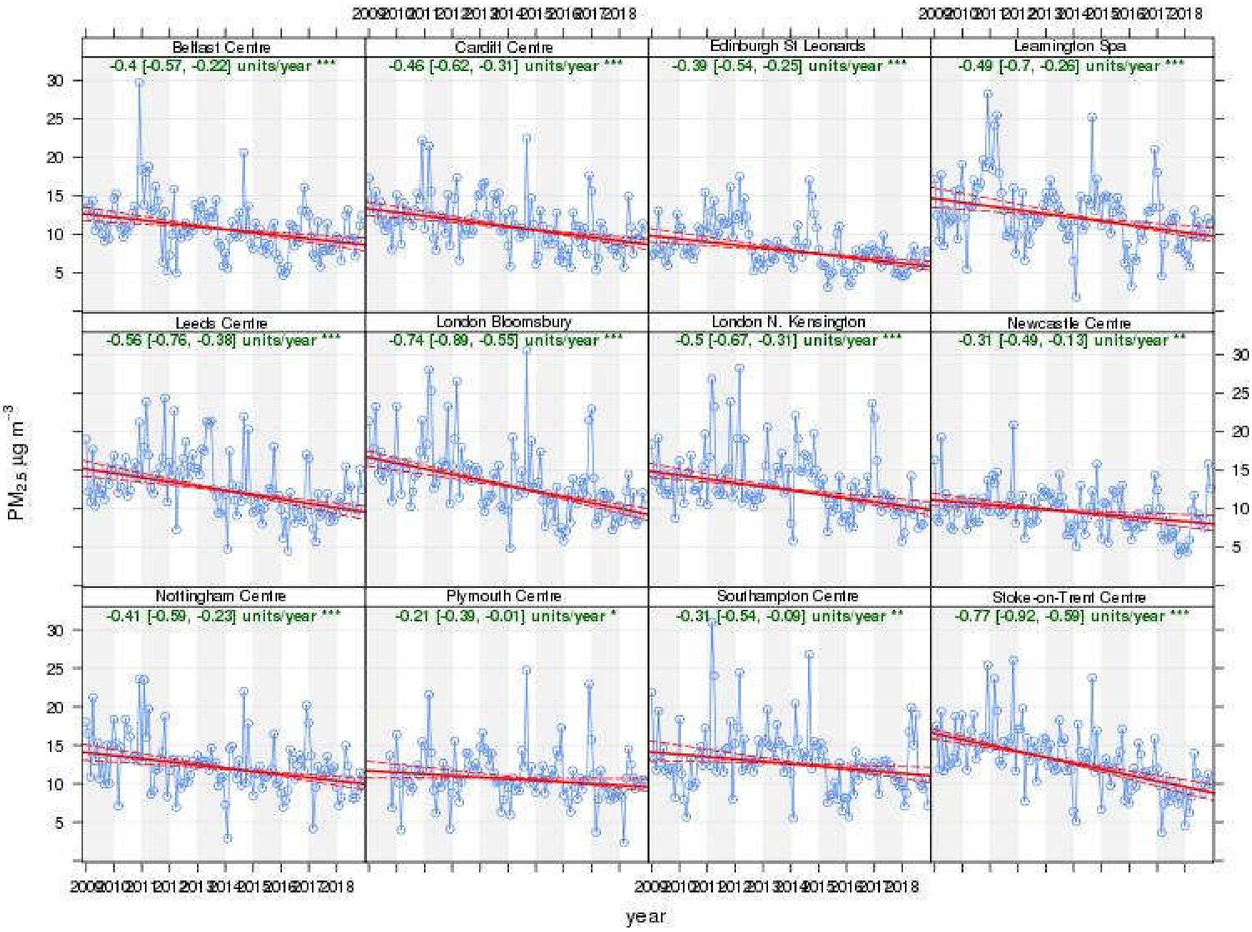
2.4.3.2. Concentrations

Annual mean urban $PM_{2.5}$ concentrations in the UK are typically in the range 5-15 µg/m^3.

2.4.3.3. Trends

Figure 2-17 shows trends in $PM_{2.5}$ concentrations at 12 long-running urban background AURN sites, 2009-2018 with all sites showing a statistically significant downward trend in $PM_{2.5}$ concentrations.

Figure 2-17 - De-seasonalised Trends in $PM_{2.5}$ Concentrations at Urban Background Sites[12]

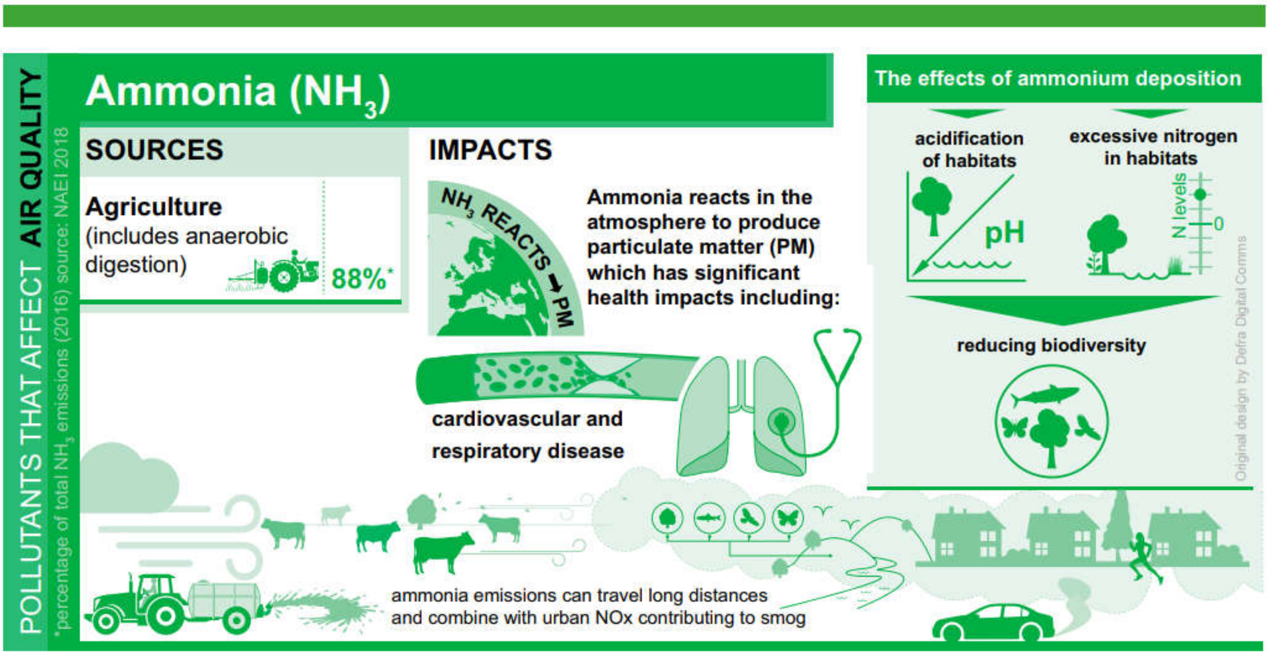


Between 1970 and 2016 primary $PM_{2.5}$ emissions fell by 78%, although more recently emissions of $PM_{2.5}$ have shown little change since 2009.

Despite this, road transport remains a significant source of PM emissions (12 per cent of $PM_{2.5}$ in 2017)[7]. Exhaust emissions have decreased markedly since 1996 due to stricter emissions standards however this has been partially offset by an increase in non-exhaust emissions (e.g. brake, tyre and road wear) as traffic activity has increased.

2.4.4. By Pollutant - Ammonia (NH_3)

Figure 2-18 – Ammonia sources, impacts and effects[7]



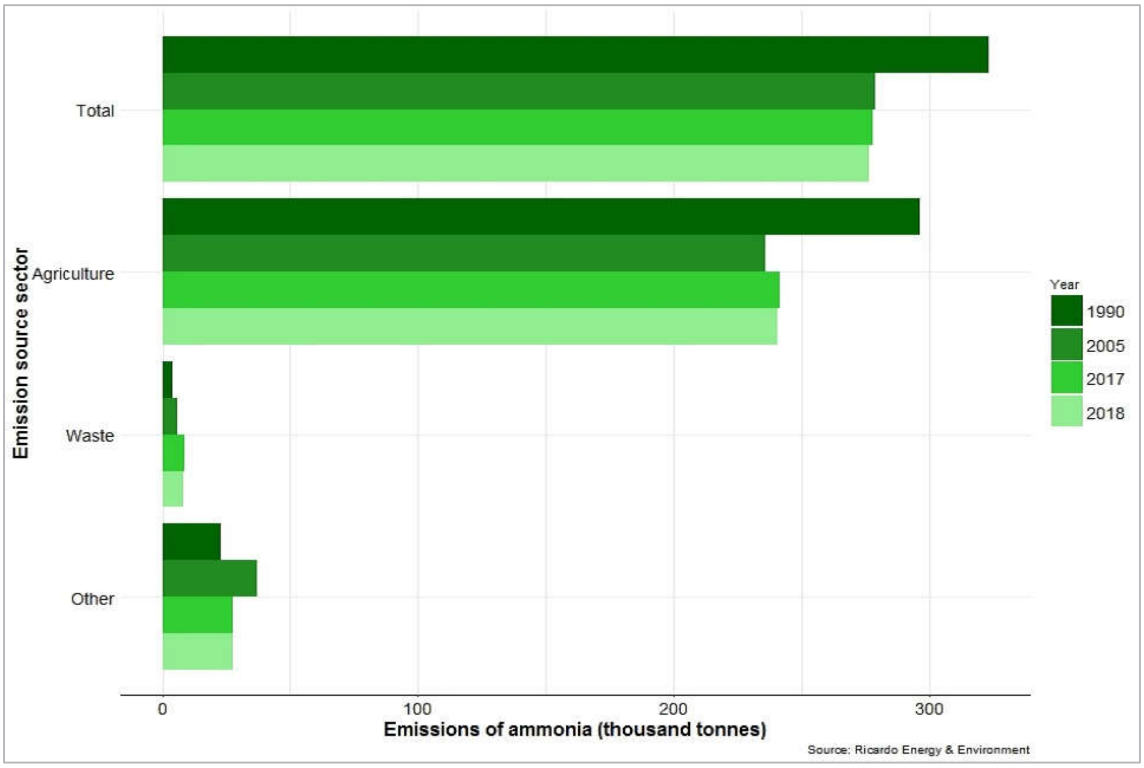
2.4.4.1. Sources and emissions

The largest source of ammonia emissions is from agriculture (88%). A small proportion of emissions come from the waste sector (4%) with the remaining emissions coming from a mix of sources including vehicles, human waste and industry.

There are two sources of ammonia from road vehicles: early petrol cars with three-way catalysts; and diesel vehicles which use selective catalytic reduction (SCR) systems which use urea or ammonia to convert NOx emissions to diatomic nitrogen (N_2). ‘Ammonia slip’ can occur when the reagent leaves the exhaust unreacted, with causes including: insufficient temperature for the reaction to occur, on oversupply of urea, or a degraded or blocked catalyst (see section 2.6.2).

Further information on the sources of ammonia and the relative proportion of emissions 1990-2018 is shown in Figure 2-19.

Figure 2-19 – UK Emissions of Ammonia[11]



2.4.4.2. Concentrations

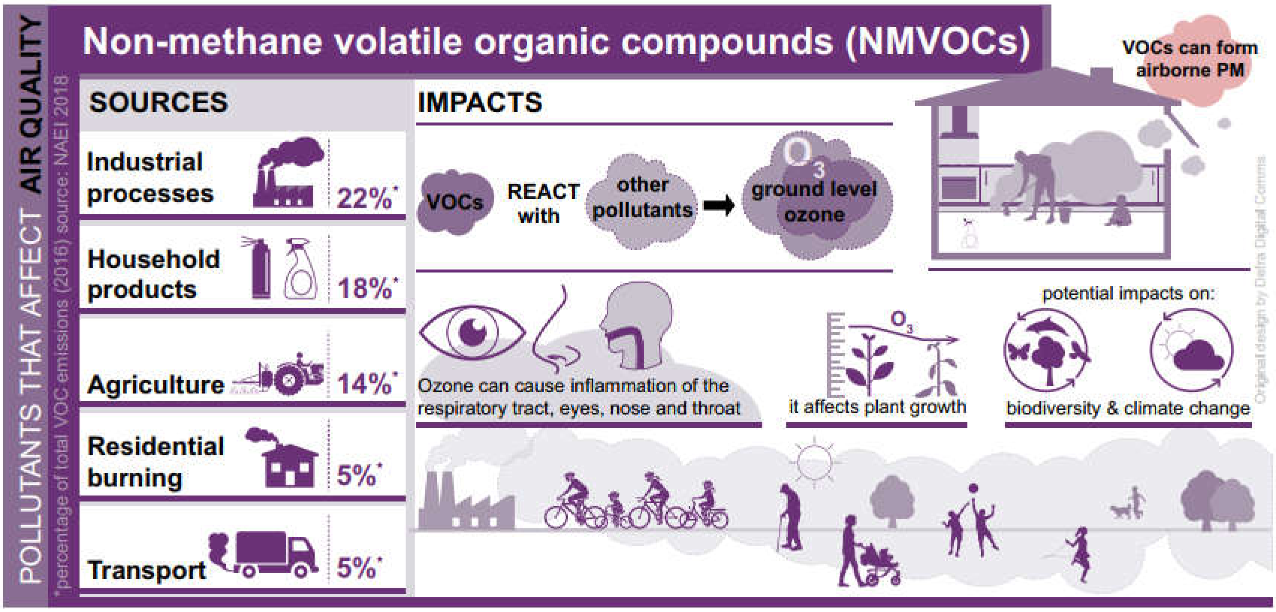
As noted above, the key source of ammonia is from agriculture, and it is monitored for its effects on ecosystems rather than on human health. There are no clear trends in monitored concentrations as discussed in Section 2.2.2.

2.4.4.3. Trends

An overall reduction in ammonia emissions was observed from 1990 to 2015 however there have been periods of year on year increases more recently. Defra[7] notes that emissions from agriculture are the main contributor to the recent increase in emissions through increased fertiliser use, as supported by NAEI emissions data[15].

2.4.5. By Pollutant - Non-methane volatile organic compounds (NMVOC)

Figure 2-20 - Non-methane volatile organic compounds (NMVOCs) sources, impacts and effects[7]



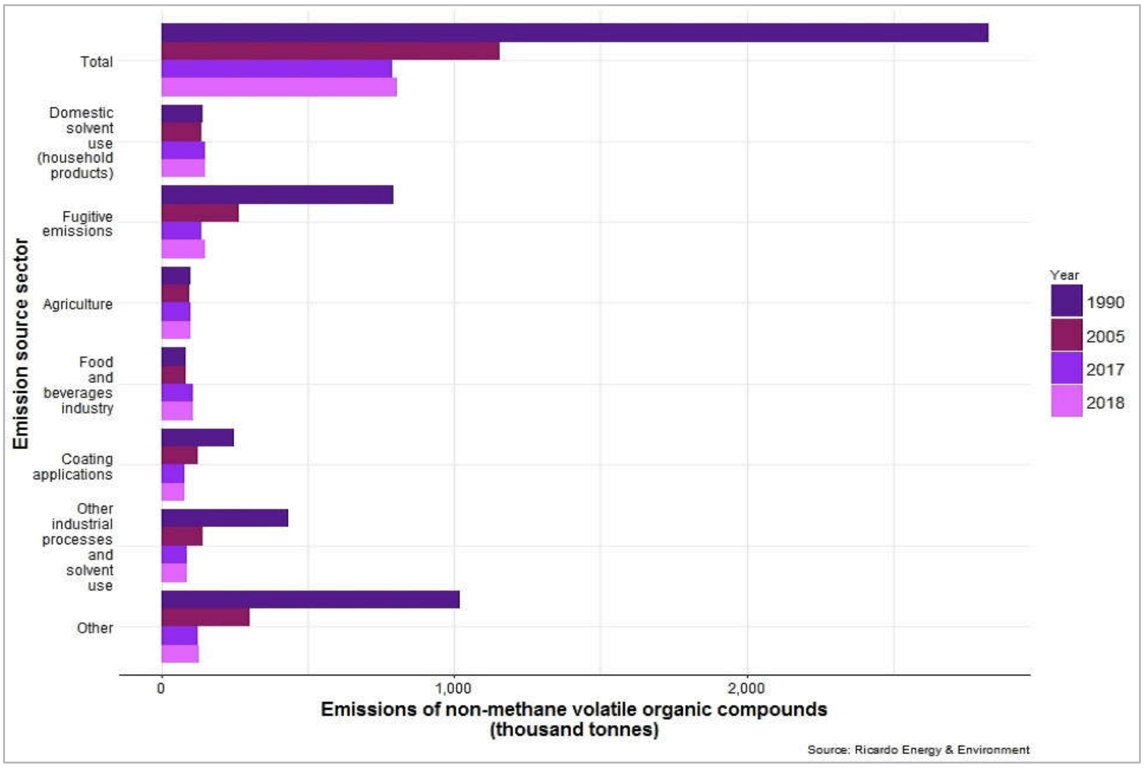
2.4.5.1. Sources and emissions

Non-methane volatile organic compounds (NMVOCs) are a large group of organic compounds, which differ in their chemical composition but can display similar behaviour in the atmosphere.

- NMVOCs can be emitted to air as combustion products and as vapour arising from petrol and solvents.
- Products and processes which emit NMVOCs include industrial processes (22%), household products (18%), agriculture (14%), domestic burning and transport (5% each).
- The key NMVOCs for road transport are benzene and 1,3-butadiene.

Further information on the sources of NMVOCs and the relative proportion of emissions between 1990 and 2018 is shown in Figure 2-21. Emissions have decreased since 1990, with no clear dominant sector.

Figure 2-21 – UK Emissions of NMVOCs[11]



2.4.5.2. Concentrations

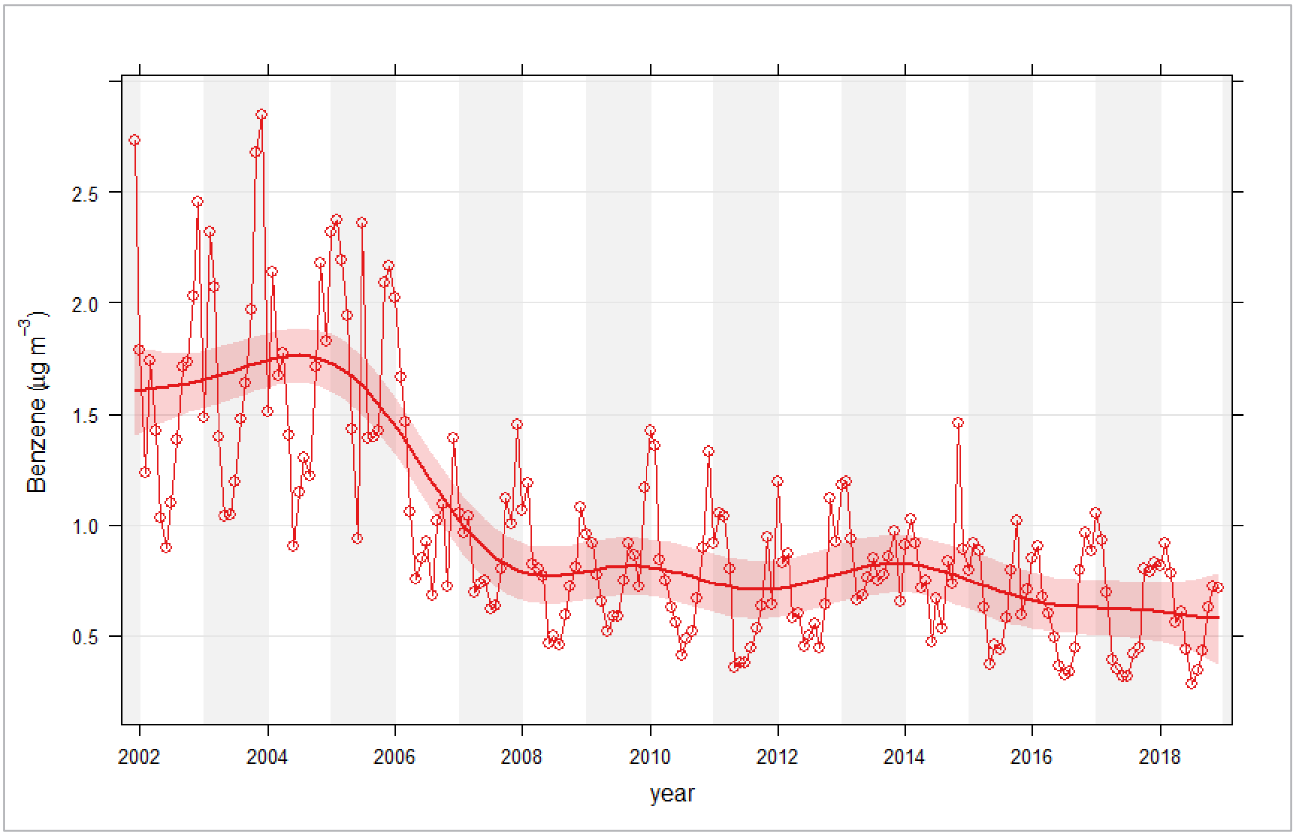
Annual mean concentrations of benzene are low (consistently below 2 μg/m^3) in part due to the introduction of catalytic converters on car exhausts. The UK meets both the AQS objective and EU limit value for benzene of 5 μg/m^3. This is demonstrated in Figure 1.20 below.

2.4.5.3. Trends

Figure 2-22 shows a smoothed trend plot based on the combined dataset from 14 long-running sites in the Non-Automatic Hydrocarbon Network, which have operated since 2002[12].

The smoothed trend plot for these sites shows a slight increase from 2002 to 2004, followed by a steep decrease between 2004 and 2008 and a much flatter trajectory until 2018.

Figure 2-22 - Smoothed Trend Plot of Ambient Benzene Concentrations[12]

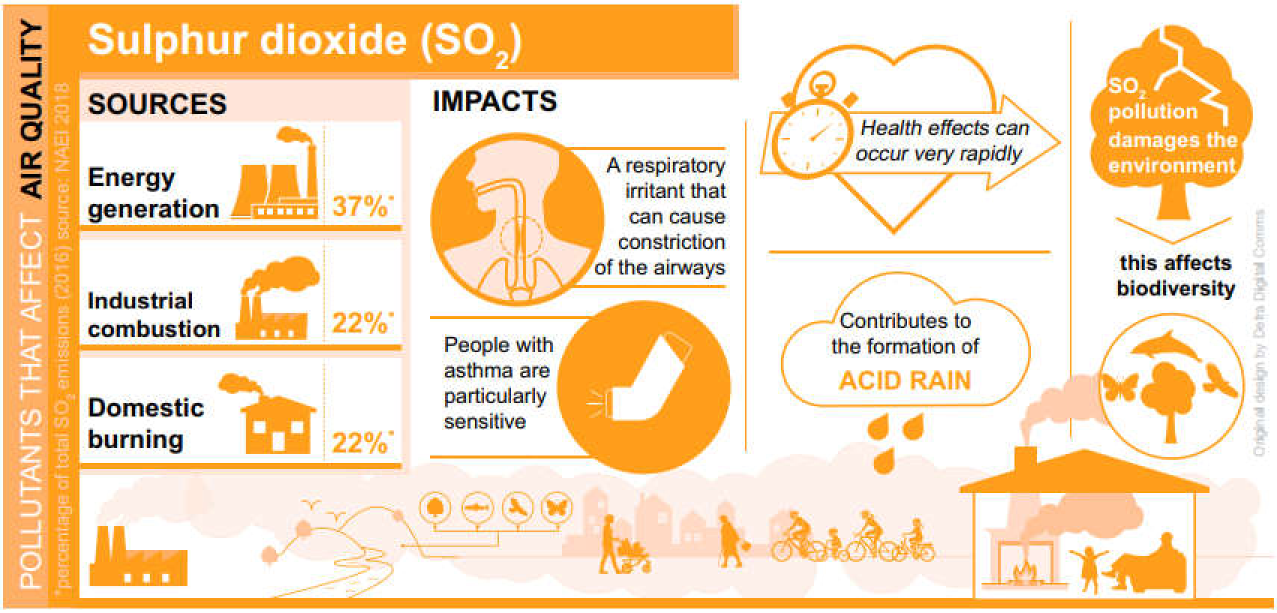


The long-term trend has been a steady reduction in emissions of NMVOC:

- Road transport was a significant source of NMVOCs in the early 1990s, contributing 30 per cent of total NMVOCs emissions in 1990.
- Stricter emission standards have reduced the contribution of road transport to just 5 per cent of emissions in 2017[7].

2.4.6. By Pollutant - Sulphur dioxide (SO_2)

Figure 2-23 - SO_2 sources, impacts and effects[7]



2.4.6.1. Sources and emissions

Emissions of SO_2 are primarily from combustion of fuels for energy generation and industrial processes. Emissions have reduced due to restrictions on the sulphur content of liquid fuels, as well as a shift away from a reliance on coal for energy generation.

It is noted that emissions from shipping are excluded from national calculations but may be a significant source of SO_2 from fuel combustion, as the majority of ships use fuels with significant sulphur content.

Further information on the sources of sulphur dioxide and the relative proportion of emissions 1990-2018 is shown in Figure 2-24.

2.4.6.2. Concentrations

Annual mean concentrations are typically less than 5 μg/m^3 and well below the AQS objective for the protection of vegetation and ecosystems. Higher concentrations may be observed in industrial or port locations, or in residential areas with high use of solid fuel for heating[12].

2.4.6.3. Trends

Figure 2-25 shows how ambient concentrations have changed over the period 1992 to 2018, at the six AURN monitoring stations that have monitored SO_2. All stations show a statistically significant downward trend.

Emissions of SO_2 dropped to their lowest level in the time series in 2018 continuing the decline driven mainly by reduced coal use in power stations.

Emissions reductions from the energy production and manufacturing sectors have been the strongest drivers for the long-term trend of decreasing emissions, by switching fuel use from coal to gas and the fitting of flue gas desulphurisation in the remaining coal fired plants in the power sector.

Figure 2-24 – UK Emissions of SO_2[11]

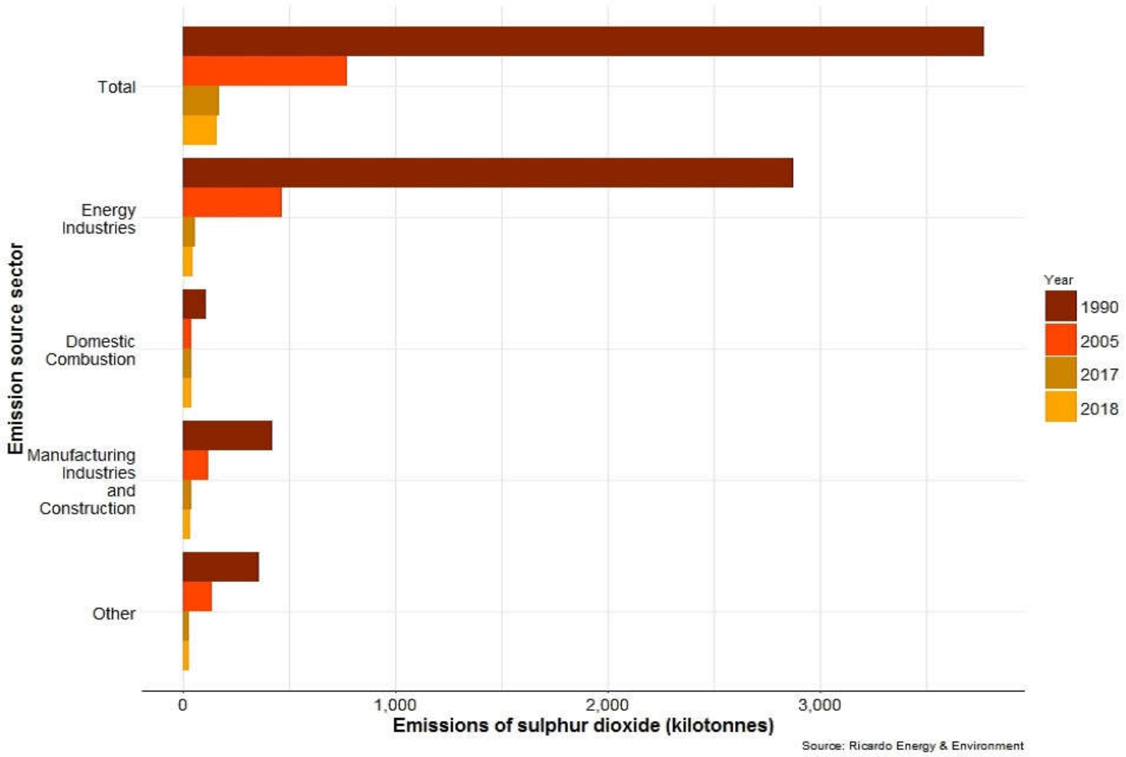
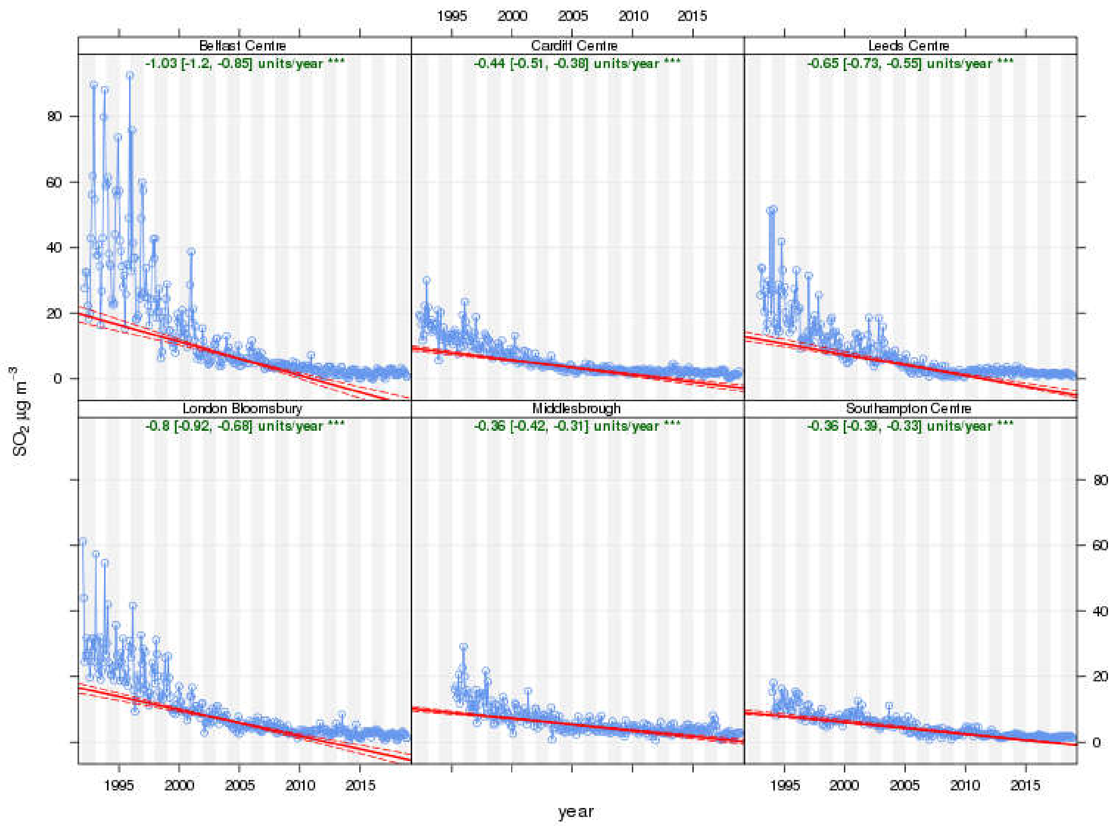
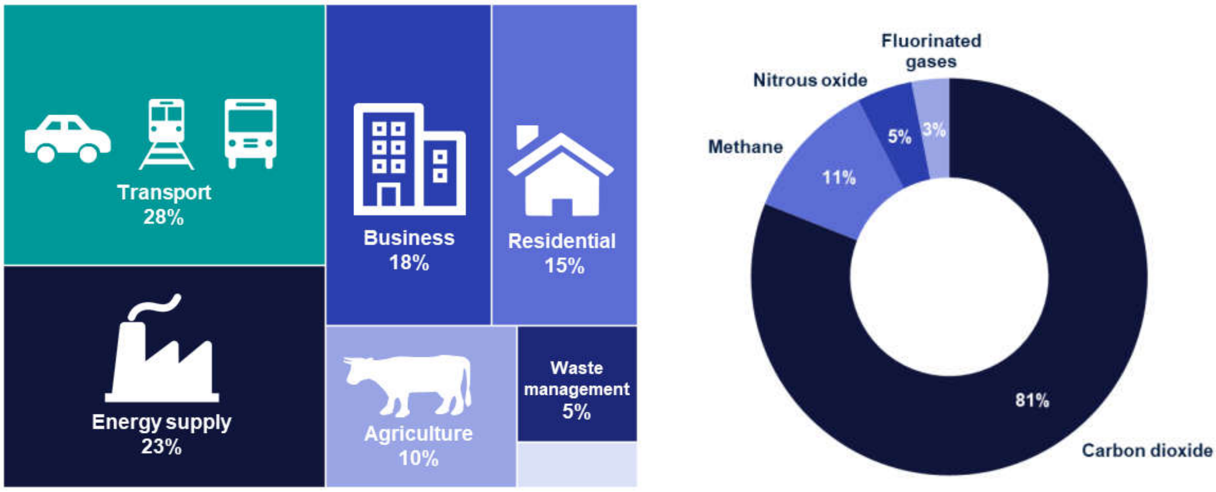


Figure 2-25 – De-seasonalised Trends in SO_2 Concentrations[12]



2.4.7. By Pollutant – Greenhouse Gases

Figure 2-26 – UK greenhouse gas sources and emission by gas (2018) [19][14]



2.4.7.1. Sources and emissions

Historically the transport sector has been the second highest emitting sector, after energy, as shown in Table 2-4; however, decarbonisation of the energy supply has meant that since 2016 transport has been the highest emitting sector and as such is receiving greater focus in achieving reductions over the next 30 years.

Table 2-4 - UK sources of greenhouse gas emissions[14]

UK, 1990-2018								MtCO$_2$e
	1990	1995	2000	2005	2010	2015	2017	2018
Transport	128.1	129.7	133.3	136.0	124.5	123.5	126.1	124.4
Energy supply	278.0	238.0	221.6	231.5	207.4	145.3	112.3	104.9
Business	113.8	111.9	115.7	109.2	94.3	85.2	81.1	79.0
Residential	80.1	81.7	88.7	85.7	87.5	67.4	66.6	69.1
Agriculture	54.0	52.9	50.3	47.9	44.6	45.2	45.8	45.4
Waste management	66.6	69.3	63.1	49.1	29.7	20.7	20.4	20.7
Industrial processes	59.9	50.9	27.2	20.7	12.7	12.7	11.0	10.2
Public	13.5	13.3	12.1	11.2	9.5	8.0	7.7	8.0
LULUCF	-0.1	-2.3	-4.1	-7.2	-9.3	-10.0	-10.1	-10.3
Total	**793.8**	**745.4**	**707.9**	**683.9**	**600.9**	**497.9**	**461.0**	**451.5**

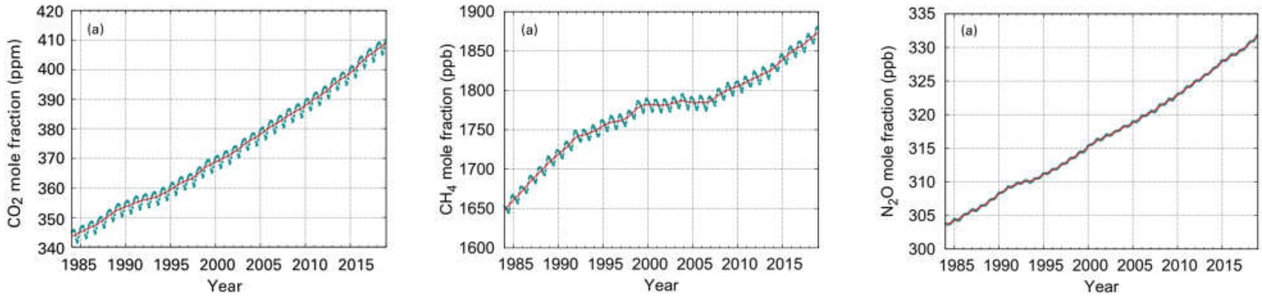
Source: Table 3, Final UK greenhouse gas emissions national statistics 1990-2018 Excel data tables

[19] https://data.gov.uk/dataset/9a1e58e5-d1b6-457d-a414-335ca546d52c/provisional-uk-greenhouse-gas-emissions-national-statistics

2.4.7.2. Concentrations

Greenhouse gas concentrations are measured at an international level by the World Meteorological Organisation (WMO). Global atmospheric concentrations for the most important greenhouse gases (CO_2, CH_4 and N_2O) are provided below, all showing a continued upward trend from 1984 to 2018.

Figure 2-27 - Globally averaged atmospheric CO_2, CH_4 and N_2O concentrations from 1984 to 2018[20]



2.4.7.3. Trends

Whilst the overall global trend in concentrations is increasing, the UK emissions picture appears positive with a decreasing trend between 1990-2018. Reductions in emissions have not been achieved equally throughout the sectors, with emissions from the transport sector having changed little since 1990, with only a 3% decrease in emissions over this period, as shown in Figure 2-29.

Figure 2-28 – UK greenhouse gas emission trends 1990 - 2018[19]

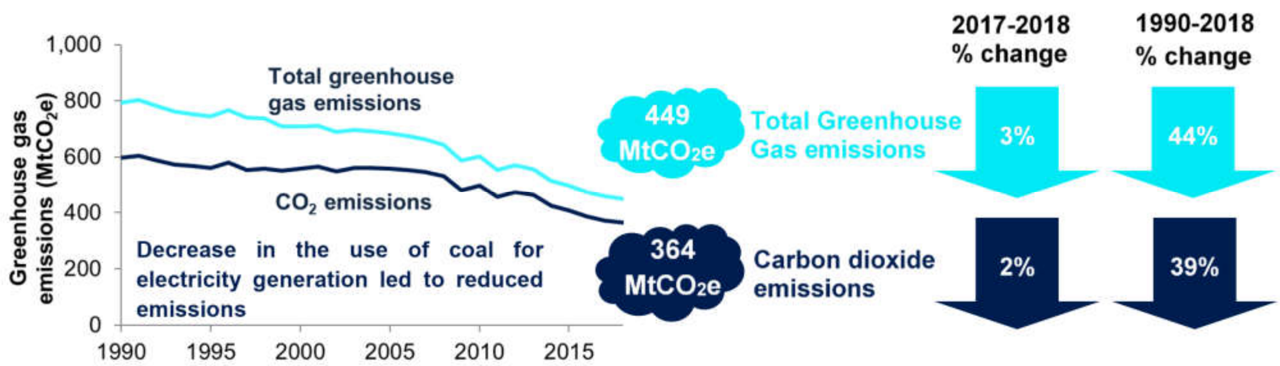
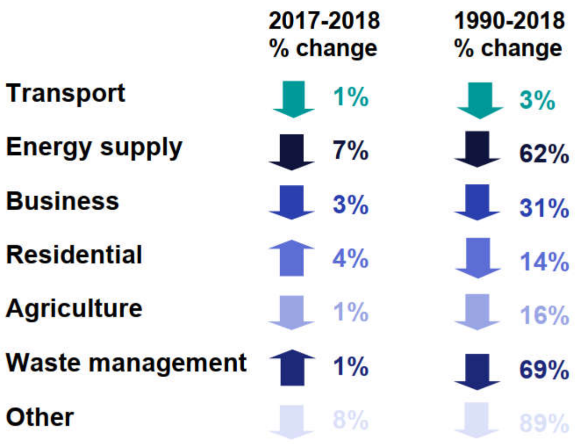


Figure 2-29 - Reductions in UK greenhouse gas emissions by sector from 2017 to 2018[14]



[20] https://library.wmo.int/doc_num.php?explnum_id=10100

2.5. What are the headlines for NO_X PM_{10} & $PM_{2.5}$?

2.5.1. NOx

Both emissions and concentrations of NOx have fallen in recent years with more stringent emissions controls on vehicles. However, Defra have concluded that concentrations of nitrogen dioxide which are of importance for affecting human health, at urban traffic monitoring locations have not necessarily fallen at the same rate as concentrations of NOx[12]. Consequently, at certain locations, predominately in urban areas near busy roads, the UK is not meeting either EU limit values or AQS objectives for NO_2.

Action is still required to ensure that emissions of NOx from road transport continue to decrease, thus reducing concentrations of NO_2 particularly at locations adjacent to busy roadsides. For example, several large cities and urban areas are implementing Clean Air Zones to only allow the cleanest vehicles into the designated zones.

2.5.2. PM_{10}

Generally, PM_{10} concentrations are meeting the AQS objective, and PM_{10} is of less concern to decision makers than NO_2. However, there is no safe level for particulate matter, although focus on health effects is more clearly associated with the finer $PM_{2.5}$ fraction.

In future, non-exhaust emissions (NEE) of particulate matter are likely to be of concern as exhaust emissions from petrol and diesel fuelled vehicles reduce. For example, roll out of electric vehicles would reduce combustion emissions but not reduce the NEE, which may actually increase per vehicle from the increased vehicle weight.

2.5.3. $PM_{2.5}$

Current background concentrations of $PM_{2.5}$ are typically below AQS objective, and current trends suggest continuing reductions. The contribution from road transport to ambient $PM_{2.5}$ concentrations is small at present (<15%) but may increase as the proportion of electric vehicles in the vehicle fleet rises in future, and the component of NEE becomes larger. As for PM_{10} there is no safe level identified for $PM_{2.5}$, and growing pressure for the government to adopt the tougher WHO guideline value, which if introduced may be challenging to meet.

2.6. Emerging Issues

2.6.1. Primary Fraction of NO_2 (fNO_2)

The Primary Fraction of NO_2 (fNO_2) is the proportion of NO_2 that is likely to be derived from direct emissions of NO_2 and the NO_2 formed through the reaction of nitric oxide (NO) with O_3. It is typically in the range 0.2-0.3 for most traffic mixes but can be as low as 0.05-0.1 for certain transport modes (e.g. buses). Greater knowledge of the fleet composition and accuracy in the fNO_2 related to differing vehicle types will provide greater accuracy in modelling air quality and the impact of restricting certain vehicle types/classes in certain areas - as has been modelled in several Clean Air Zone studies.

2.6.2. Ammonia

Emissions of ammonia may face further scrutiny in future due to a process named “Ammonia slip”. This is where, in an attempt to reduce NO_X emissions from diesel vehicles, SCR systems have been implemented which inject ammonia/urea into the vehicle exhaust – but where excess ammonia from the chemical reaction with the exhaust gases is emitted.

2.6.3. PM_1

There is a finer fraction of PM known as the ultrafine fraction (PM_1) about which very little evidence exists for health effects. It is possible that it is the ultrafine fraction (or indeed a non-mass metric, such as particle number) that is primarily responsible for health effects.

As no wholly safe level for particle exposure has been identified it is likely that in the future, once evidence has been provided, these ultrafine fractions will be subject to legislation to improve air quality.

As noted in Section 2.4.3 road transport remains a significant source of PM and may increase in future as electric vehicles are heavier and require more braking power to stop.

2.6.4. PAH

PAHs are a large group of persistent, bio accumulative, organic compounds with toxic and carcinogenic effects. PAHs can bio-accumulate and be passed up the food chain. They are formed during incomplete combustion of organic material, their main sources being domestic coal and wood burning, outdoor fires, and some industrial processes, but they also form as a by-product of fuel combustion from road vehicles. The pollutant benzo[a]pyrene is a PAH, and because it is one of the more toxic PAH compounds it is measured as a ‘marker’ for this group of pollutants[12].

They can remain in the environment for a long time and because of their persistence may pose a problem in the future. Road runoff is a major source of PAHs which can lead to contamination of ground water and surface waters.

3. Air Quality – the Law, Policy & Guidelines

3.1. Legal Limits for Air Pollutants

3.1.1. Overview

Legal powers, responsibilities, duties and relevant policies cascaded through all levels of government, from international through to local.

3.1.2. Pollutant Ceiling Emission Limits & Ambient Concentration Limits

The existing legal frameworks for emissions and concentrations of pollutants are described in **Chapter 2: National Trends – Emissions and Air Pollutants**.

3.1.3. Direction following Brexit

The **UK-EU Withdrawal Agreement** ensures that relevant EU legislation is transposed into national law for the immediate future. An Environment Bill is currently being debated in Parliament, which may provide the basis for changes in limit values or objectives.

Inclusion of a target on $PM_{2.5}$ exposure reduction within the 2019 Clean Air Strategy, signalled that the UK Government is not planning to regress from existing standards. This will be subject to ongoing review over future months.

3.2. Where does responsibility sit?

3.2.1. Air Quality Legislation & Roles

Air quality legislation is part of a wider body of environmental legislation which aims to protect human health and the environment. To achieve this, a multi-layered legislation system is in place which aims to delegate responsibility to the stakeholders best placed to affect change.

The three main levels of regulation are:

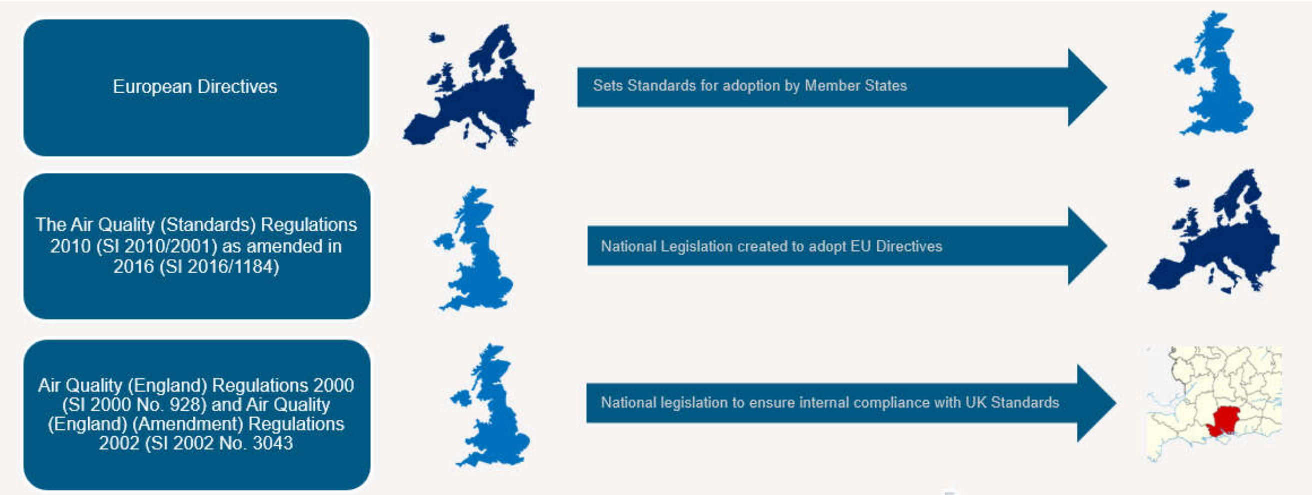
- European Union - sets targets and limit values within EU Directives
- National administrations - adopt and transpose the EU Directives into national law, setting national objectives
- Local and regional authorities - have the responsibility to aim towards the national objectives through action plans and adoption of planning policies.

The UK government has a responsibility to meet EU Directives. Regarding the AQS objectives, local authorities have a duty to review and assess air quality within their local area against the AQS objectives, and to declare an Air Quality Management Area where the objectives are not met. The Department for Environment, Food and Rural Affairs (Defra) coordinates local air quality assessment and air quality plans.

Local authorities and individual government organisations (e.g. Highways England) have a responsibility to work towards achieving UK legislation and may be assisted by the UK government to help them meet AQS objectives.

It is the responsibility of the highest level of national court to ensure that national legislation is implemented. The European Court of Justice (ECJ) can also intervene to ensure that the member states obligations are being met.

Figure 3-1 – International and National Stakeholders and Obligations



Note: The withdrawal from the EU has the following impacts:

- After formal withdrawal, the ECJ is likely to not have any continuing jurisdiction over UK environmental matters. As the EU Directives have been written into UK law, no immediate changes in standards are expected after the UK's withdrawal from the European Union.
- This does not preclude the enhancement or relaxation of UK air quality standards in legislation at a later date.
- Equally, the UK government may not be obliged to adopt any subsequent changes to EU legislation or standards.
- The UK High Court will remain as the arbiter of the implantation of national standards however the UK is likely to be under no higher obligation to meet air, or any other environmental standards.

Figure 3-2 – Regulatory Background - National and Local Stakeholders and Obligations

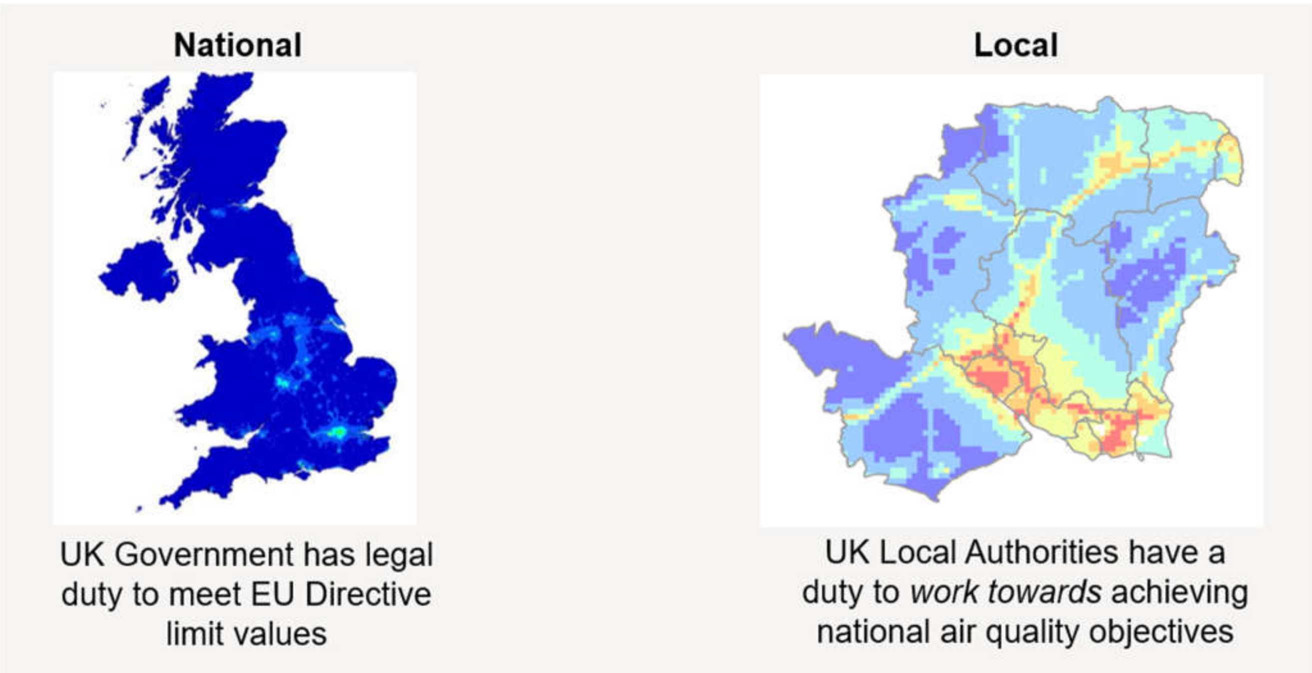


Table 3-1 details the full suite of legislation which applies in the UK. This can be used a reference guide for understanding the responsibilities and obligations of stakeholders.

Table 3-1 – Scale and Responsibility - Air Quality Legislation and Guidelines

Responsibility	Scale	Policy Document	Content
Non statutory	Global	WHO Air quality guidelines – global update 2005[21]	Fixed guideline values for pollutants with a known dose response health relationship Graduated interim targets for pollutants that can cause harm at any level (particulate matter)
EU Member States - transposed into UK Law	European	Directives 2008/50/EC and 2004/107/EC on ambient air quality	Sets limit values for a range of pollutants, including nitrogen dioxide (NO_2) and fine particulate matter (PM_{10}). Member States are required to meet limit values in all outdoor areas (excluding certain workplaces). Also includes exposure reduction target for $PM_{2.5}$.
Non statutory		Critical loads for nitrogen deposition set by the United Nations Economic Commission for Europe (UNECE)[22]	A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge. Critical loads vary by type of habitat and species. The critical load for deposition (eutrophication) is given as a range and is quoted in units of kg/ha/year.
National Government	National	The Air Quality (Standards) Regulations 2010 (SI 2010/2001)[23] as amended in 2016 (SI 2016/1184)[24]	Transposes EU Directives for legally binding limit values for human health and vegetation Includes EU critical level for annual mean concentrations of nitrogen oxides (NO_x) to protect sensitive vegetation.
National Government		The Air Quality (England) Regulations 2000 (SI 2000/928)[25] The Air Quality (England) (Amendments) Regulations (SI 2002/3043)[26]	Sets the objectives given in the AQS for England, Scotland, Wales and Northern Ireland, applicable to local air quality management.
National Government		Environment Act 1995 (Part IV)	Under Part IV - all local authorities are responsible for Local Air Quality Management (LAQM), the mechanism by which the National AQS objectives are to be worked towards. Statutory responsibility for achieving EU limit values rests with the Secretary of State. Local authorities have no responsibility for achieving the national air quality criteria, although they should contribute to this through local action plans designed to reduce pollution levels in AQMAs.

[21] WHO (2005) Air quality guidelines – global update 2005. Available online: https://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/. Accessed Jan 2020.
[22] https://www.eea.europa.eu/data-and-maps/indicators/critical-load-exceedance-for-nitrogen/critical-load-exceedance-for-nitrogen
[23] The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made
[24] The Air Quality Standards (Amendment) Regulations 2016: http://www.legislation.gov.uk/uksi/2016/1184/pdfs/uksi_20161184_en.pdf
[25] The Air Quality (England) Regulations 2000: http://www.legislation.gov.uk/uksi/2000/928/contents/made
[26] The Air Quality (England) (Amendment) Regulations 2002: http://www.legislation.gov.uk/uksi/2002/3043/contents/made

Responsibility	Scale	Policy Document	Content
National Government		National Air Quality Plan on Roadside NO_2 2017[27] and Supplement 2018[28]	UK Plan to meet EU's limit values (PCM non-compliance) for NO_2 in the *"shortest possible time"*, directing specific local authorities to establish further measures to reduce NO_2 at specific road links. Measures to include Clean Air Zones or equivalent reductions. Note: Within the Hampshire area, Ministerial Directions issued to: • Southampton City Council • Fareham Borough Council • Rushmoor Borough Council as part of the 'Blackwater Valley' grouping of local authorities • New Forest District Council • Basingstoke & Deane Borough Council • Hampshire County Council • Portsmouth City Council These local authorities have since followed a set process with the Defra/DfT Joint Air Quality Unit (JAQU), to identify and fund additional measures to reduce roadside NO_2 as required.
National Government		Clean Air Strategy 2019[29]	Proposes Government actions to improve air quality through emission reduction. Includes target to halve the population exposed to concentrations of $PM_{2.5}$ above 10 µg/m^3 by 2025.
National Government		National Policy Statement for National Networks 2014[30]	Notes that the Secretary of State should refuse consent where, after taking into account mitigation, the air quality impacts of the scheme will: • result in a zone/agglomeration which is currently reported as being compliant with the Air Quality Directive becoming non-compliant; or • affect the ability of a non-compliant area to achieve compliance within the most recent timescales reported to the European Commission at the time of the decision.

[27] Defra (2017) UK plan for tackling roadside nitrogen dioxide concentrations. July 2017. Available online: https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017. Accessed Jan 2020.
[28] Defra (2018) Supplement to the UK Plan for tackling roadside nitrogen dioxide concentrations. October 2018 Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746100/air-quality-no2-plan-supplement.pdf. Accessed Jan 2020.
[29] Defra, 2019. Clean Air Strategy 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf.
[30] Department for Transport (2014) National Policy Statement for National Networks. December 2014. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/387223/npsnn-web.pdf. Accessed Feb 2020.

Responsibility	Scale	Policy Document	Content
Local Authority	Local	National Planning Policy Framework (NPPF) 2019[31]	Paragraph 181[32] of the NPPF requires local planning authorities to take account of air quality in plan making.
Local Authority		Planning Practice Guidance (PPG)[33]	Paragraph 005 of the PPG, establishes information relating to air quality which the local planning authority should obtain in relation to proposed development[34]
Local Authority		Environment Act 1995 (Part IV)	Under Part IV - all local authorities are responsible for Local Air Quality Management (LAQM), the mechanism by which the National AQS objectives are to be worked towards.
Local Authority		The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) 2007[35]	Sets air quality standards and objectives for specific pollutants, to protect health and the environment. Local authorities have a responsibility (under Part IV of the Environment Act 1995) to review and assess local pollution levels against these objectives. Note: UK AQS objectives only apply in locations likely to have 'relevant exposure' i.e. where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. Locations of relevant exposure include building façades of residential premises, schools, public buildings and medical facilities. Places of work (other than certain community facilities) are excluded. (c.f. difference in interpretation with EU limit values, which apply everywhere to where the public access)

3.2.2. County Council's Role

3.2.2.1. Duty & Policy

County councils do not have a well-defined role in meeting air quality objectives. The main role of a county council as Local Highway Authority related to air quality is to support local authorities in adopting policies which do not undermine the ability of local authorities or national government to meet their obligations.

From an HCC perspective, matters relating to air quality are detailed in the Hampshire Local Transport Plan[36]. The document reiterates HCC's statutory duty and policies as shown below:

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[31] Ministry of Housing, Communities and Local Government (2019) National Planning Policy Framework. February 2019. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf. Accessed Jan 2020.

[32] Specific reference is made to presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, so far as possible at the plan-making stage.

[33] Ministry of Housing, Communities and Local Government (2019) Planning Policy Guidance: Air Quality. Available online: https://www.gov.uk/guidance/air-quality--3. Accessed Jan 2020.

[34] *"the 'baseline' local air quality; whether the Proposed Development could significantly change air quality during the construction and operational phases (and the consequences of this for public health and biodiversity); and whether occupiers or users of the development could experience poor living conditions or health due to poor air quality."*

[35] https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1

[36] HCC – Hampshire Local transport Plan 2011 – 2031 (April 2013) - https://documents.hants.gov.uk/transport/HampshireLTPPartALongTermStrategy2011-2031RevisedApril2013.pdf

- Statutory Duty: *"Support district councils with respect to carrying out air quality reviews, the assessment of air quality management areas and the preparation of air quality action plans"*
- Policy Objective: *"Policy Objective 10: Contribute to achieving local targets for improving air quality and national carbon targets through transport measures, where possible and affordable"*

All decisions made by HCC in relation to transport policy should be made with due consideration to their statutory duty and policy direction. This includes review of local authority air quality action plans and review of any Town Access Plans[37] that may be in place.

3.2.2.2. Cooperation & Planning

Wider roles and responsibilities related to air quality are not so straightforward, particularly in two-tiered local government, with statutory responsibilities & powers for health, environment, planning and transport split between tiers.

Whilst county and district councils are required to work together to identify suitable measures to address unacceptably poor air quality, improving background air quality more generally via planning and health protection systems, (which at this level are somewhat fragmented), can be challenging,

Transport is a significant contributor to poor local air quality, but people, transportation and air pollution traverse the administrative boundaries of Environmental Health authorities each day.

Cooperation on delivering planned housing growth requires the Local Highway Authority to confirm the impacts of associated traffic growth have been made acceptable, an assessment based on traditional road safety & capacity assessments, under statutory responsibility to operate a safe, well-functioning network.

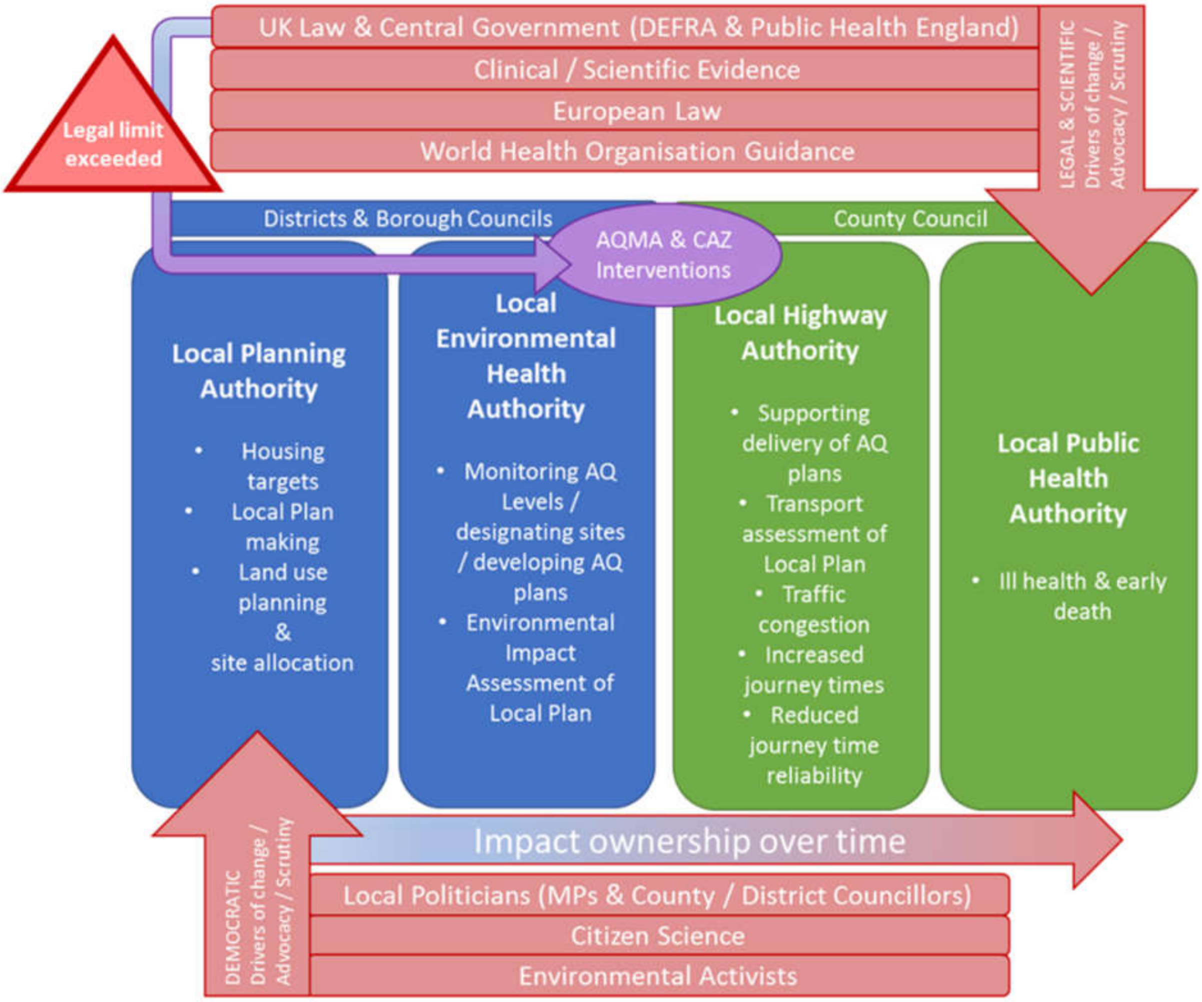
The County Council is not required to assess, quantify or comment on the air quality impact of network changes, which is the responsibility of the Local Planning and Environmental Health Authority, despite the likely greater impact in terms of life-years lost from road pollution compared to road traffic accidents.

Similarly, in April 2013 The Health and Social Care Act (2012) gave Hampshire County Council a new duty to improve and protect the health of people in its area, but primary responsibilities under Part IV of the Environment Act 1995 to monitor and manage local pollution levels sit with district councils.

When air quality is considered at a system-wide level over a longer-term period, (using delivery of planned growth as an example), complex and less-well defined interrelationships and implications emerge, particularly how statutory 'ownership' of poor air quality and its impact transfers between tiers, organisations, and areas of responsibility over time (Figure 3-3).

[37] Town Access Plans set out aims and proposals to improving access to services and facilities.

Figure 3-3 – Air Quality responsibilities and interrelationships



Viewed in this context, intervention in the form of AQMA or CAZ designation can be considered an emergency declaration and signifier that, in public health terms, prevention is not succeeding, triggering reactive intervention.

As the upper tier authority with the overarching geography, the County Council is well-placed to help facilitate coordination of preventative activity across the multiple tiers of local government, where related to core functions as highway and public health authority.

3.2.2.3. Local Transport Plans

Local transport plans (LTPs) are drafted by strategic transport authorities (county councils, unitary authorities, passenger transport authorities and London Borough councils). Reducing the need to travel and encouraging sustainable transport can reduce local emissions, whilst also improving public health and activity levels. With transport being a significant contributor to local air pollution, good cooperation between transport planning, air quality and also spatial planning, is essential to ensure a strategic approach. Integrating Air Quality Action Plans (AQAPs) with LTPs is strongly encouraged, and requires partnership working in two-tier areas, such as Hampshire.

3.2.2.4. Town Access Plans

In Hampshire, Town Access Plans (TAP) have been developed jointly with district and borough councils. They set out a shared vision for making the best use of roads and public spaces with the aim of improving access to services and facilities.

3.3. LAQM support and guidance

As part of the Environment Act 1995, local authorities have a duty to review and assess air quality against the objectives as set out within the Air Quality (England) Regulations 2000 (as amended 2002)[38].

Local authorities have the authority under the Environment Act 1995 to declare Air Quality Management Areas (AQMA) and an obligation to create action plans within a defined period to aim to reduce concentrations below the AQS objectives.

Regional and local planning policies, including local transport plans and town access plans are cognisant of the air quality obligations which are designed to ensure that development does not interfere with the obligations of the local authority or its ability to meet the obligations at either a local, regional or national scale.

Defra provides support and has issued technical guidance for Local Authorities undertaking Local Air Quality Management (LAQM)[39]. Other support includes[40]:

- A Helpdesk for email and telephone queries on all aspects of local air quality management
- Tools to assist with assessment of air quality – including:
  - Emissions Factors Toolkit: for predicting emissions of NOx, PM_{10}, $PM_{2.5}$ and CO_2 from road transport vehicles
  - Background Maps: for NOx, NO_2, PM_{10} and $PM_{2.5}$ are available.
  - NOx/NO_2 Calculator: Allows local authorities to derive NO_2 from NOx wherever NOx is predicted by modelling emissions from roads.
  - Roadside NO_2 Projection Factors: for projecting measured annual mean roadside NO_2 concentrations to future years.
  - Diffusion Tube Tools
- A website showing all currently declared Air Quality Management Area (AQMA) in the UK and an AQMA Information Updating System that allows the updating of records.
- Information for Review and Assessment - Checklists, example Reports and the Report Submission Webpages.
- Information for Action Planning including details on Measures, Good Practice, Case Studies, Action Planning Supporting Guidance and Funding Sources.

3.4. Recent Legal Judgements and Case Studies

3.4.1. ClientEarth and the UK Plan to Reduce Nitrogen Dioxide

Under the EU Directive (2008/50/EC), the deadline for meeting NO_2 limit values was 1 January 2010. Member States were able to apply to postpone the deadlines for up to five years, on condition that an air quality plan was developed and agreed to show how the limit values would be met.

The National Plan on NO_2 submitted by the government in 2015, was ruled inadequate by the English High Court, following a case brought by ClientEarth.

A revised plan was submitted to the European Commission in 2017[41] which identified local authorities with roads predicted to exceed the EU limit value for NO_2 in 2021.

These local authorities were directed by the UK Government to undertake feasibility studies to establish additional measures to meet the limit value.

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[38] The Air Quality (England) Regulations 2000. Available online: http://www.legislation.gov.uk/uksi/2000/928/contents/made. Accessed February 2020. The Air Quality (England) (Amendment) Regulations 2002. Available online: http://www.legislation.gov.uk/uksi/2002/3043/regulation/2/made. Accessed February 2020.

[39] Defra (2018) Local Air Quality Management Technical Guidance (TG16). Available online: https://laqm.defra.gov.uk/technical-guidance/. Accessed February 2020.

[40] Local Air Quality Management Support: https://laqm.defra.gov.uk/

[41] Defra (2017) UK plan for tackling roadside nitrogen dioxide concentrations. July 2017. Available online: https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017. Accessed Jan 2020.

The following Hampshire Local Authorities were required to undertake feasibility studies with a view to subsequent implementation of either Clean Air Zones (CAZ) or measures achieving equivalent reductions:

- Southampton City Council;
- Fareham Borough Council - required to identify measures required for the A27;
- Rushmoor Borough Council as part of the 'Blackwater Valley' grouping of local authorities - required to identify measures for the A331;
- New Forest District Council, required to identify measures for a short section of the A35 on the boundary with Southampton City Council.

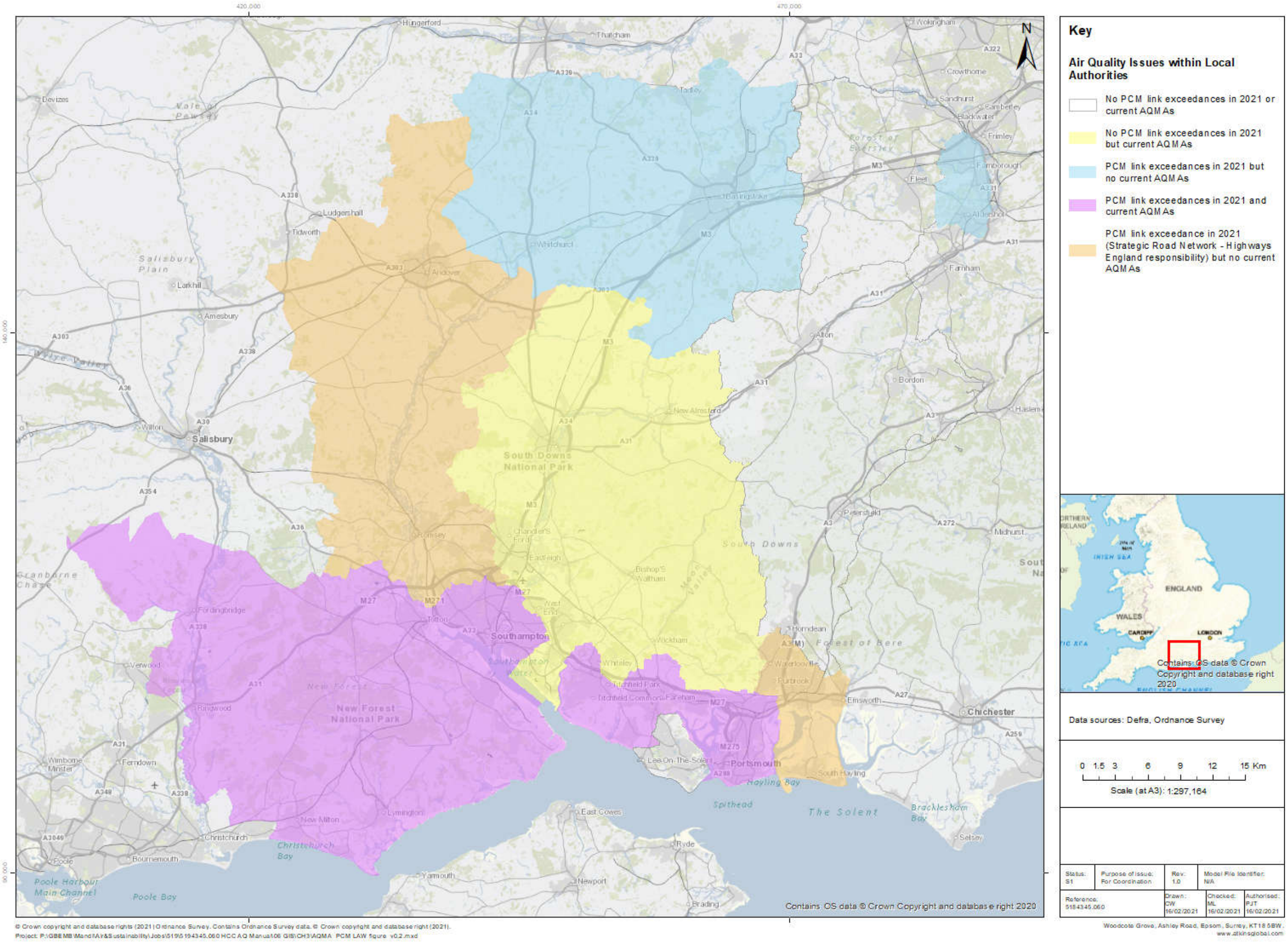
The 2017 Plan was subject to further scrutiny in February 2018, with the High Court again judging the plan to be inadequate. Following the judgement, the government published a "Supplement to the Plan"[42] and identified a further 33 local authorities with roads predicted to exceed the EU limit value for NO_2 between 2018 and 2021.

Under this supplement, Portsmouth City Council and Basingstoke and Deane Borough Council were required to consider additional measures, although the direction for Basingstoke and Deane BC was later withdrawn following submission of evidence to show that the NO_2 limit value was not being exceeded.

At the time of writing no CAZ or CAZ equivalent has been implemented in the HCC area. Further information is provided in Chapter 6 on air quality action plans within Hampshire.

[42] Defra (2018) Supplement to the UK Plan for tackling roadside nitrogen dioxide concentrations. October 2018 Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746100/air-quality-no2-plan-supplement.pdf. Accessed Jan 2020.

Figure 3-4 – Hampshire Local Authorities with AQMA and EU Limit Value Roadside NO_2 Exceedances



3.4.2. Highways England - EU Limit Value Roadside NO_2 Exceedances

There are roadside NO_2 concentrations predicted to exceed the EU limit value in 2021 in Test Valley on the M27 and Havant district on the A27 although these links are managed by Highways England.

Highways England is responsible for operating, maintaining and improving the Strategic Road Network (SRN) which consists of motorways and major A roads. The feasibility studies covered local authority managed roads only.

Highways England is taking steps to improve air quality on the SRN outside of the 2017 NO_2 Plan and is using traffic management and temporary speed limits to reduce nitrogen dioxide (NO_2) levels at certain locations.[43]

3.4.3. Habitat Regulations Assessment and In-Combination Effects

The EU Habitat Directive requires the competent authority to carry out an appropriate assessment (Habitat Regulation Assessment [HRA]) of any plan or project which may have a significant effect on a European designated site (Natura 2000 sites: SPA, SAC and Ramsar). There is a statutory requirement for the competent authority to formally consult statutory nature conservation agencies (in England, Natural England) for the purposes of an appropriate assessment. Recent case law relating to HRA include:

[43] https://highwaysengland.co.uk/air-quality-programme-activity

Wealden Judgement	Wealden DC took a neighbouring authority (Lewes DC) and South Downs National Park to court for not taking account of the Ashdown Forest SAC in its Joint Core Strategy (JCS) which had been adopted in 2016. The change in daily vehicle flows on the A26 with the JCS was less than the screening criteria of 1000 AADT (Annual Average Daily Trips), but this did **not** include other developments, such as those in Wealden's local plan. By doing so, this would tip the change over the 1000 AADT threshold and an appropriate assessment (under the Habitats Regulations) would be required. The High Court Decision[44] in March 2017 criticised Natural England's advice on 'in-combination' assessment. Natural England issued guidance on assessment of road traffic emissions on designated sites following this decision[45]. Following the High Court Decision, the need for collaboration between local authorities is recognised when considering the habitats assessment for local planning purposes.
People over Wind v Coillete Teoranta, the Sweetman case	Decision to allow the laying of cables to connect a wind farm to the electricity grid across two SACs in Republic of Ireland. Screening report concluded that appropriate assessment not required because measures had been built into the project design to control surface run off during construction. The Court of Justice of EU (CJEU) judgement[46] was that it is more important to consider mitigation at the assessment stage than at screening stage. Mitigation measures to be included are not clear yet – however the implications are that more assessments will require appropriate assessment rather than being ruled out at screening. In terms of assessment of road traffic emissions, the screening step can include the application of a vehicle change criterion (1000 AADT), alone or in-combination, however it can also include the application of 1% of the critical load or level. The method for assessment should be agreed with Natural England.
Dutch national nitrogen strategy case	The Dutch courts requested a preliminary ruling from the Court of Justice of the European Union (CJEU) in C-294/17 on questions relating to the implementation of the Dutch State's national nitrogen strategy. In 2018 the CJEU ruled that a reduction in emissions can only be taken into account in an appropriate assessment if the expected benefits are certain at the time of the assessment. In terms of assessment of road traffic emissions, and as noted by both the inspector in her decision for Wealden's local plan[47] and the High Court judge in the Compton Parish Council v Guildford Borough Council case[48], it would be unreasonable not to take into account

[44] High Court (2017) Wealden DC vs Secretary of State for Communities and Local Government, Lewes District Council and South Downs National Park. [2017] EWHC 351. Available online: http://www.wealden.gov.uk/nmsruntime/saveasdialog.aspx?lID=21727&sID=3484. Accessed Jan 2020.

[45] Natural England (2018) Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001). July 2018. Available online: http://publications.naturalengland.org.uk/publication/4720542048845824. Accessed Jan 2020.

[46] European Court of Justice (2018) Case C-323/17. People Over Wind and Peter Sweetman v Coillte Teoranta. Available online: http://curia.europa.eu/juris/document/document.jsf?docid=200970&doclang=EN. Accessed Jan 2020.

[47] https://www.wealden.gov.uk/UploadedFiles/Inspectors_conclusion_after_stage_one_of_the_Examination_of_the_Submission_Wealden_Local_Plan.pdf

[48] High Court (2019) Compton Parish Council v Guildford Borough Council. [2019] EWHC 3242. Available online: https://www.bailii.org/cgi-bin/format.cgi?doc=/ew/cases/EWHC/Admin/2019/3242.html&query=(.2019.)+AND+(EWHC)+AND+(3242). Accessed January 2020.

emission improvements in future fleet projections, arising from planned technological and political interventions.

The standard approach for air quality assessment, in terms of using the DEFRA emission factors for future years, has therefore been judged to be reasonable.

HCC Key Point – Other neighbouring local authorities and county councils' plans may have implications for internationally designated ecological sites (SAC, SPA, Ramsar). Equally HCC and the Hampshire local authorities should be aware that their plans may have implications beyond their jurisdiction.

3.4.4. Evidencing the Effect of Air Quality Mitigation Measures

Gladman

November 2017 – High Court[49] rejected a claim by Gladman Developments Ltd. which sought to change the decision of a Planning Inspector to refuse planning permission for 140 new homes in Newington, Kent.

CPRE (Kent) appeared as a Rule 6 Party at the inquiry arguing that the appeal should be dismissed due to a failure to mitigate the adverse effects on the designated Newington and Rainham AQMAs. The Inspector agreed. Gladman had proposed a fund, calculated in accordance with the Defra damage cost analysis model, however the Inspector found there to be no evidence of the likely effectiveness of the indicative mitigation measures to reduce private petrol and diesel vehicles, and thus reduce NO_2 emissions.

Mr. Justice Supperstone found that:

- The Inspector was under no obligation to assume local air quality would improve by any particular amount within any particular timeframe. It was not known, at the time of the decision, what measures the new draft Air Quality Plan would contain, let alone what the final Plan would contain after consultation. It was also not known how any national measures would relate to local measures, nor the timeframe in which they would come forward. Accordingly, the Inspector was entitled to consider the evidence and not simply assume the UK would soon by compliant with the Directive.
- The financial contribution had not been shown to translate into actual measures likely to reduce the use of petrol or diesel vehicles, and thus reduce NO_2 emissions.

May 2019 – Court of Appeal dismissed Gladman's Appeal of the 2017 High Court Decision[50].

HCC Key Point – Damage costs whilst providing context for air quality impacts do not necessarily translate into easy mitigation actions to be implemented. Policies that apply damage costs to secure mitigation should consider those costs as an indicative *minimum* level of contribution towards appropriate, effective mitigation, with avoidance preferred.

3.5. Emerging issues

3.5.1. Use of Traffic Regulation Orders for Clean Air Zones

Highway authorities can place temporary, or permanent restrictions on traffic within their areas by way of a Traffic Regulation Order (TRO). Some of the most popular uses for TROs are restricting the movements of HGVs in residential areas and implementing parking restrictions but they are also the mechanism to implement charging or access restrictions for Clean Air Zones.

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[49] High Court (2017) [2017] EWHC 2768. Available online at: https://www.bailii.org/ew/cases/EWHC/Admin/2017/2768.html. Accessed Jan 2020.

[50] Court of Appeal (2019) Gladman Developments Ltd vs Secretary of State for Communities and Local Government and Swale Borough Council and CPRE Kent. [2019] EWCA Civ 1543. Available online: https://www.bailii.org/ew/cases/EWCA/Civ/2019/1543.pdf. Accessed Jan 2020.

3.5.2. Lower Speed Limits to Reduce Vehicle Emissions

Highways England are currently undertaking research into the use of speed management (reduced and variable speed limits) to smooth traffic flow and reduce emissions, including a trial on the M1 in South Yorkshire with the aim to introduce more widely on their network in the future.

The Welsh Government (through its Trunk Road Authorities) has introduced reduced speed limits on 5 sections of their strategic road network to help improve air quality (both as a temporary stop-gap and as part of a medium term strategy).

In 2019, Hampshire County Council, in partnership with Surrey County Council, introduced a speed limit reduction from 70mph to 50mph along a short stretch of the A331, in response to the national plan and Ministerial Direction from the Secretary of State to reduce nitrogen dioxide concentrations to within legal limits in 'the shortest possible time'.

To support this, authority has been delegated to the Director of Economy, Transport, and Environment, in consultation with the Executive Member for Environment and Transport, to make exceptions to the established Traffic Management Policy to allow the amendment or setting of speed limits on public health grounds with regard to air quality, in response to exceptional circumstances, and in accordance with the following qualifying criteria:

- where legal limits of air quality are exceeded in CAZ designations or Air Quality Management Area (AQMA)

AND

- when all other reasonable options for achieving compliance with legal air quality levels have been exhausted.

4. Air Quality & Health

The main air pollutants of concern relating to transport emissions are fine particulate matter (PM_{10}/$PM_{2.5}$) and nitrogen dioxide (NO_2). There are also health effects associated with elevated levels of ozone (O_3) and non-methane volatile organic compounds (NMVOCs), to which transport emissions also contribute.

National Air Quality Objectives and European Directive Limit and Target Values exist for the protection of human health. They are informed by guidelines published by the World Health Organisation (WHO)[51] but not all WHO guidelines are adopted in the UK (see chapter 3).

4.1. What is the impact on human health?

Poor air quality is the largest environmental risk to public health in the UK[52].

- Long term exposure to air pollution (over several years) reduces life expectancy by:
  - increasing incidence of lung, heart and circulatory conditions; and
  - increasing risk of lung cancer[53].
- Short-term exposure (over hours or days):
  - exacerbates asthma,
  - affects lung function,
  - increases respiratory and cardiovascular hospital admissions
  - increases mortality.
- Recent / emerging evidence of effects on:
  - fertility[54];
  - birth outcomes[55];
  - neurological development[56];
  - type 2 diabetes[57]; and
  - dementia[58].

The most vulnerable suffer the most harm.

- Deprived areas often have higher levels of air pollution, as people live, study or work near busy roads.
- Those most vulnerable to health impacts are: children, the elderly and those with existing respiratory or cardiovascular conditions.

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[51] WHO (2005) Air quality guidelines – global update 2005. Available online: https://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/. Accessed Jan 2020.
[52] Public Health England (PHE) (2019) Review of interventions to improve outdoor air quality and public health. Published 11 March 2019. Available online: https://www.gov.uk/government/publications/improving-outdoor-air-quality-and-health-review-of-interventions. Accessed January 2020.
[53] The International Agency for Research on Cancer (IARC) has classified particulate outdoor air pollution as carcinogenic to humans (IARC Group 1).
[54] La Marca, A. *et al.* (2019) New understanding of environmental influences on female fertility marker. Presented at the *Review of the 35th European Society of Human Reproduction and Embryology Congress*, 8 Aug 2019. Available online at: https://www.emjreviews.com/reproductive-health/congress-review/review-of-the-35th-european-society-of-human-reproduction-and-embryology-eshre-congress-2019/
[55] Ha S, *et al.* (2018), Ambient air pollution and the risk of pregnancy loss: a prospective cohort study. *Fertility and Sterility*. Vol 109, Iss 1, p 148-153. Available online: https://www.fertstert.org/article/S0015-0282(17)31973-8/fulltext
[56] Royal College of Physicians (2016) Every breath we take: the lifelong impact of air pollution. Available online: https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution. Accessed Jan 2020.
[57] Bowe, B., Xie, Y., Li, T., Yan, Y. and Xian, H. (2018) The 2016 global and national burden of diabetes mellitus attributable to $PM_{2.5}$ air pollution. The Lancet Planetary Health. Vol 2, Issue 7, PE301-E312. 1 July 2018. Available online: https://www.thelancet.com/journals/lanpla/article/PIIS2542-5196(18)30140-2/fulltext. Accessed Jan 2020.
[58] Carey, I.M, Anderson, H.R., Atkinson, R.W, Beevers, S.D, Cook, D.G, Strachan, D.P., Dajnak, D., Gulliver, J. and Kelly, F.J. (2018) Are noise and air pollution related to the incidence of dementia? A cohort study in London, England. *BMJ Open*, 11 Sept 2018. Available online: https://bmjopen.bmj.com/content/8/9/e022404. Accessed Jan 2020.

The impact of poor air quality on the most vulnerable is described in Chapter 10: Protecting the most vulnerable.

Figure 4-1 - Health impacts of air pollution over a lifetime (ref: Royal College of Physicians, "Every breath we take: the lifelong impact air pollution", February 2016) [59]

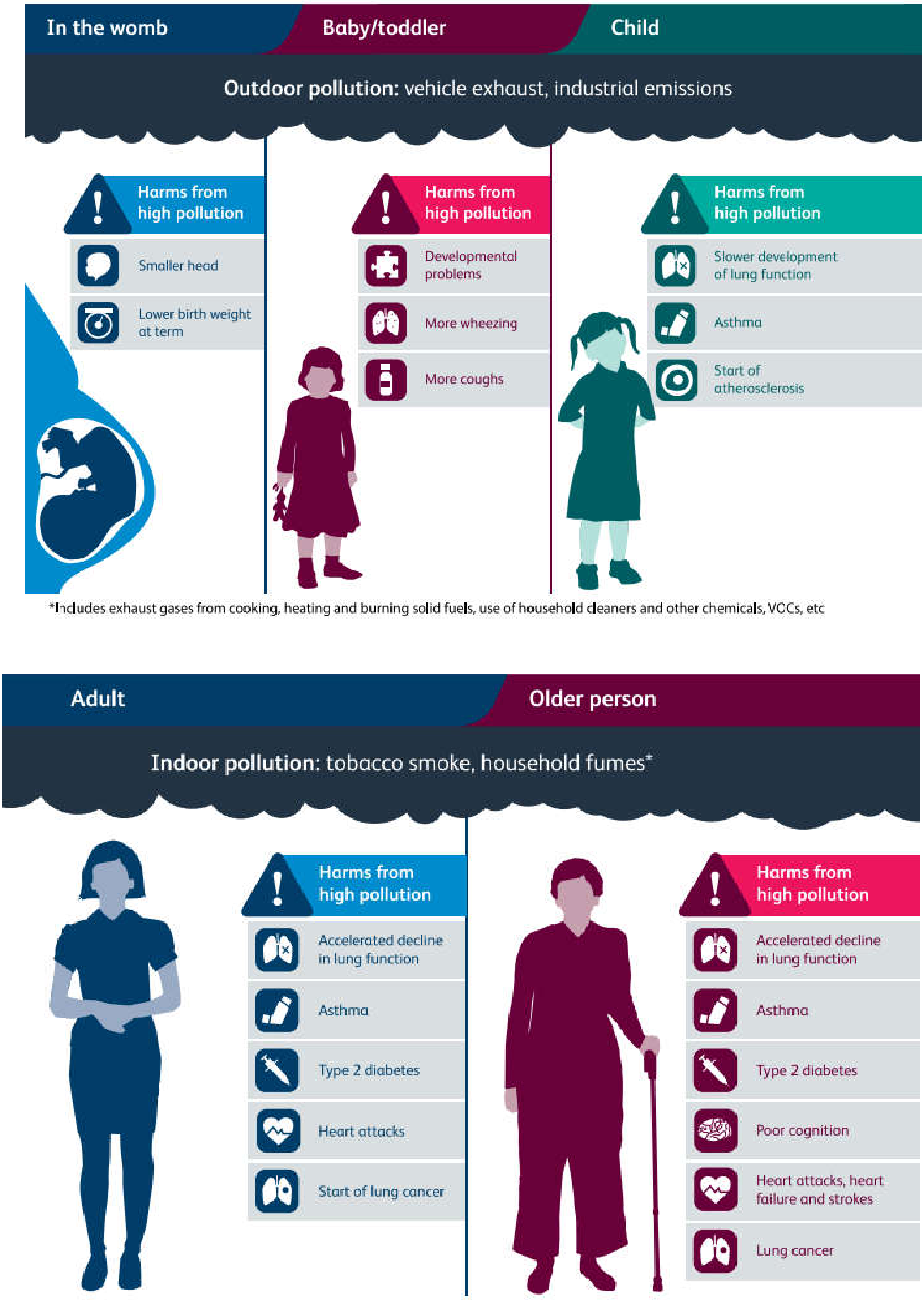
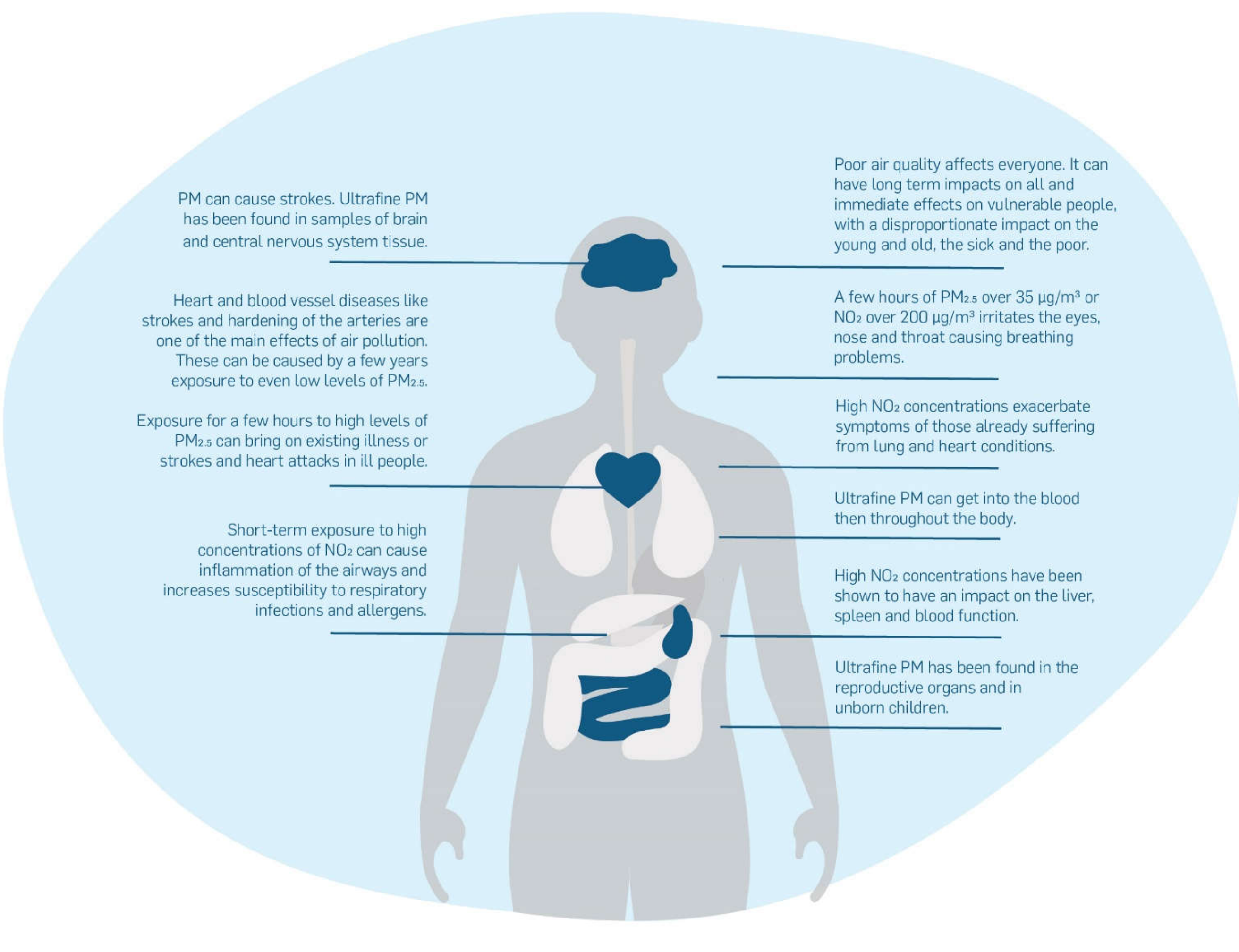


Table 4-1 – Health effects of air pollutants

Pollutant	Health Effects	Notes
Particulate matter (PM)	Long term exposure reduces life expectancy through: - cardiovascular disease, via atherosclerosis (hardening / narrowing of the arteries) and coronary events. - respiratory diseases and - lung cancer [60] Short term exposure (hours to weeks) can cause: - wheezing / coughing - exacerbates asthma and bronchitis - myocardial ischemia - myocardia infarctions - arrhythmias - strokes[60] - cardiovascular mortality	Fine particles are those with a diameter of less than 10 µm (PM_{10}), less than 2.5 µm ($PM_{2.5}$), and ultrafine particles, less than 0.1 µm ($PM_{0.1}$). Small particles penetrate and lodge inside lungs. The smaller the particle, the deeper into the body they can penetrate. PM_{10} are respirable. The strongest evidence for effects on health are associated with $PM_{2.5}$, as at this size the particles can be inhaled deep into the lungs. The very smallest particles, ultrafine $PM_{0.1}$ (the smallest fraction of $PM_{2.5}$) are nano-particles smaller than 0.1 µm in diameter, and are thought, once inhaled, to be able to pass directly into the bloodstream and become embedded in organs such as the brain and heart. There is no evidence of a 'safe' level of exposure to PM, or a threshold below which no adverse health effects would occur[61]. Clean Air Strategy[62] cites an ambition of the UK Government to meet the WHO annual mean guideline limit of 10 µg/m³ $PM_{2.5}$.
Nitrogen dioxide (NO_2)	Long term exposure associated with: - reduced lung development - childhood respiratory infection - effects on lung function Short term exposure, acts as a respiratory irritant that can cause inflammation of the airways leading to: - coughing - production of mucus - shortness of breath.	Notably, NO_2 has been associated with adverse health effects at concentrations that were at or below current EU Limit Values[61]. Whilst some studies report associations with regards to NO_2 impacts on mortality, it is not straightforward to separate the impacts of NO_2 specifically from effects caused by other pollutants emitted by the same source[63].

[60] Royal College of Physicians (2016) Every breath we take: the lifelong impact of air pollution. Published February 2016. Available online: https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution. Accessed Jan 2020.
[61] World Health Organisation (2006) Air Quality Guidelines. Global Update 2005. Available online: https://www.who.int/airpollution/en/. Accessed Jan 2020.
[62] Defra (2019) Clean Air Strategy. Published 14 January 2019. Available online: https://www.gov.uk/government/publications/clean-air-strategy-2019.Accessed January 2020.
[63] COMEAP (2018) Associations of long-term average concentrations of nitrogen dioxide with mortality. Published August 2018. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf. Accessed Jan 2020.

Figure 4-2 – Where air pollutants go in our bodies and what they do – Particulate Matter and Nitrogen Dioxide



4.2. Public health data reporting by district

The Public Health Outcomes Framework for England[64] includes an indicator of mortality associated with air pollution. This enables Directors of Public Health to appropriately prioritise action on air quality in their local areas. The indicator reflects the fraction of all-cause adult mortality attributable to long-term exposure to current levels of anthropogenic particulate air pollution. It should be noted that this indicator only reflects particulate matter and does not account for any contribution from nitrogen dioxide concentrations. Although long term exposure to nitrogen dioxide concentrations is also linked with early mortality, it is difficult to distinguish between the effects of nitrogen dioxide on its own, due to the combined effect with particulate matter. This makes it challenging when using these data for any particular local authority area, given that most local authorities, such as those in Hampshire, are focusing on reductions in nitrogen dioxide in order to meet relevant air quality criteria, while criteria for particulate matter concentrations are already being met.

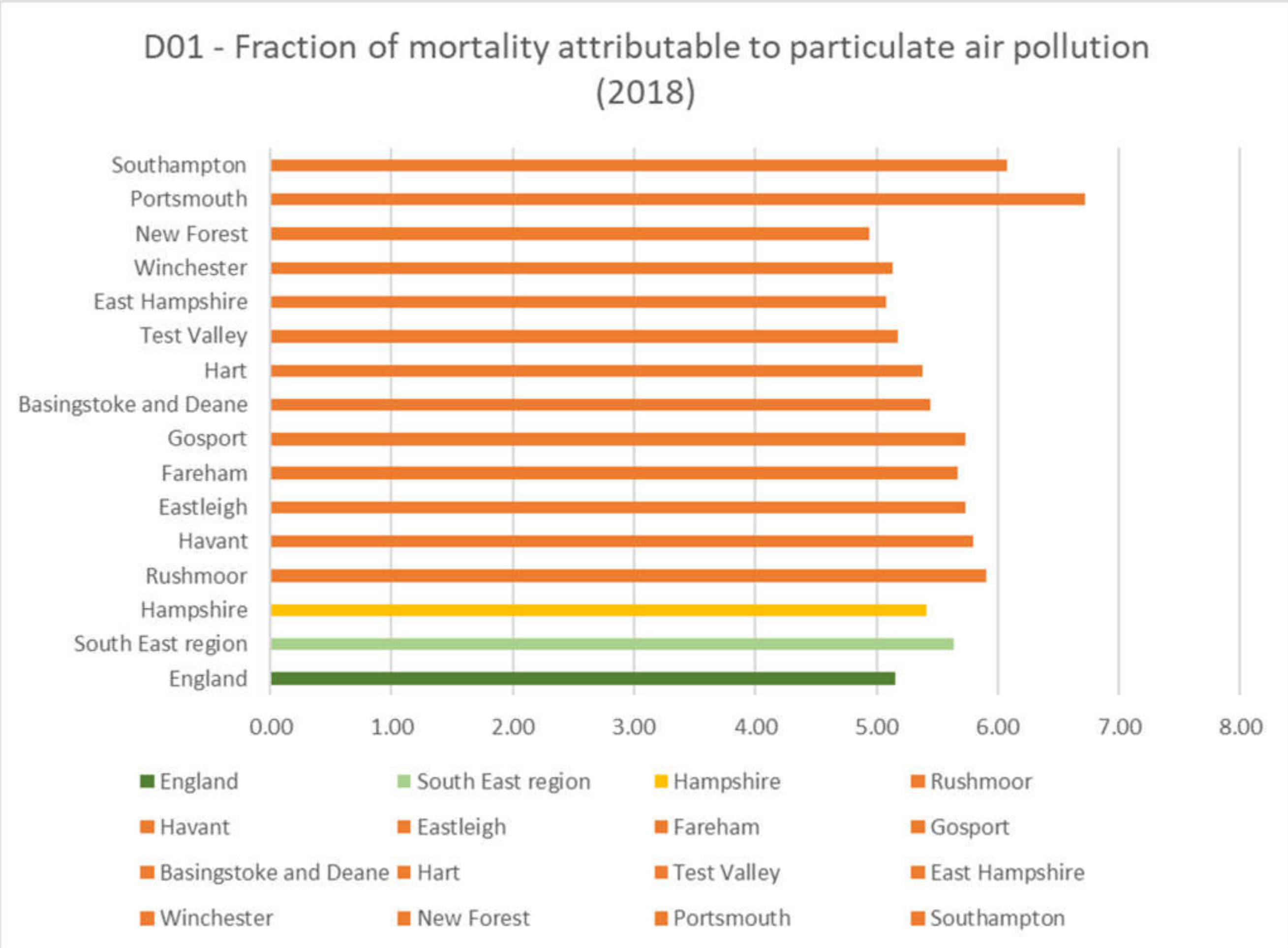
Estimates of the percentage of mortality attributable to long term exposure to particulate air pollution in local authority areas range from 3% in the least polluted rural areas to 8% in some London Boroughs, where pollution levels are highest.

[64] Public Health Outcomes Framework. 2018 data. Accessed Jan-20.: http://www.phoutcomes.info/

Figure 4-3 presents the fraction of mortality attributable to particulate air pollution for England, the South East, Hampshire, the 11 local authority areas within Hampshire and for Portsmouth and Southampton Unitary Authorities:

- The fraction of mortality attributable to particulate air pollution in Hampshire (5.4%) is lower than the average for the South East (5.6%) but higher than the average across England (5.2%).
- Performance varies across the county, reflecting the mix of rural and urban areas. The New Forest has the lowest fraction (4.9%), with the highest fractions in Havant (5.8%) and Rushmoor (5.9%).
- All Hampshire CC districts have lower fractions of mortality than the unitary authorities of Portsmouth and Southampton (6.7% and 6.1% respectively).

Figure 4-3 – Fraction of mortality attributable to particulate air pollution



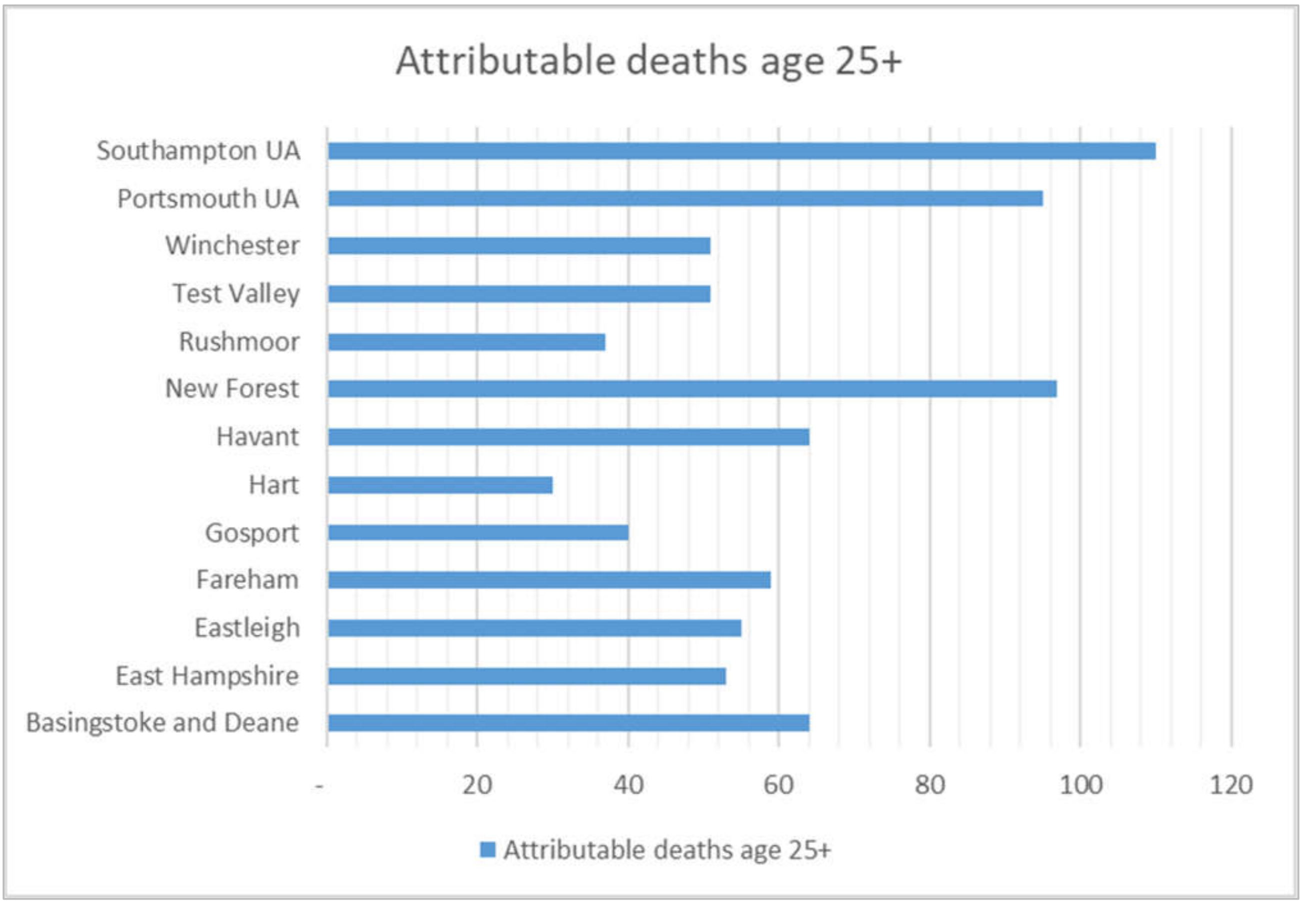
In 2014, PHE collated data from all UK local authorities, to calculate the attributable fraction of annual mortality, and also the total number of attributable deaths and associated life years lost[65].

Based on 2010 data, the fractions reflect those reported above, and cite 601 attributable deaths (age 25+) across Hampshire CC, with 6,211 associated life years lost.

The breakdown by local authority area is shown in figure below.

[65] PHE (2014) Estimating Local Mortality Burdens associated with Particulate Air Pollution. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf. Accessed Jan 2020.

Figure 4-4 – Attributable deaths (age 25+) due to anthropogenic PM2.5 air pollution in 2010, across Hampshire [65] Comparative figures for Hampshire 601 deaths, and for England 25,002 deaths.



4.3. What are the relative impacts of each pollutant?

PM is associated with a wider range of health impacts (or 'health impact pathways') than NO_2 (Table 4-2 and Table 4-3).

In Table 4-2 and Table 4-3, Low / Central / High, refers to the range of estimates of health impacts that are included within sensitivity analyses and reflects varying levels of certainty of underlying epidemiological evidence.

Low sensitivity scenarios take account of the core, well known health impacts, whereas high sensitivity scenarios include health impacts which may have only weak or emerging evidence of an association with air pollution.

Table 4-2 - Health impact pathways for PM and NO_X[66]

Impact Pathway	PM			NO_x		
	Low	Central	High	Low	Central	High
Chronic mortality	x	x	x	x	x	x
Respiratory hospital admissions	x	x	x			x
Asthma (children)		x	x		x	x
Cardiovascular hospital admissions	x	x	x			
Lung cancer		x	x			x
Coronary heart disease		x	x			
Stroke		x	x			
Diabetes			x			x
Asthma (adults)						x
COPD chronic bronchitis)			x			

Table 4-3 - Concentration response functions – relative risk (% change per 10 μg/m³ change in pollutant)[17]

Pollutant	Pathway	Low	Central	High
$PM_{2.5}$	Chronic mortality	4	6	8
PM_{10}	Respiratory hospital admissions	0.8	0.8	0.8
PM_{10}	Cardiovascular hospital admissions	0.8	0.8	0.8
NO_2	Respiratory hospital admissions			0.5
NO_2	Chronic mortality	0.6	0.9	1.3
$PM_{2.5}$	Diabetes			10
$PM_{2.5}$	Lung cancer		9	4
NO_2	Diabetes			5
NO_2	Lung cancer			2

4.4. Emerging issues

- Non-exhaust PM emissions – important to note that electrification of vehicles won't solve all of the air quality problems.
  - The proportion of 'non-exhaust' PM (brake and tyre wear and resuspension) is very high (~90% of total road traffic PM_{10} and 85% of total road traffic $PM_{2.5}$)[67],
  - It is disproportionately under researched – given added health importance of PM, compared with other pollutants.
  - A positive relationship exists between vehicle weight and non-exhaust emissions. That is the growth in larger vehicles of the same type (e.g. SUV rather than saloon cars) means the importance of non-exhaust emissions of PM is growing over time.

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[66] Defra (2019) Impact Pathways Approach: Guidance for air quality appraisal. Jan 2019. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770649/impact-pathway-approach-guidance.pdf. Accessed Jan 2020.
[67] Defra's Emission Factor Toolkit: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

- Electric vehicles are ~24% heavier than their conventional counterparts[68]

- As NO_X pollution reduces, ozone pollution may increase in urban areas, due to changes in the photochemical balance (the limiter on NO_2 formation is usually the quantity of ozone available in the immediate locality for the reaction)
- Increasing recognition of the role of emissions of ammonia (primarily from agriculture) in the formation of secondary particulate matter in the atmosphere and resultant effects on human health. This remains relevant to transport as these would be roadside sources where there is arable land adjacent.
- Emerging evidence on health impacts of ultrafine particles (UFPs [$PM_{0.1}$]) indicates that they can penetrate deep into lungs and enter the bloodstream. However, there is no widespread monitoring or specific air quality standards.
- Recent study by researchers from the Environmental Research Group at Kings[69] examined the distribution of UFPs in four European cities (Barcelona, Helsinki, London, and Zurich). The study identified, characterised and quantified sources of UFPs between 2007 and 2017, measuring particle and gas pollutants at different sites. It found that:
  - London had the greatest concentrations of UFPs compared to other cities
  - Traffic is the predominant source of UFPs, accounting for 71-94%
  - Highest concentrations were found when the wind was blowing from the direction of the main airports in each of the four cities. This indicates that aviation is both a substantial source of the particulates and that they can travel significant distances (e.g. >11 miles from Heathrow into Central London).

It should be noted that while there are a plethora of research reports on potential health impacts from air pollution, until the work has been independently peer reviewed and shown to be repeatable and transferable, it should not be, and has not been, referred to.

[68] Timmers, V.R.J.H. and Achten, P.A.J. (2016) 'Non-exhaust PM emissions from electric vehicles'. *Atmospheric Environment*, **134**, June 2016, p10-17. Available online: https://www.sciencedirect.com/science/article/abs/pii/S135223101630187X. Accessed Jan 2020.
[69] Rivas, I, Beddows, D.C.S, Amato, F., Green, D.C., Leena, J., Hueglin, C., Reche, C., Timonen, H., Fuller, G.W. Niemi, J.V. Perez, N., Aurela, M., Hopke, P.K., Alastuey, A., Kulmala, M., Harrison. R.M., Querol, X., Kelly, F.J. (2020) Source apportionment of particle number size distribution in urban background and traffic stations in four European Cities. *Environment International*. **135** (2020). 105345.

5. Air Quality & the environment

5.1. Local Air Quality and its impact on Ecological Sites

5.1.1. Air pollutants of concern

Separate to its impact on human health, air pollution in various forms and from a variety of sources can have an adverse effect on vegetation and soils, damaging protected habitats and biodiversity within designated ecological sites.

Air pollutants that affect vegetation include dust and particulate matter (PM), nitrogen oxides (NO_x), ammonia (NH_3), ozone (O_3), and sulphur dioxide (SO_2).

Figure 5-1 - Emission sources and deposition processes affecting vegetation

5.1.2. Road transport pollutants

Road transport is responsible for emissions of NOx, small amounts of NH_3 (from selective catalytic reduction (SCR) systems needed to meet Euro 6 standards and earlier three-way catalytic convertors for petrol vehicles), and fine particulate matter (PM_{10} and $PM_{2.5}$).

- **Fine particulate matter (PM_{10} and $PM_{2.5}$)** emissions from vehicles contribute to direct effects which may:
    - affect both physical and chemical processes
    - cover the leaf surface and reduce the amount of light, affecting growth
    - enhance infestation by pests and pathogens

5.1.3. Indirect effects

NOx is of primary concern for road schemes, principally for its contribution to total nitrogen and acid deposition[71].

NO_x and NH_3 emissions from vehicles contribute to indirect effects:

- **Nitrogen deposition** (nutrient nitrogen) – too much nitrogen causes nitrogen enrichment (eutrophication), which can have an adverse effect on sensitive ecosystems:
    - changes the balance of an ecosystem, with the loss of some species, and changes in structure and function
    - reduction in species richness
    - causes depletion of other nutrients
    - can become toxic to some plants
    - can affect sensitivities to climate extremes

- **Acid Deposition** – Emissions of NO_x and NH_3 can enhance the acidification of soils and watercourses, and damage vegetation:
    - Changes the balance of an ecosystem with the loss of acid-sensitive species
    - Leaf damage affects ability to take in nutrients
    - Reduces pH in soils
    - Toxicity to fauna
    - Reduces fertility, nutrient deficiencies
    - Release of toxic metals in soils
    - Reduces pH and alkalinity which reduce viability of a range of aquatic plants
    - Changes in microbial transformations

- **Tropospheric Ozone** – a secondary pollutant (formed during photochemical reactions in the atmosphere involving NO_x), which reduces plant growth. Atmospheric reactions occur far from the point of release, so it is not generally considered within local air quality assessment[70].

5.1.4. Critical loads and critical levels

Critical levels and critical loads are set for gaseous air pollutant concentrations and rates of deposition from air to ground respectively and allow the assessment of the risk of impact to vegetation and ecosystems.

- **Critical levels** are defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as… plants, ecosystems or materials, may occur according to present knowledge"[71]
- The critical levels for the protection of vegetation are provided in the table below and are derived from research by the World Health Organisation (WHO) or the Convention on Long-Range Transboundary Air Pollution (CLRTAP). The critical levels for NO_x and SO_2 are set within the EU Directive (2008/50/EC) and incorporated into the UK Air Quality Standards, and in addition those for NO_x, SO_2 and ozone have been adopted as UK national objectives.

[70] https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2019.pdf

Table 5-1 - Critical levels for the protection of vegetation

Pollutant	Ecological critical level
NO_x	Annual average concentration should not exceed 30 µg/m^3 Daily average concentration should not exceed 75 µg/m^3
SO_2	Annual average concentration should not exceed 20 µg/m^3 (10 µg/m^3 where lichens or bryophytes are present.
NH_3	Annual average concentration should not exceed 3 µg/m^3 (1 µg/m^3 where lichens or bryophytes are present.
O_3	Target value of 18,000 µg/m^3 to be calculated from 1 hour values from May to July, averaged over 5 years.

- **Critical loads** are habitat specific and are defined as *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*[71].
  - Critical loads for nitrogen and acid deposition are provided for specific habitat types as a range.
  - The ranges are based on empirical evidence and reflect variation in ecosystem response.
  - Recommended values for use in assessments are available from the Air Pollution Information System (APIS) website[71].
  - The APIS website also provides information on the reliability of the critical load range, and the impacts if the higher limit of the range is exceeded.
  - Expressed in units of kilograms of nitrogen per hectare per year (Kg N/ha/yr) for nitrogen deposition or kilo-equivalents per hectare per year (Keq/ha/yr) for acid deposition.

5.1.5. AQ assessment requirements for road transport

Statutory nature conservation agencies (in England, Natural England) apply the critical level for NO_x in designated conservation sites; 'Ramsar' sites, special protection areas (SPA), special areas of conservation (SAC) and Sites of Special Scientific Interest (SSSI).

Highways England requires assessment of nitrogen oxides concentrations and nitrogen deposition for the above designated sites plus local nature reserves, local wildlife sites, nature improvement areas, ancient woodland and veteran trees. Note that this is a recent change in Highways England guidance (LA105, 2019) meaning that there will be more assessment work on ecological sites in the future, not less.

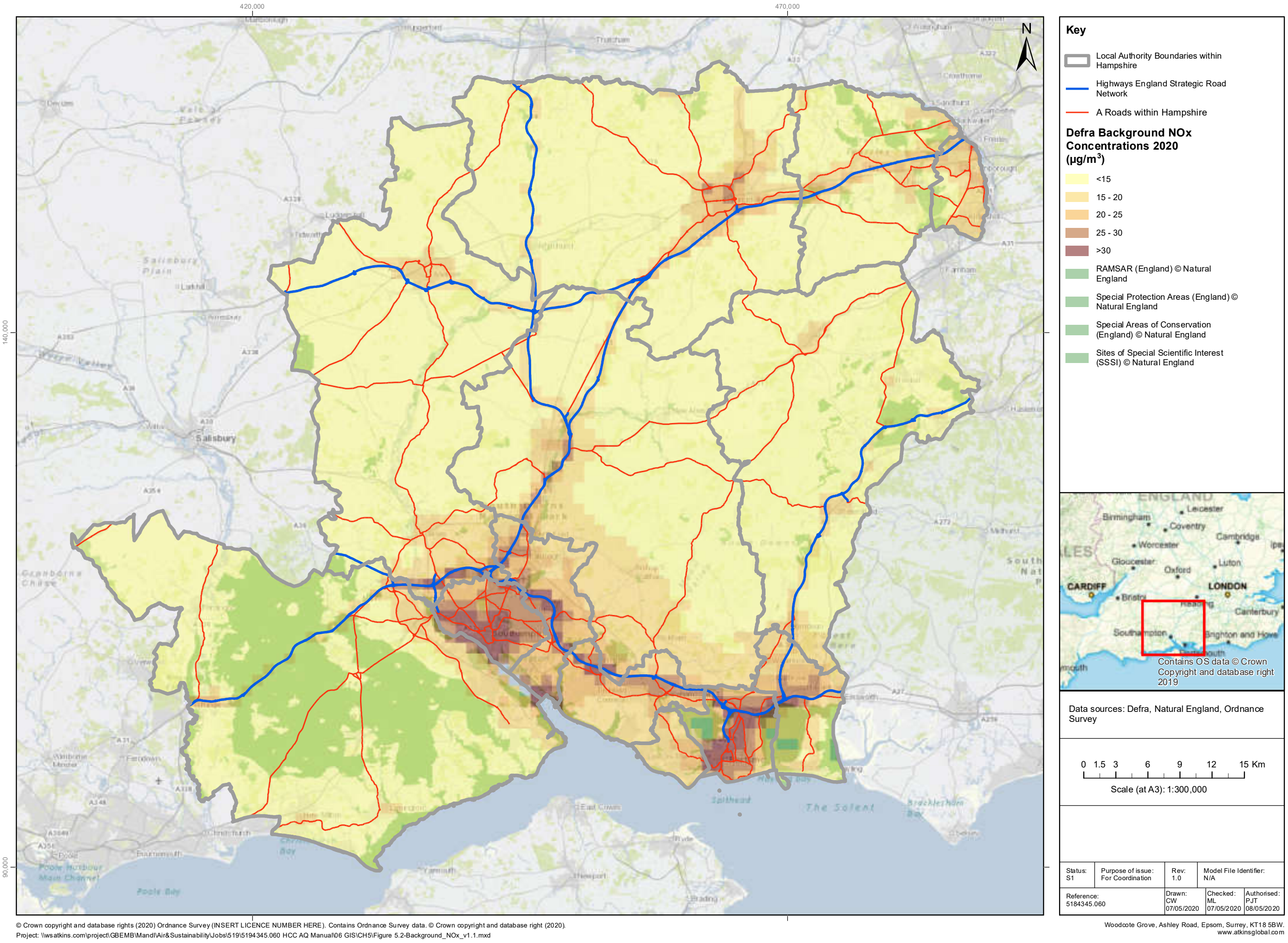
The EU Habitat Directive requires the competent authority to carry out an appropriate assessment (Habitat Regulation Assessment [HRA]) of any plan or project which may have a significant effect on a European designated site (Natura 2000 sites: SPA, SAC and Ramsar). There is a statutory requirement for the competent authority to formally consult statutory nature conservation agencies for the purposes of an appropriate assessment.

When undertaking HRA, Natural England advise the application of a screening threshold of either a change in traffic volume of 1000 AADT or 1% of the critical load or critical level, below which there is unlikely to be a significant effect on vegetation.

[71] http://www.apis.ac.uk/

5.1.6. Air Quality & Ecological Sites in Hampshire

Figure 5-2 - Statutory designated ecological sites in Hampshire (SAC, SPA, Ramsar, SSSI)



5.2. Wider Impacts on the Environment

5.2.1. Balancing carbon and local air quality

Traditional combustion engines also emit carbon dioxide (CO_2), contributing to the greenhouse effect, with electric vehicles also emitting CO_2 at the point of electricity generation, where the electricity is not generated using renewable sources. Carbon dioxide is not directly harmful to vegetation (or human health) and is therefore not considered an air pollutant and is not included within national air quality regulations.

Ecosystems may, however, be affected indirectly by relatively small changes to the local climate affecting growing seasons, vitality, soil processes and composition.

Emissions of CO_2 are closely related to engine efficiency and the amount of fuel used, whereas NOx and PM emissions are also influenced by the type of fuel, vehicle type and age, state of maintenance (especially of the ERD) and driving style. Actions taken to reduce local air pollutant emissions may have inadvertently led to an increase in CO_2 emissions and vice versa[72].

[72] Air Quality Expert Group, Air Quality and Climate Change: A UK Perspective, 2007, https://uk-air.defra.gov.uk/library/assets/documents/reports/aqeg/fullreport.pdf

For example, diesel vehicles were incentivised by the UK Government from 2001 as they are generally more efficient than petrol vehicles and thus produce fewer CO_2 emissions. However, diesel vehicles produce higher emissions of NO_x and PM, which affect both human health and ecosystems.

In the process of improving local air quality, however, diesel cars are being taxed more heavily in some urban centres and large cities, leading to a decline in sales of new diesel vehicles, and a consequent increase in CO_2 emissions from the transport sector. It is anticipated that this increase will be reversed with the uptake of electric vehicles.

5.3. Non-exhaust emissions

Non-exhaust emissions (NEE) from road traffic refers to particulate matter released from brake, tyre and road surface wear and resuspension of road dust. NEE are discussed further in chapter 4 section 4.4. NEE is predominantly a human health issue but larger particles will remain on the road surface and wash off in drainage water.

Tyre and road surface wear also constitutes a large source of microplastics entering the environment, with a recent estimate indicating that tyre wear whilst driving contributes up to 28% of the releases of primary microplastics to the world's oceans[73][74]. Microplastics in watercourses and the marine environment impact marine wildlife and the food chain.

For NOx emissions, there is evidence that some physical approaches to mitigation (such as air scrubbers and coated surfaces (e.g. pavements, barriers)) can result in an increased nitrogen content in leachate, with impacts on the wider environment once in main watercourses.

5.4. Emerging issues

High levels of nitrogen nutrients within the Solent have led to eutrophication and excessive growth of green algae, which is detrimental to the coastal and estuarine habitats. Sources of the nutrients are primarily treated wastewater and agriculture leaching, not transport.

Following recent changes in European Case law, Natural England has advised the relevant Local Planning Authorities (LPAs) that all new development with the potential to impact the Solent SPA and SAC should be 'nitrate neutral', ensuring that development does not add to existing nutrient burdens. The Solent is therefore particularly sensitive to additional nitrogen disposition. This is relevant in the context of the transport contribution from such developments.

As NO_X pollution reduces, ozone pollution may increase in urban areas, due to changes in the photochemical balance.

[73] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf

[74] Boucher, J., Friot D., 2017. Primary microplastics in the oceans: A global evaluation of sources. International Union for Conservation of Nature and Natural Resources. Gland, Switzerland.

6. A local assessment - The Hampshire picture

6.1. Hampshire fleet composition & predicted improvement rates

6.1.1. Hampshire Fleet Composition

Vehicle fleet composition varies at differing scales (local, regional) and also by type of area (urban, rural) and by geography (e.g. suburban area in the south of England vs suburban area in north Scotland).

Defra produces a national fleet composition for use in air quality tools, which relies on national averages and is not specific to regions or localities.

The national fleet may differ significantly to local fleet compositions. The Defra Fleet Projection Tool[75] provides average projected fleet composition for England (except London), Scotland, Wales, Northern Ireland for years up to 2030 for urban, rural and motorway links.

Road source emissions can also be calculated for the specific make up of individual fleets using bespoke tools.

Recent Clean Air Zone (CAZ)[76] feasibility studies and Local NO_2 Action Plans have all used information on local fleets, collected using automatic number plate recognition (ANPR) surveys, to improve local air quality model accuracy and better inform policy decisions.

There are several factors relating to fleet composition which impact emissions:

- age of the fleet;
- types and proportions of vehicles in the fleet;
- size or weight of the vehicles in the fleet;
- emission standards at the time of sale;
- addition of an abatement technologies used to reduce emissions;
- how well the vehicle is maintained;
- degradation of emission reduction systems; and
- type and quality of fuel used

Clean Air Zones

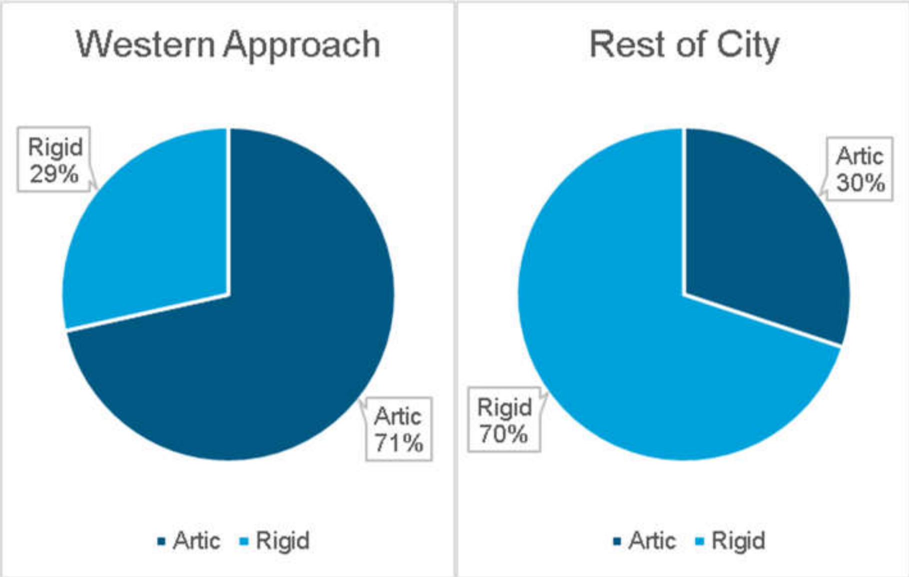
A Clean Air Zone is defined by Defra[2] as *an area where targeted action is taken to improve air quality and resources are prioritised and coordinated in order to shape the urban environment in a way that delivers improved health benefits and supports economic growth.*

Within a Clean Air Zone there is a focus on measures to accelerate the transition to a low emission economy, to ensure improvements are ongoing and sustainable, support future development and decouple local growth from air pollution. Clean Air Zones are intended to bring together local measures to deliver immediate action to improve air quality and health which may be supported by restrictions to encourage only the cleanest vehicles to operate in the city.

The Southampton City Council CAZ study[77] used specific proportions of rigid and articulated heavy goods vehicles (HGVs) to reflect the impact of the unique port activities in Southampton on fleet composition. The difference in HGV fleet make up is illustrated in Figure 6-1.

[75] Defra, Emissions Factor Toolkit, May 2019, https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html. Accessed February 2020.
[76] Defra, Clean Air Zone Framework, February 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863730/clean-air-zone-framework-feb2020.pdf. Accessed February 2020.
[77] Southampton City Council, Southampton Clean Air Zone – Air Quality Modelling Methodology Report (AQ2), December 2018,

Figure 6-1 - Southampton HGV Fleet Composition– CAZ Study[77]



The Hampshire fleet composition will also be unique – at county, city, town and individual street level.

Sufficient data has not been collected to produce a specific Hampshire county level fleet composition, however data used by Fareham BC and Gosport BC to develop their Local NO_2 Action Plan can be used to illustrate potential differences between local authorities in Hampshire and the national fleet composition as complied by Defra.

Euro Standards
European emission standards are related to the emissions standard the vehicle meets and range from pre-Euro I to Euro 6/VI (including Euro 6 subcategories). The latest Euro standards are Euro 6 (LGV) and Euro VI (HGV). The regulations are designed to become more stringent over time to ensure improvements in reducing vehicle emission as newer vehicles join the fleet.

6.1.2. Comparison with National Fleet Composition

From the graphs and analysis below, generally the fleet in Fareham BC is older than the national average (a greater number of earlier euro number vehicles). Older vehicles are associated with higher emission rates of pollutants as in the past the Euro emission standards were not as stringent.

- The petrol car fleet in Fareham BC consists of double the number of older vehicles Euro 2 (2%) and Euro 3 (19%) compared to the national average Euro 2 (1%) and Euro 3 (10%). Similarly, there are fewer Euro 5 (27%) and Euro 6 (22%) vehicles compared to the national average of 34% and 32% respectively.
- The diesel car fleet in Fareham BC consists of fewer newer vehicle - Euro 6 (15%) and Euro 6c (23%) compared to the national average Euro 6 (23%) and Euro 6c (13%). However, proportions of Euro 4 and Euro 5 vehicles are similar.
- The diesel LGV fleet in Fareham BC has half the number of newer Euro 6 (17%) vehicles compared to the national average (33%) but also fewer older Euro 2 (0% Fareham BC, 1% national average). There are also increased numbers of Euro 4 (31%) and Euro 5 (47%) diesel LGVs in Fareham BC relative to the national average of 20% and 41% respectively.

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https://www.southampton.gov.uk/modernGov/documents/s39061/AQ2%20Air%20Quality%20Modelling%20Methodology.pdf. Accessed February 2020.

- The rigid HGV fleet in Fareham BC consists of fewer newer Euro VI (43%) vehicles compared to the national average of 57%. Proportions of Euro III and Euro V_EGR are similar, whilst there are more Euro IV (16%) and Euro V_SCR (25%) relative to the national average of 8% and 19% respectively.
- The articulated HGV fleet in Fareham BC consists of much fewer Euro VI (54%) vehicles compared to the national average (71%) and four times as many Euro IV (11% Fareham, 3% national average).
- The bus fleet in Fareham BC consists of slightly fewer Euro VI (37%) vehicles compared to the national average (40%) but also more Euro II, III, and IV than the national fleet.

Figure 6-2 - Fareham BC LGV Fleet from CAZ Study Compared to the National Average Fleet

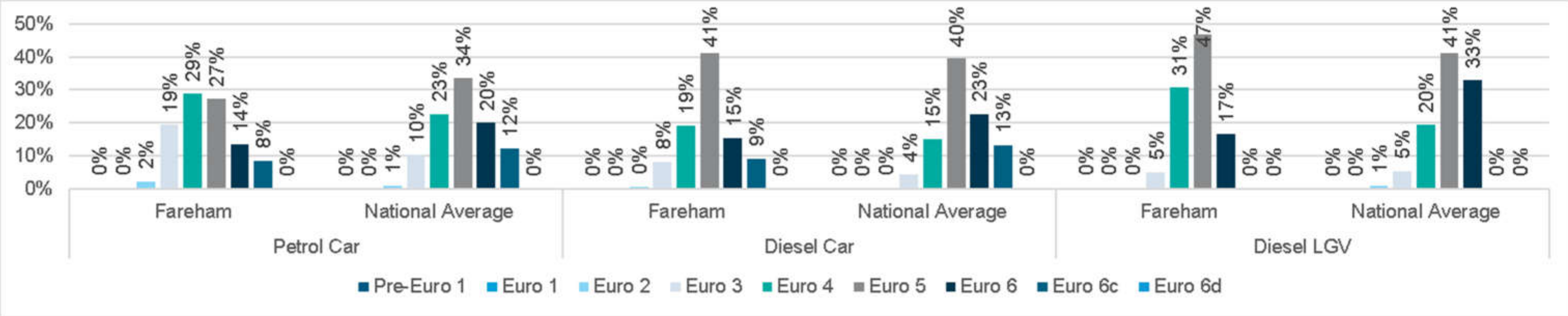
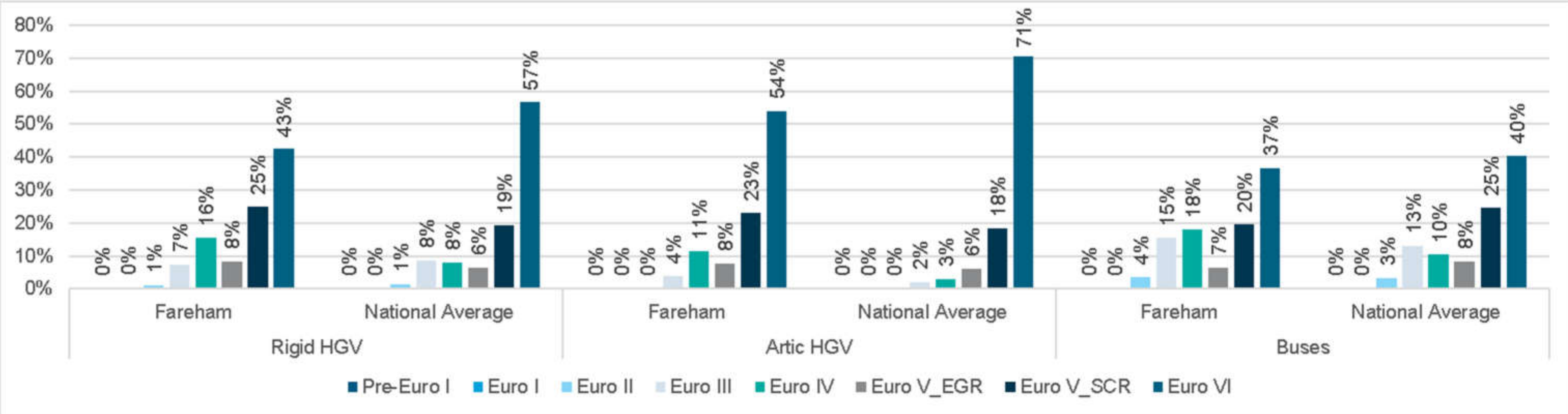


Figure 6-3 - Fareham BC HGV Fleet from CAZ Study Compared to the National Average Fleet



6.1.3. Predicted improvement rates

Models are underpinned by numerous assumptions on how variables will change over time, which can add uncertainty to the predictions.

Generally, vehicle emission rates are expected to improve over time as more efficient engines are produced, emission standards tighten, and fleets move towards lower emission vehicles (hybrids and electric vehicles).

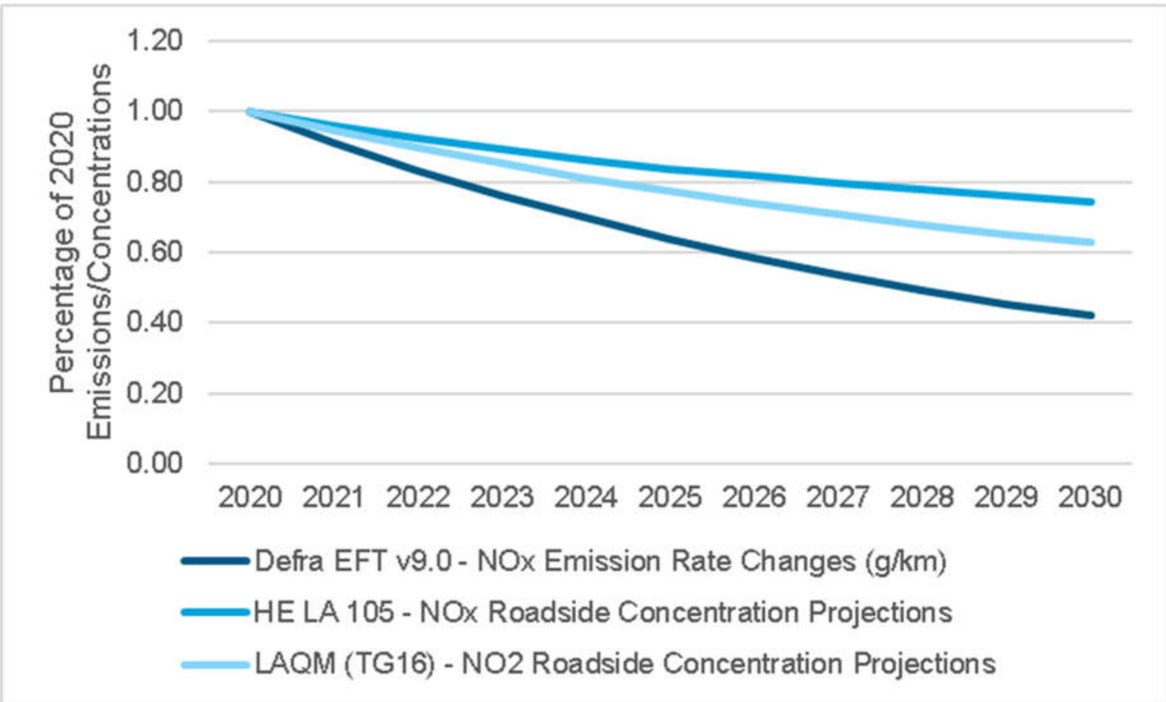
A comparison of different future projection methods shows the inherent uncertainty in how much emissions (and by extension pollutant concentrations) will improve over time. Three approaches have been compared:

- Defra (Emissions Factor Toolkit V9.0)[75];
- Highways England Design Manual for Roads and Bridges, Air Quality (DMRB LA 105)[78]; and
- Local Air Quality Management Technical Guidance (LAQM (TG16))[79] February 2018.

Using traffic data for an average minor road within Hampshire[80] as an example (urban, speed 48 kph), the expected change in emission rates over the period 2020-2030 has been calculated using Defra's Emission Factors Toolkit.

These data have then been normalised to 2020 to show the expected decrease in NOx emissions within Hampshire and allow comparison with Highways England (DMRB LA 105) annual mean NO_X roadside concentration projections and also the LAQM (TG16) projected annual mean NO_2 roadside concentration projections ("rest of UK, HDV =<10%" factors applied).

Figure 6-4 – Example Hampshire Road – Range in Projected Improvements in NOx Emissions and NO_2 Roadside Concentrations 2020-2030



[78] Highways England, Design Manual for Roads and Bridges - Air Quality, November 2019, https://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20105%20Air%20quality-web.pdf. Accessed February 2020.

[79] Defra, Roadside NO_2 Projection Factors, February 2020, https://laqm.defra.gov.uk/tools-monitoring-data/roadside-no2-projection-factor.html. Accessed February 2020.

[80] as reported in chapter 7 based on DfT traffic counts across Hampshire in 2018

The comparison shows the Defra EFT is the most optimistic projection of future improvements in NO_X emissions over the period 2020-2030, whilst the Highways England projections are the most pessimistic.

This highlights the variability in projections and the inherent uncertainty in future improvements: with the Defra EFT predicting a 58% decline in vehicle emissions over this period whereas Highways England predict a 26% decline in roadside concentrations.

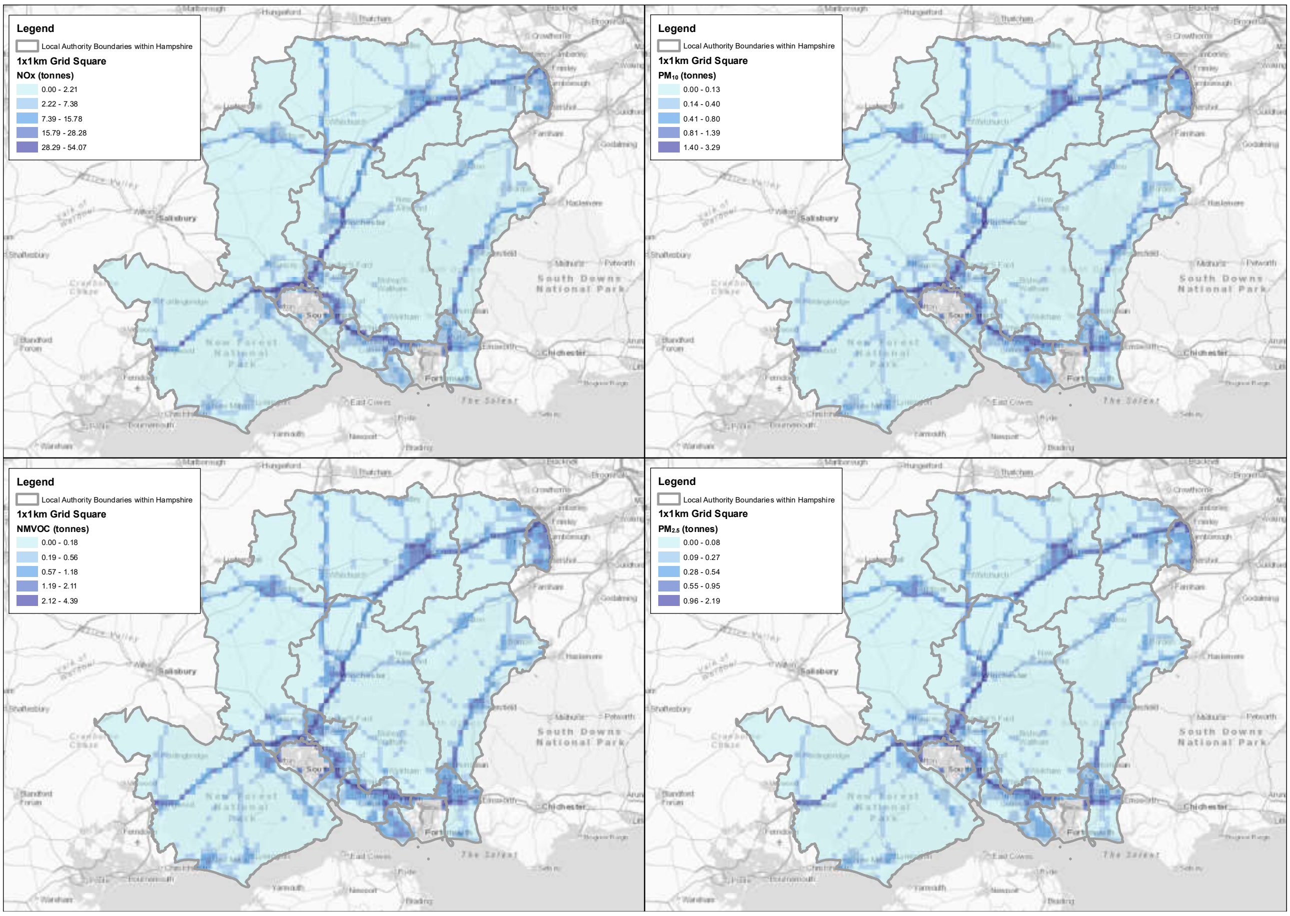
6.2. Hampshire-wide pollutant emissions and concentrations

6.2.1. Pollutant Emissions

The National Atmospheric Emissions Inventory (NAEI)[81] estimates annual pollutant emissions from 1970 to the most current publication year (2017) for several pollutants. These estimates are available as individual sector contributions based on national energy statistics and emissions reporting from industrial facilities.

Total emissions of NOx, PM_{10}, $PM_{2.5}$, NMVOC within Hampshire have been extracted and show that emissions are higher in urban centres, and along and adjacent to major roads in Hampshire.

Figure 6-5 - Hampshire Emissions (NAEI)[81]



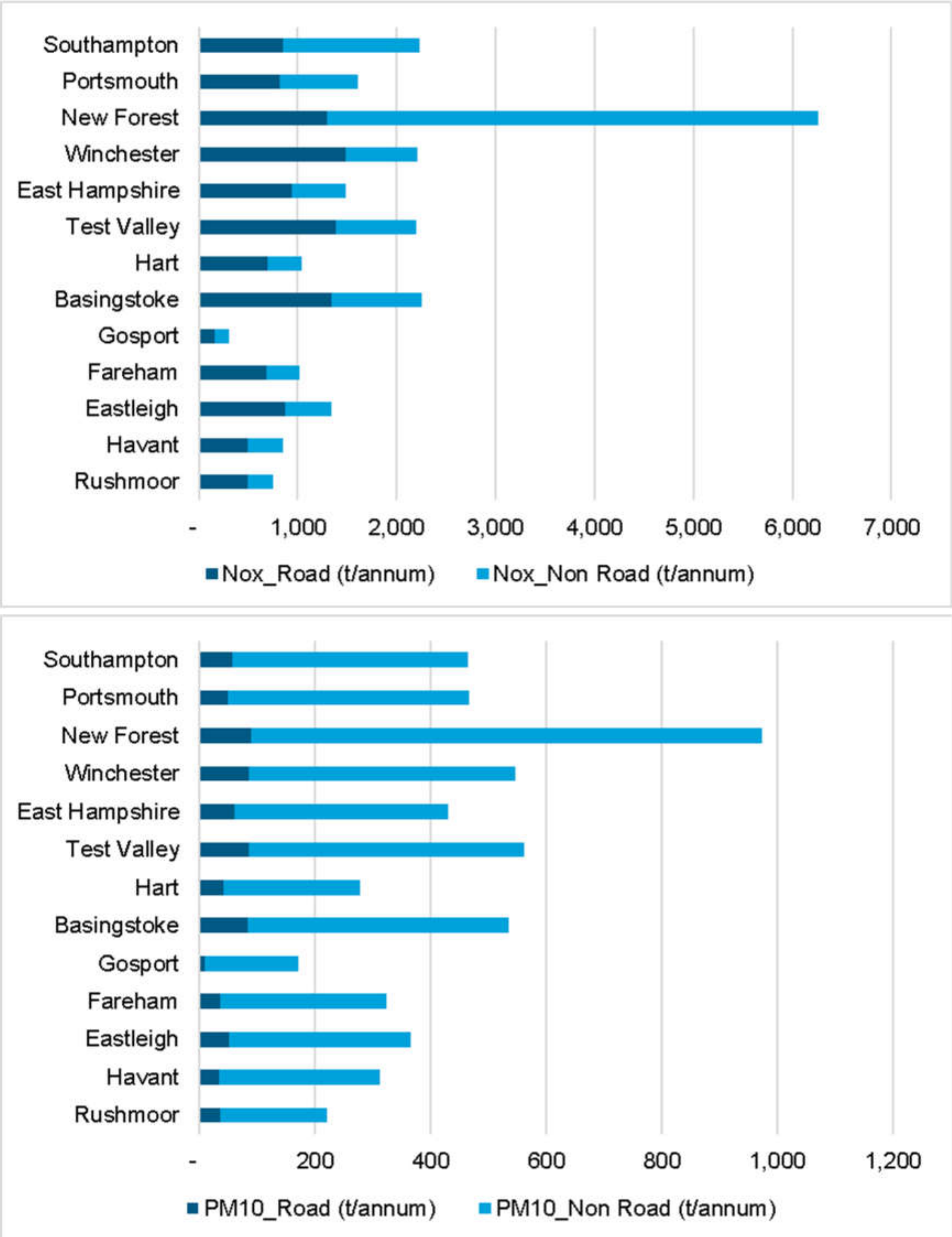
Examining the data by local authority and isolating the road transport contribution from total emissions:

- New Forest DC has the largest total emissions of NOx and $PM_{2.5}$ (driven by local industrial sources)
- Gosport BC has the smallest total emissions of NOx and PM_{10} from (driven by its small size compared to other local authorities).

[81] NAEI, UK National Atmospheric Emissions Inventory for 2017 Interactive Map, https://naei.beis.gov.uk/emissionsapp/. Accessed February 2020.

- Hart DC, Fareham BC, and Winchester CC have the largest contribution from road traffic to total NO_X emissions (67%).
- Gosport BC has the smallest percentage of road traffic contribution to PM_{10} emissions (6%); and
- Rushmoor BC has the largest contribution from road traffic to total PM_{10} emissions (17%).

Figure 6-6 - Hampshire NO_X and PM_{10} Emissions by Local Authority (NAEI)[81]



6.2.2. Background Pollutant Concentrations

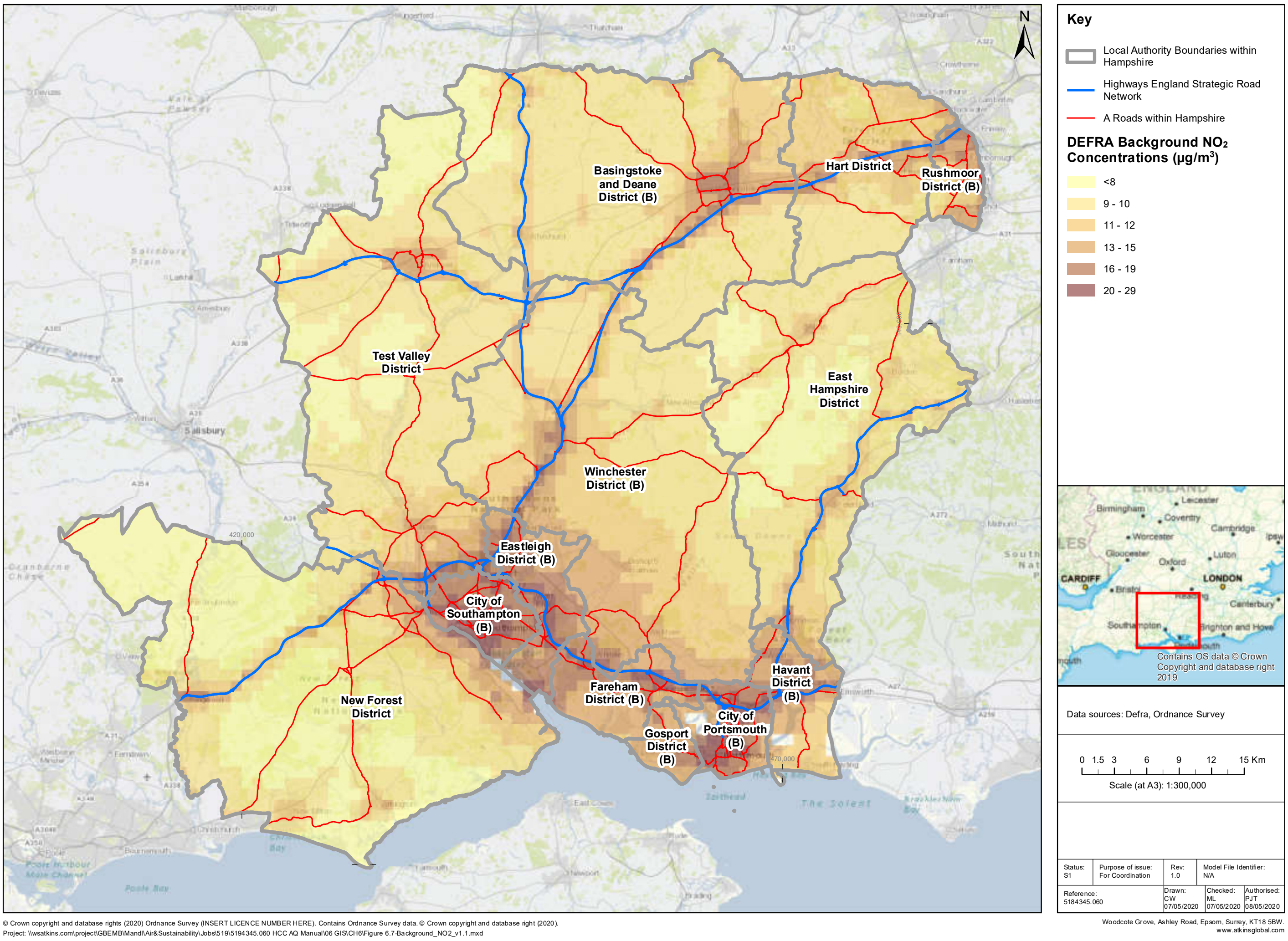
Defra publish air pollution background concentration maps which provide estimates of how background concentrations change over time across the UK and include an estimated breakdown of the relative sources of pollution.

As with the NAEI emission maps, Defra mapped background concentrations are higher in urban areas and along major roads within Hampshire.

The maximum background annual mean NO_2 concentration in 2020 within Hampshire is 29.4 µg/m^3 at the Western Docks in Southampton and 29.0 µg/m^3 on the north-eastern side of Southampton Water opposite Fawley refinery in Eastleigh BC. In contrast the lowest background concentrations are less than 8 µg/m^3 such as in the New Forest district.

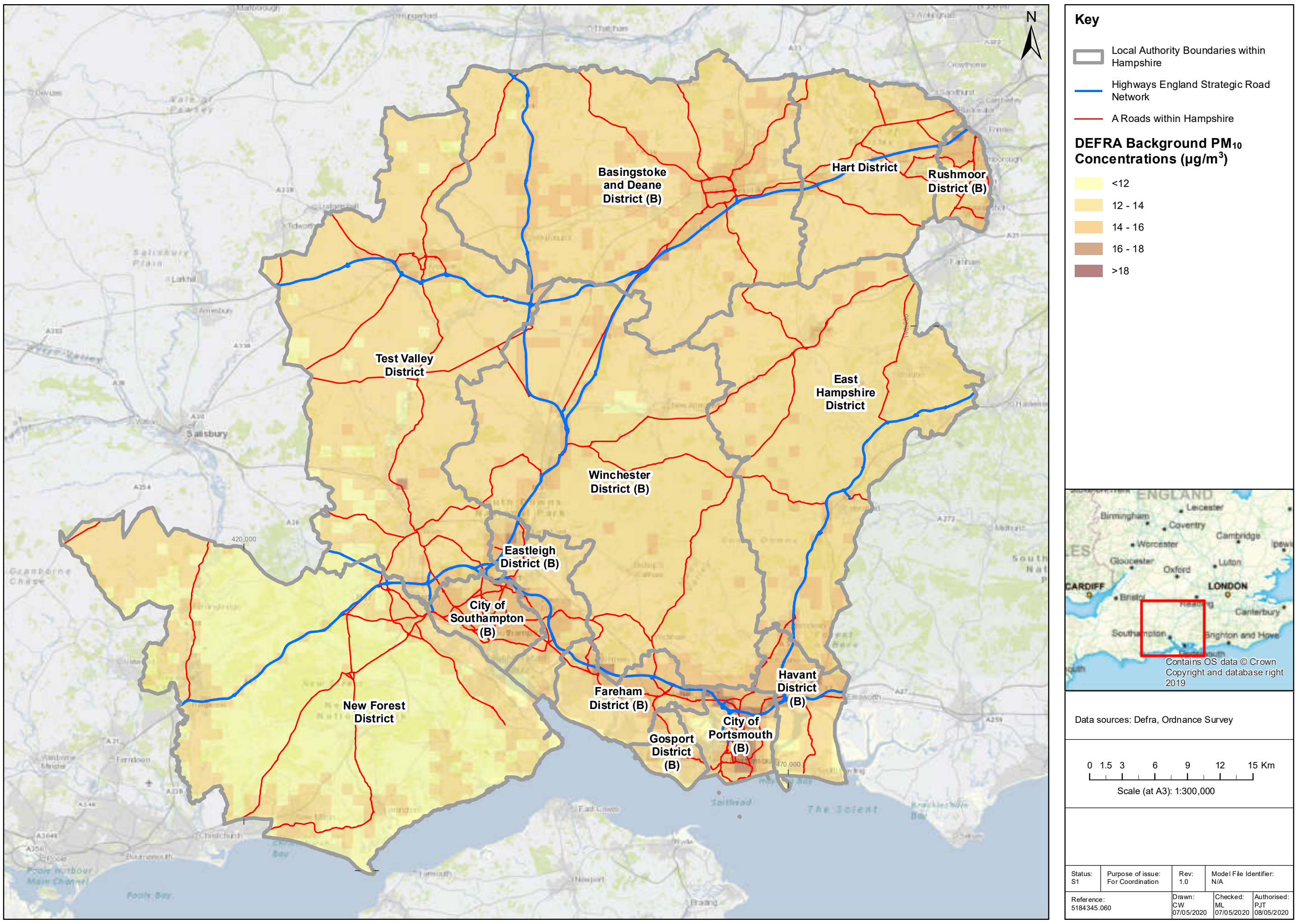
There are no areas exceeding the annual mean NO_2 or PM_{10} AQS objective from background sources alone within Hampshire.

Figure 6-7 – Hampshire Annual Mean NO_2 Background Concentrations[82]



82 Defra, 2017-based background maps, May 2019, https://uk-air.defra.gov.uk/data/laqm-background-home. Accessed February 2020.

Figure 6-8 – Hampshire Annual Mean PM_{10} Background Concentrations[82]



6.2.3. EU Directive Compliance

The UK Government has identified the risk of exceeding the annual mean EU limit value for NO_2 at roadside locations based on national Pollution Climate Mapping (PCM) modelling.

Approximately 100 major roads across the UK are expected to exceed the EU limit value in 2021, mostly in cities and towns.

The UK Government requires local authorities to act to improve air quality in those areas where air pollution is above EU limit value legal limits (non-compliance) in the "*shortest possible time*". These local authorities are required by ministerial direction to produce local NO_2 action plans to address the problem in specified timescales.

In developing their NO_2 local action plan, local authorities are encouraged to consider a wide range of innovative options. Plans could include a wide range of measures such as:

- changing road layouts at congestion and air pollution pinch points
- encouraging public and private uptake of ULEVs
- using innovative retrofitting technologies and new fuels
- encouraging the use of public transport
- access restrictions on vehicles, from turning limits, to vehicle bans, to charging zones

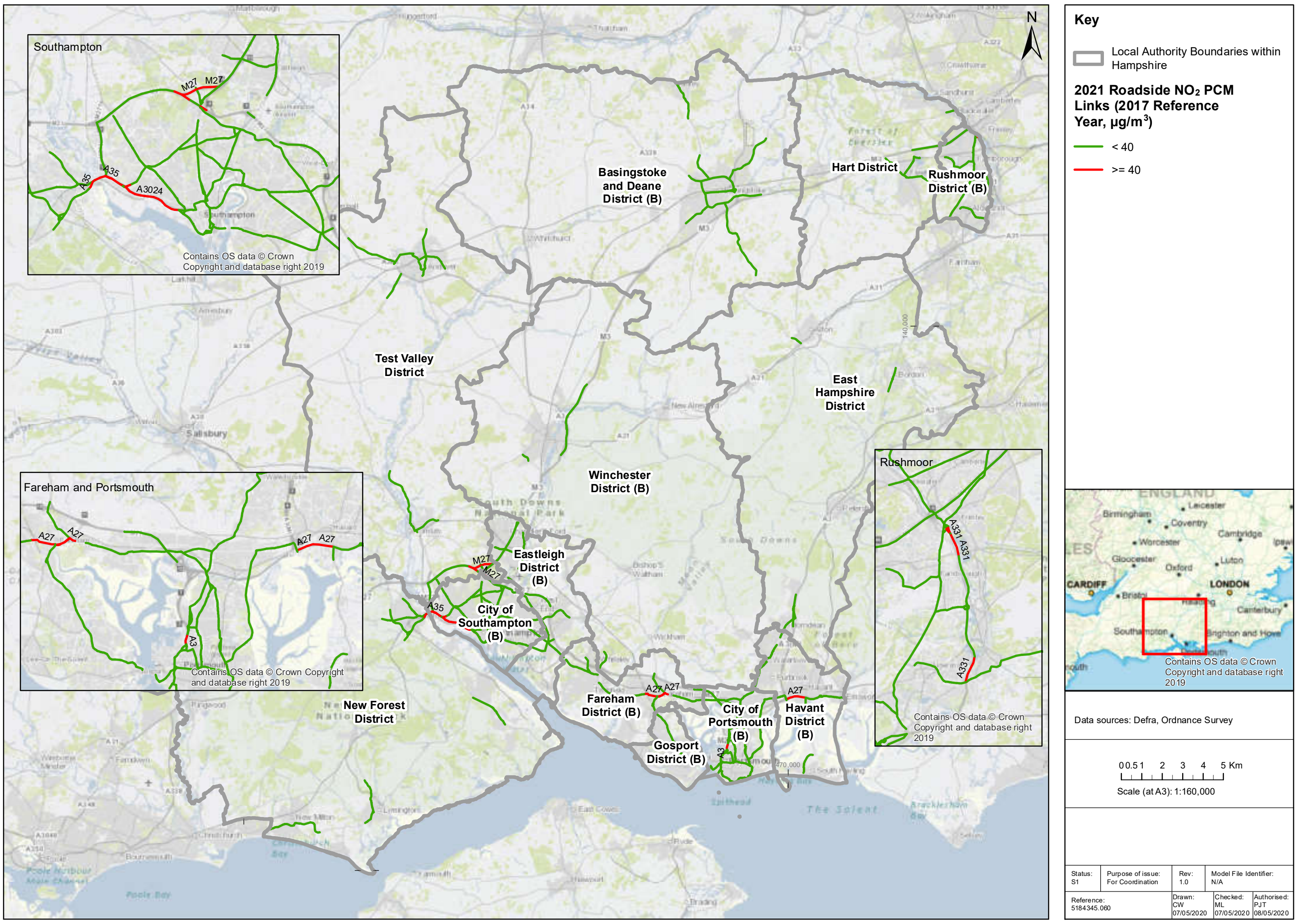
A summary of actions being undertaken by local authorities within Hampshire to address PCM non-compliance is presented in Table 6-1 below.

Table 6-1 – Hampshire Local Authorities with PCM Roadside NO_2 Link Exceedances in 2021 and Air Quality Actions

Local Authority	PCM links >40µg/m^3	Actions
Basingstoke and Deane BC	No	Considered a short list of measures and concluded that a reduction in the speed limit from 70 to 50 mph could bring forward compliance to 2019. However, further work is ongoing to identify if this is a feasible measure[83].
East Hampshire DC	No	None
Eastleigh BC	No	None
Fareham BC	Yes	Providing better infrastructure and encouraging residents to walk and cycle Real time information (RTI) on bus stops Improvements to SCOOT traffic signals on Market Quay A scheme to encourage Fareham taxis to change from older diesel vehicles to newer cleaner vehicles[84].
Gosport BC	No	None
Hart DC	No	None
Havant BC	No	None
New Forest DC	Yes	(considered by Southampton CC)
Portsmouth CC	Yes	A combination of retrofitting buses to meet higher Euro emissions standards, reducing car use and promoting uptake of cleaner vehicles is expected to bring forward compliance. There is still a persistent exceedance with compliance projected to be achieved by 2022. The government has therefore directed Portsmouth CC to carry out a more detailed study to develop a plan to bring forward compliance in the shortest possible time[85].
Rushmoor BC	Yes	Part of the Blackwater Valley group of local authorities - Considered a short list of measures on the outstanding link and concluded that reducing the speed limit from 70 to 50 mph could bring forward compliance. Further scoping work is required to consider safety and impacts on other road links.[86]
Southampton CC	Yes	Southampton CC and New Forest DC are continuing to consult on a CAZ and technical assessment activities are ongoing. A proposed business case has been published to deliver compliance with the EU limit by 2020.[87]
Test Valley BC	No	None
Winchester CC	No	None

[83] Defra, Supplement to the UK plan for tackling roadside nitrogen dioxide concentrations, October 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746100/air-quality-no2-plan-supplement.pdf. Accessed February 2020.
[84] Fareham Borough Council, Let's clear the air together, February 2020, https://www.fareham.gov.uk/licensing_and_inspections/air_quality/letscleartheair.aspx. Accessed February 2020.
[85] Portsmouth City Council, Air Quality in Portsmouth, February 2020, https://www.portsmouth.gov.uk/ext/environmental-health/air-quality-and-pollution/air-quality-in-portsmouth. Accessed February 2020.
[86] Blackwater Valley Group, Working Together to Reduce Roadside Nitrogen Dioxide Concentrations, February 2020, https://www.a331airquality.co.uk/. Accessed February 2020.
[87] Southampton City Council, Clean Air Update, February 2020, https://www.southampton.gov.uk/environmental-issues/pollution/air-quality/clean-air-zone.aspx. Accessed February 2020.

Figure 6-9 – Hampshire 2021 PCM Roadside Annual Mean NO_2 Concentrations



Highways England is responsible for operating, maintaining and improving the Strategic Road Network (SRN) which consists of motorways and major A roads. There are several PCM links on the SRN in Hampshire expected not to be compliant in 2021: adjacent to the M27 in Test Valley BC and to the A27 in Havant BC. As these links are managed by Highways England, they are not the responsibility of the local authority. Highways England is taking a number of steps to improve air quality on the network outside of the 2017 NO_2 Plan.

6.2.4. Air Quality Management Areas (AQMA)

Local Air Quality Management (LAQM) is the statutory process by which local authorities monitor, assess and act to improve local air quality.

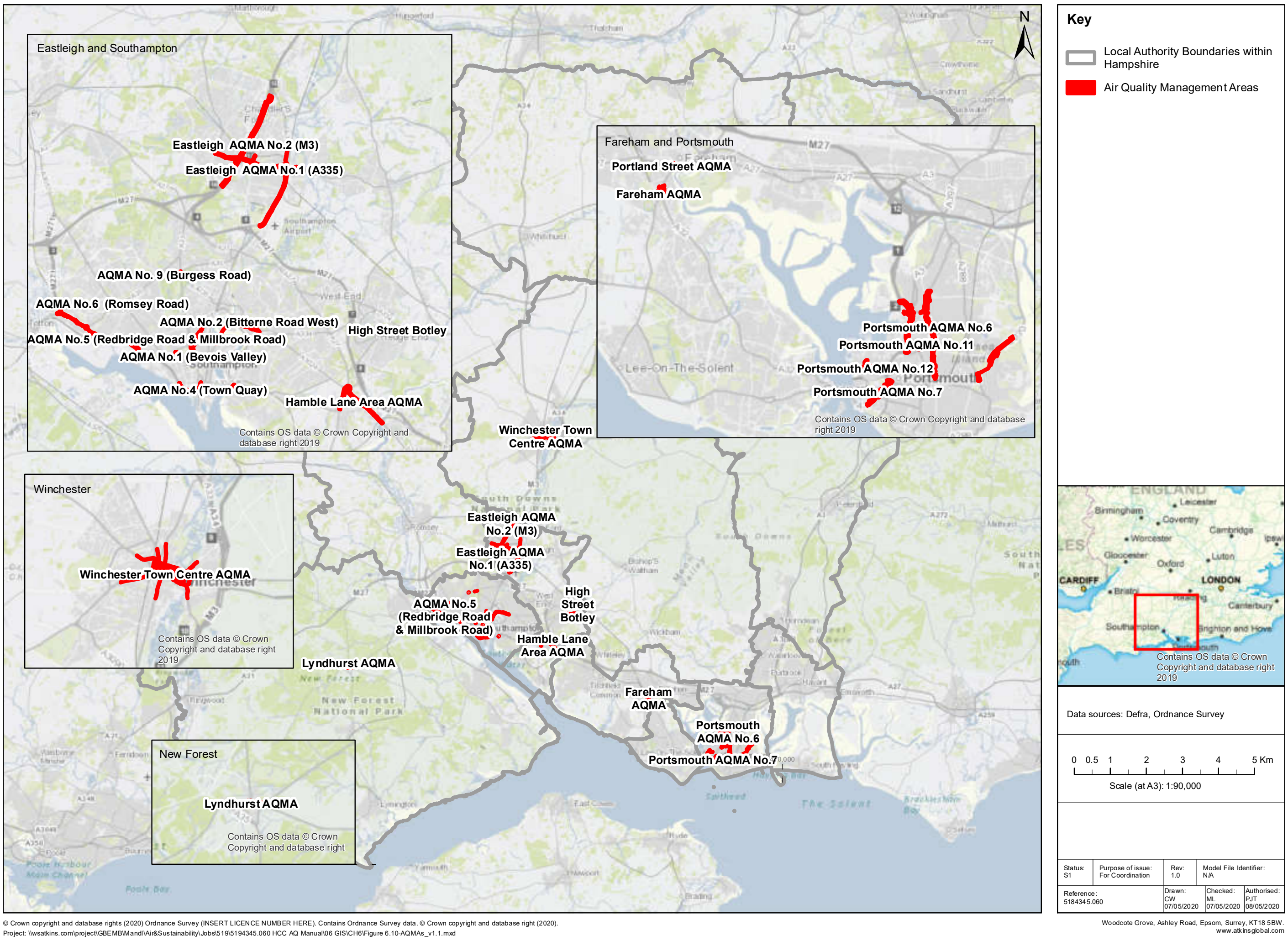
Where a local authority identifies areas where the national AQS objectives are exceeded, and there is relevant public exposure, there is a statutory requirement to declare an AQMA and to draw up an air quality action plan of remedial measures to address the problem.

Table 6-2 – Hampshire Local Authorities with AQMAs and Proposed Actions

Local Authority	AQMA	Actions
Basingstoke and Dean	No	None
East Hampshire DC	No	None
Eastleigh BC	Yes	Consulted on a draft AQAP in Sept/Oct 2019 with finalised plan to be published in 2020[88].
Fareham BC	Yes	Extension of the Eclipse Busway Bus Rapid Transit (BRT) is underway. Full funding has been secured for the Stubbington Bypass, which will divert traffic away from AQMA.[89]
Gosport BC	No	None
Hart DC	No	None
Havant BC	No	None
New Forest DC	Yes	To reduce congestion and air pollution in the High Street in Lyndhurst (particularly within a street canyon), a new traffic light sequencing system has been installed. Working collaboratively with Southampton CC on delivering the Southampton CAZ. Working with Hampshire County Council and local schools to promote air quality locally.[90]
Portsmouth CC	Yes	PCC's existing AQAP will be updated following the production of the Local NO_2 Action Plan (PCM).
Rushmoor BC	No	None
Southampton CC	Yes	Southampton CC has one Action Plan for the entire city, first published in 2007 soon to introduce a CAZ[91]
Test Valley BC	No	None
Winchester CC	Yes	• Review car parking charges • Introduce a new park and ride • Reduce emissions from lorries and buses in the city centre • Reduce emissions from council vehicles[92]

[88] Eastleigh Borough Council, Air Quality, February 2020, https://www.eastleigh.gov.uk/environmental-health/pollution/air-quality. Accessed February 2020.
[89] Fareham Brough Council, 2019 Air Quality Annual Status Report, June 2019.
[90] New Forest District Council, 2019 Air Quality Annual Status Report, June 2019, http://www.newforest.gov.uk/media/39604/Annual-Status-Report-2019/Pdf/ASR_2019_final.pdf.
[91] Southampton City Council, Air Quality, February 2020, http://www.southampton.gov.uk/environmental-issues/pollution/air-quality/. Accessed February 2020.
[92] Winchester City Council, Air Quality in Winchester, February 2020, https://www.winchester.gov.uk/environment/air-quality/air-quality-winchester/. Accessed February 2020.

Figure 6-10 – Hampshire Air Quality Management Areas[93]



6.2.5. Air Quality Monitoring in Hampshire

The table and figure below summarise available monitoring for NO2 across Hampshire[94]. Summary statistics for 2018 NO_2 concentrations from the 11 local authorities within Hampshire show that of a total of seven continuous (automatic) and 328 passive diffusion tube monitoring sites:

- the majority are located at roadside sites (74%)
- the minimum concentration monitored in 2018 was 10.3 at a suburban site in East Hampshire DC
- the maximum concentration was 57.7µg/m3 at a kerbside site in Fareham BC
- 4% of the monitoring locations recorded an exceedance of the annual mean NO_2 AQS objective in 2018 (13 monitoring locations)

[93] Defra, Interactive AQMA Map, February 2020, https://uk-air.defra.gov.uk/aqma/maps/. Accessed February 2020.
[94] Data was not made available for Portsmouth or Southampton city councils. Data for East Hampshire is from different sources to the other districts reported.

- exceedances of the annual mean NO_2 AQS objective are only observed at kerbside (3 sites) and roadside sites (10 sites)[95,96]
- the importance of road traffic to NO_2 concentrations is underlined by the fact that there are no sites with an annual mean concentration >36µg/m^3 in 2018 located over 5m from a road.
- exceedances of the annual mean NO_2 AQS objective are only observed at kerbside (3 sites) and roadside sites (10 sites)[97,98]
- the importance of road traffic to NO_2 concentrations is underlined by the fact that there are no sites with an annual mean concentration >36µg/m^3 in 2018 located over 5m from a road.

Table 6-3 – Annual Mean NO_2 Monitored Concentrations - Summary Statistics by Site Type, µg/m^3 (2018)

Site Type	Average NO_2 concentration	Number of Sites	Max NO_2 concentration	Min NO_2 concentration
Background	14.8	2	14.8	14.8
Industrial	12.6	2	12.9	12.3
Kerbside	33.2	22	**47.8**	15.7
Not Classifiable	25.3	1	25.3	25.3
Other	24.8	13	**40.5**	12.3
Roadside	28.0	248	**57.7**	11.6
Rural	10.6	1	10.6	10.6
Suburban	24.3	14	31.6	20.3
Urban Background	17.6	28	30.0	10.3
Urban Centre	23.2	5	27.1	18.4

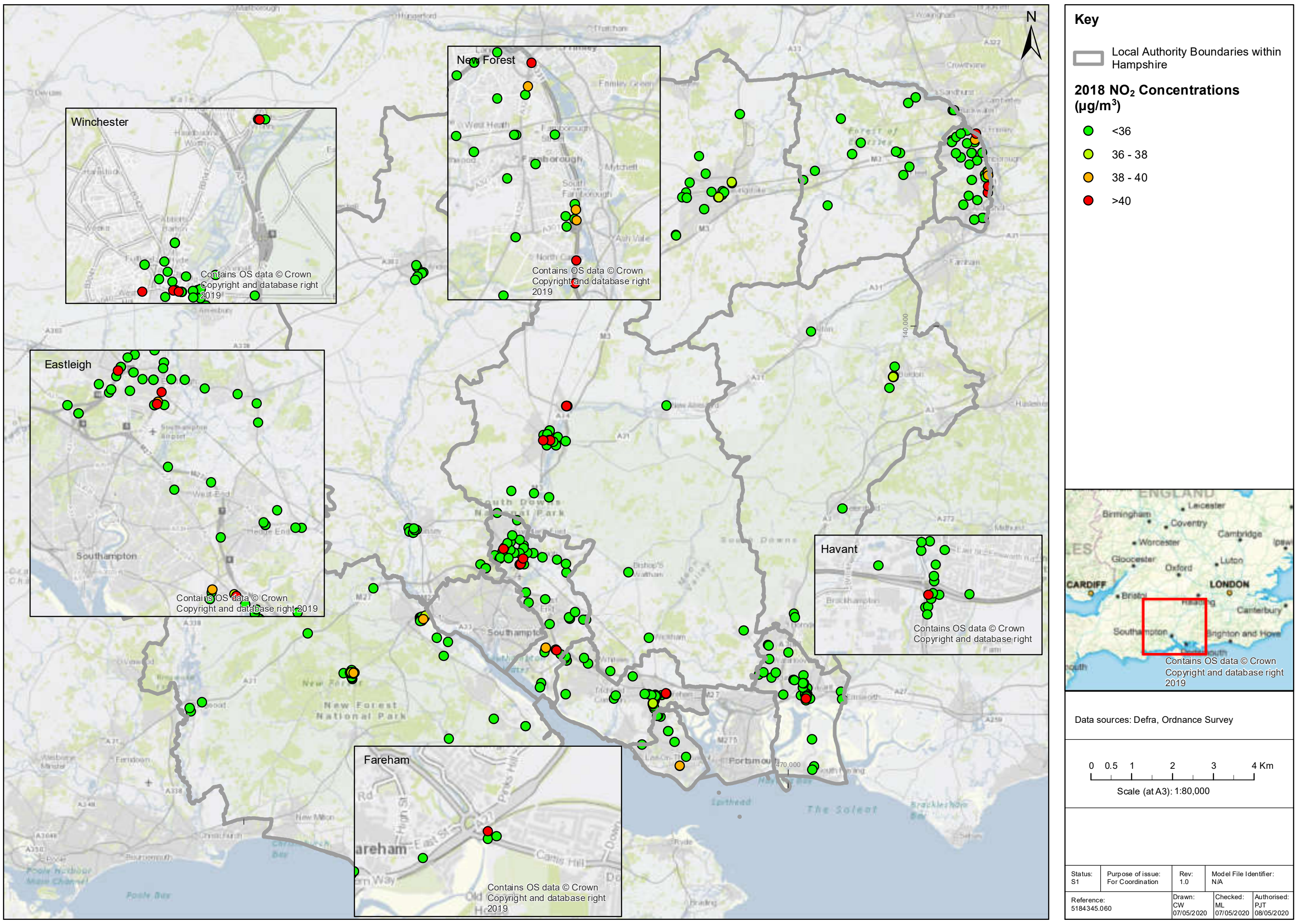
[95]A roadside site is typically located within one to five metres of the kerb of a busy road (although distance can be up to 15 m from the kerb in some cases). A kerbside site is a site within one metre of the kerb of a busy road.

[96] One exceedance in also in the “Other” category (Site 3 New District Study in Winchester), however, the site is located 0.5m from the kerb and can therefore be classified as kerbside.

[97]A roadside site is typically located within one to five metres of the kerb of a busy road (although distance can be up to 15 m from the kerb in some cases). A kerbside site is a site within one metre of the kerb of a busy road.

[98] One exceedance in also in the “Other” category (Site 3 New District Study in Winchester), however, the site is located 0.5m from the kerb and can therefore be classified as kerbside.

Figure 6-11 - Hampshire Annual Mean NO_2 Monitored Concentrations (2018)



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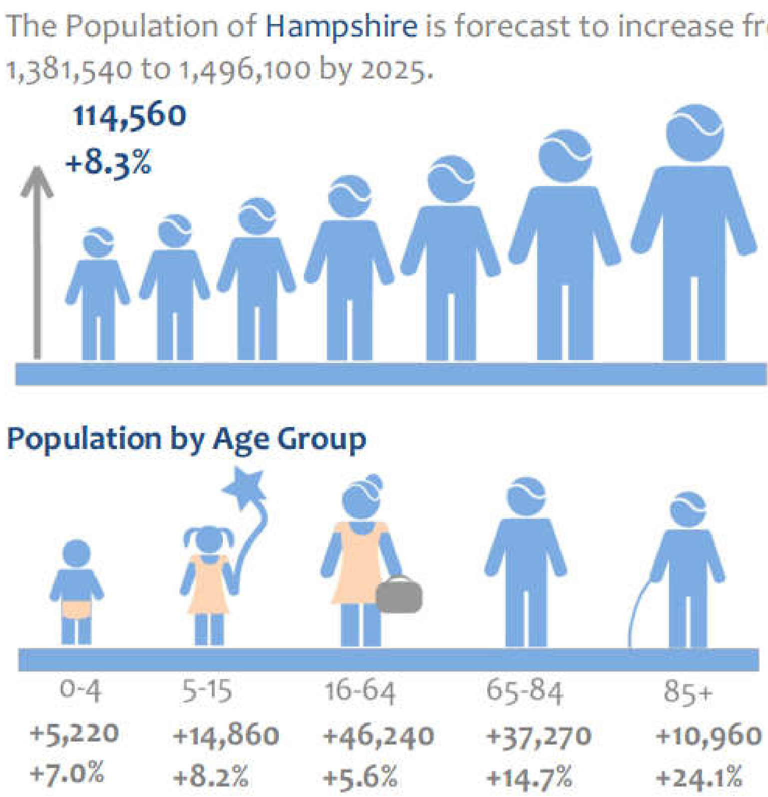
6.3. Hampshire-wide demographic analysis

6.3.1. Population Growth

The population of Hampshire is projected to increase by 8.3% with the largest proportional growth in the age groups most vulnerable to air quality impacts (children and the elderly).

Figure 6-12 - Hampshire Population Forecast[99]



Population trends across the Hampshire local authorities all show an expected increase in population between 2018 and 2025.

The most significant population increases are expected in rural local authority areas; Eastleigh BC, Rushmoor BC, Test Valley BC and Winchester CC.

Whilst this may not increase exposure to poor air quality in the short term, it requires planning to ensure that air quality is not worsened in these areas by transport schemes and that suitable transport infrastructure is implemented to accommodate population increases whilst minimising air quality impacts.

[99] Hampshire County Council, "Small Area Population Forecasts (SAPF) 2018 based", April 2019, https://documents.hants.gov.uk/population/HampshireFS17-version2.pdf. Accessed Jan 2020

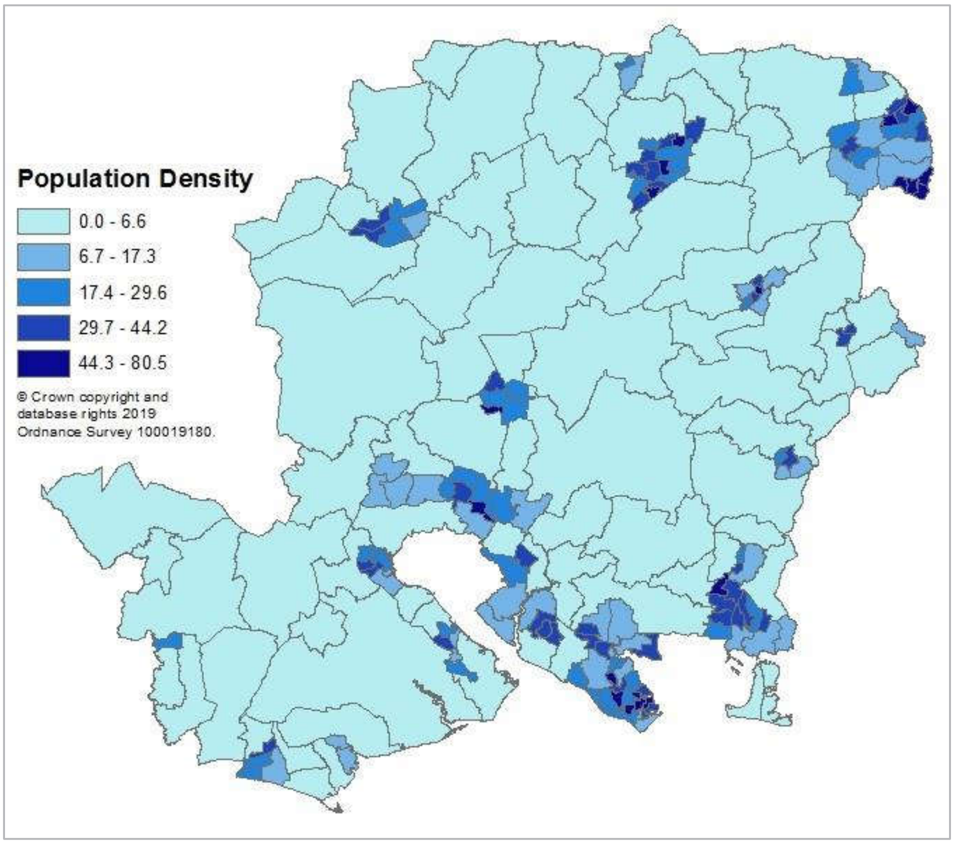
Table 6-4 - Hampshire Population Forecasts (2018 to 2025)[100]

District	2018 Total	2025 Total	Percentage change
Basingstoke and Deane BC	176,778	193,522	9%
East Hampshire DC	121,937	133,597	10%
Eastleigh BC	131,659	147,816	12%
Fareham BC	115,132	121,004	5%
Gosport BC	83,605	86,065	3%
Hart DC	97,561	106,207	9%
Havant BC	125,899	133,300	6%
New Forest DC	178,485	184,707	3%
Portsmouth CC	212,061	222,587	5%
Rushmoor BC	97,022	108,568	12%
Southampton CC	256,459	273,020	6%
Test Valley BC	127,966	140,812	10%
Winchester CC	125,492	140,507	12%

6.3.2. Population Density

Population density is shown to be highest in Hampshire around Southampton, Portsmouth, Winchester, Basingstoke and Farnborough. Large areas of the county have low population density, less than 6.6 persons per hectare (2018).

Figure 6-13 - Hampshire Population Density (persons per hectare, 2018)[99]

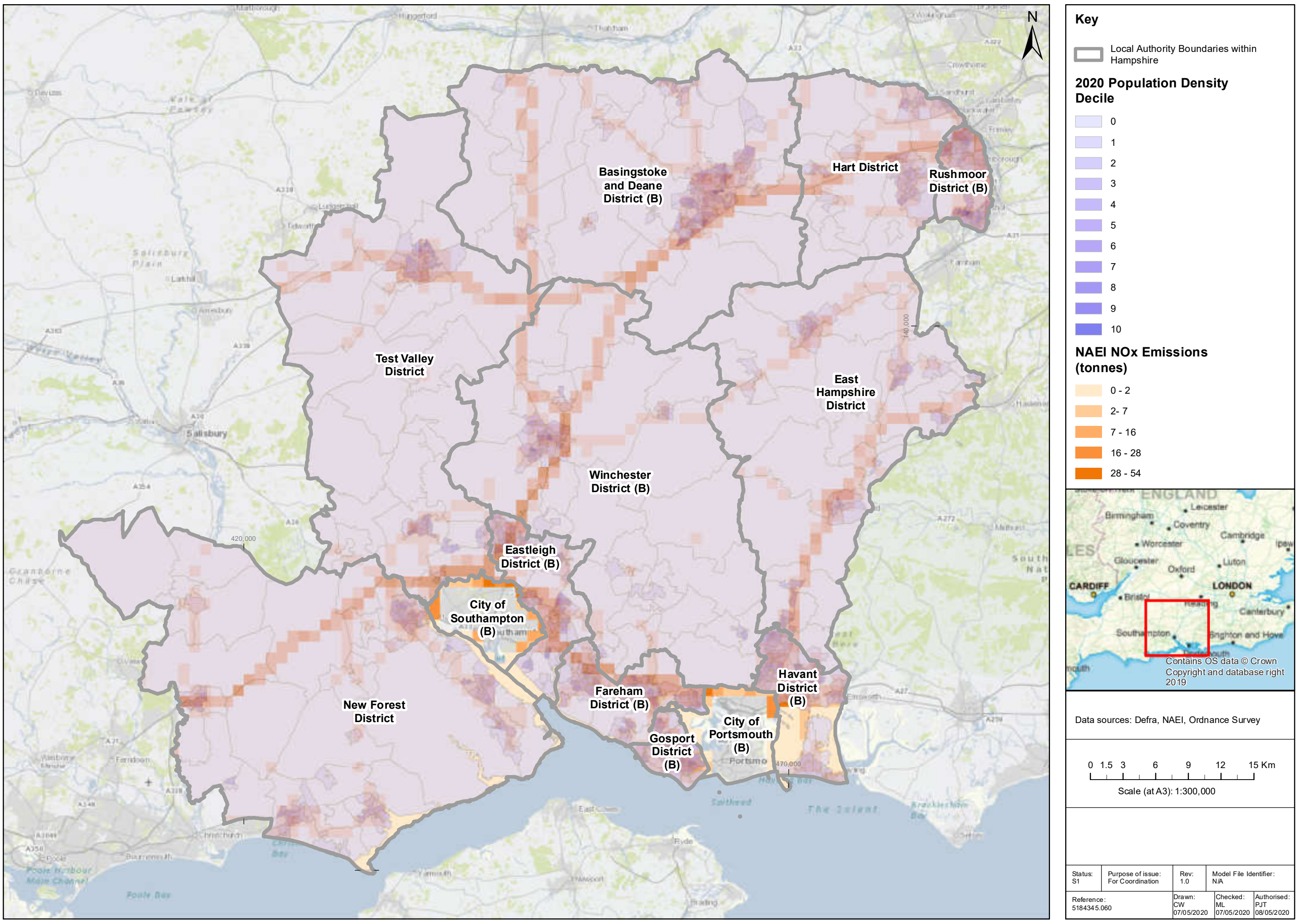


Projecting the 2018 population density figures forward to 2020 and overlaying these on the Defra annual mean NO_2 background concentrations: it is clear that areas of high population density correlate to the areas with the highest background concentrations.

The population density is highest in urban areas and correlates spatially with high monitored concentrations, NAEI emissions and AQMA designations. This indicates that areas with poor air quality are likely to affect many people, due to high population densities in affected areas.

Roadside exceedances on the PCM network do not necessarily correlate spatially with areas of high population density. Whilst some are urban roads, located in areas of high population density, many are located on major roads, which are less likely to be adjacent to high density populations.

Figure 6-14 – Hampshire Population Density Deciles and Total NOx Emissions (NAEI)[81] (2020)



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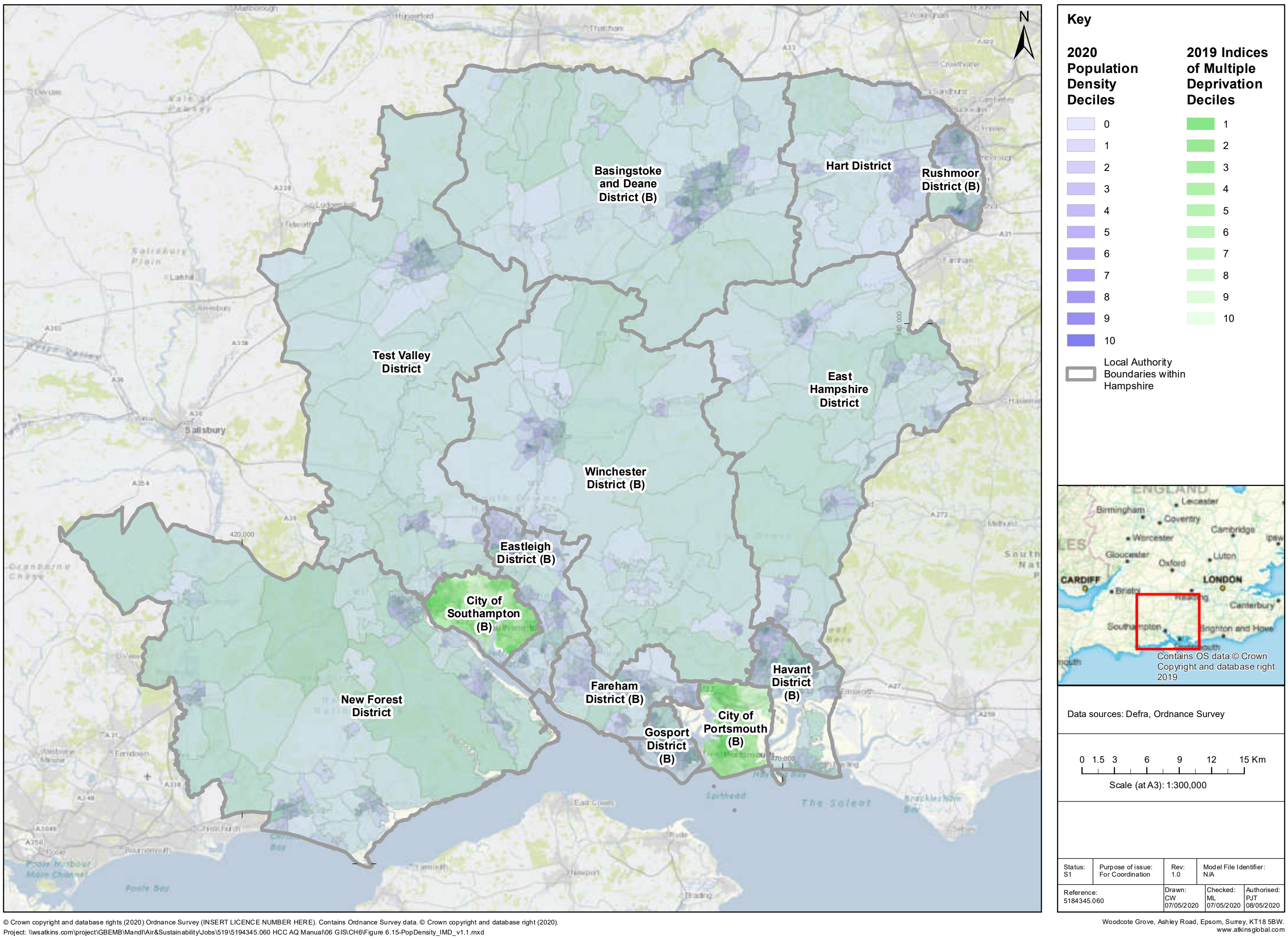
6.3.3. Deprivation

The majority of the most deprived areas within Hampshire (as defined as being within in in 1st or 2nd decile of Indices of Multiple Deprivation 2019) also correlate spatially with areas of higher background NO_2 and PM_{10} concentrations and NAEI emissions.

[100] Hampshire County Environment Department's 2018 based Small Area Population Forecasts

The correlation between deprivation, population density and high background concentrations indicates that, as is the case nationally, poor air quality is likely to disproportionately impact the most deprived in Hampshire.

Figure 6-15 – Hampshire Population Density Deciles (2020) and Indices of Multiple Deprivation (2019)



These datasets can be used to help guide decision making to improve air quality in these key areas and prevent further negative impacts on air quality in areas already with a high risk of disproportionate air quality impacts.

6.4. Carbon Dioxide Emissions

Examining the NAEI data by local authority and isolating the road transport contribution from total emissions, shows that:

- Overall 28% of CO_2 emissions in Hampshire are from road transport;
- New Forest DC has the largest total emissions of CO_2 (driven by local industrial sources), with the smallest total emissions of CO_2 from Gosport BC (driven by its small size compared to other local authorities);
- Test Valley BC and Winchester CC have the largest contribution from road traffic to total CO_2 emissions (64%);
- New Forest DC has the smallest percentage of road traffic contribution to CO_2 emissions (8%).

Electric vehicles, although not directly emitting carbon dioxide, utilise energy generated elsewhere. Depending on how the energy is generated, there remains the potential for indirect greenhouse gas emissions. However, most studies to date show that like-for-like electric vehicle use produces less CO_2 than fossil fuel engines across the majority of global regions, including the UK (the exceptions being the few countries where national energy infrastructure is still heavily reliant on coal).

Figure 6-16 – Hampshire CO_2 (as C) Emissions (NAEI[81])

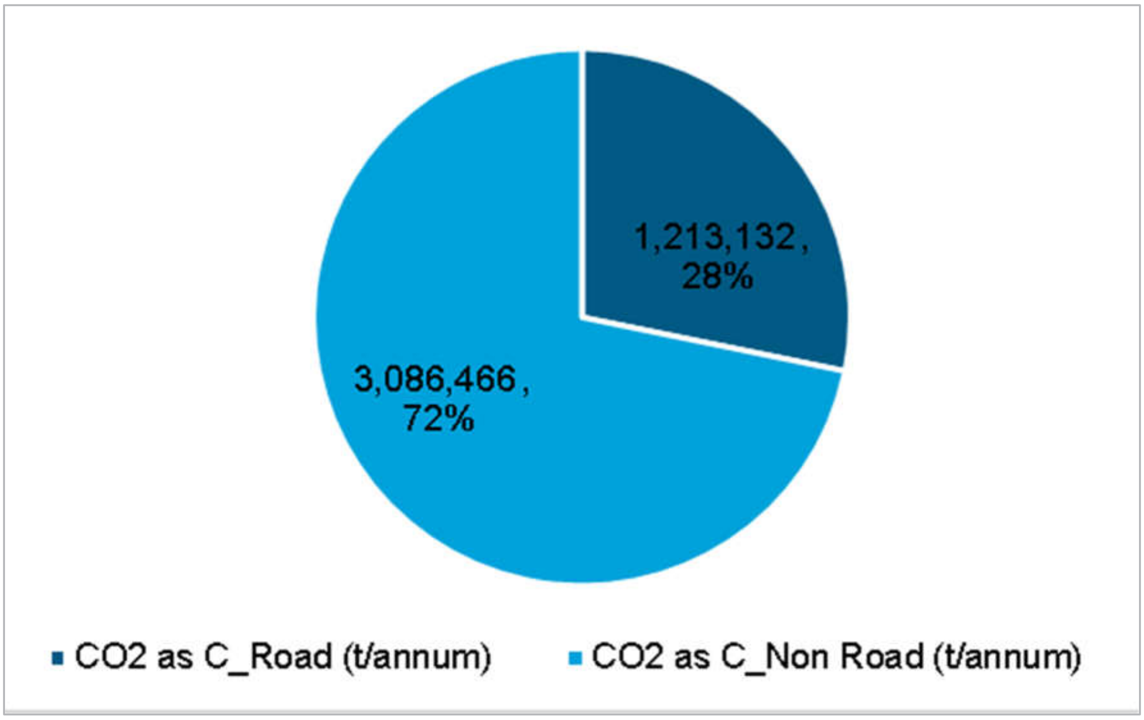
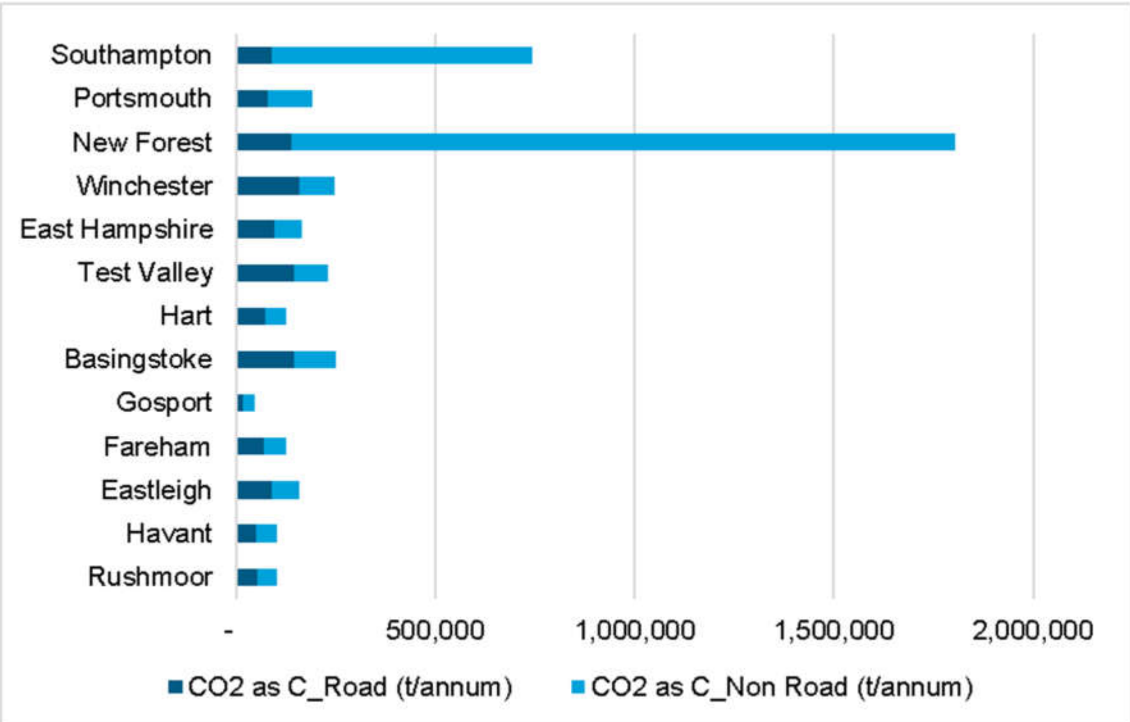


Figure 6-17 - CO_2 (as C) Emissions by Local Authority (NAEI[81])



7. Air Quality & Transport

7.1. Road Transport Emissions

Road transport emits multiple pollutants directly through the internal combustion process, but also deterioration of brakes, tyres and the road surface whilst driving.

Pollutant emissions are reported by National Atmospheric Emissions Inventory (NAEI)[101], including many with associated national Air Quality Strategy (AQS) Objectives for the protection of human health and vegetation (see further detail in chapter 2).

In the UK, only NO_2 and PM_{10} AQS objectives are at risk of exceedance due to road transport. The main emissions from road transport are NOx, CO, PM and VOCs as shown in Figure 7-1.

Gaseous pollutants are primarily sourced from internal combustion, whereas particle pollution is also emitted from wear of brakes, tyres and abrasion of the road surface as illustrated in Figure 7-1.

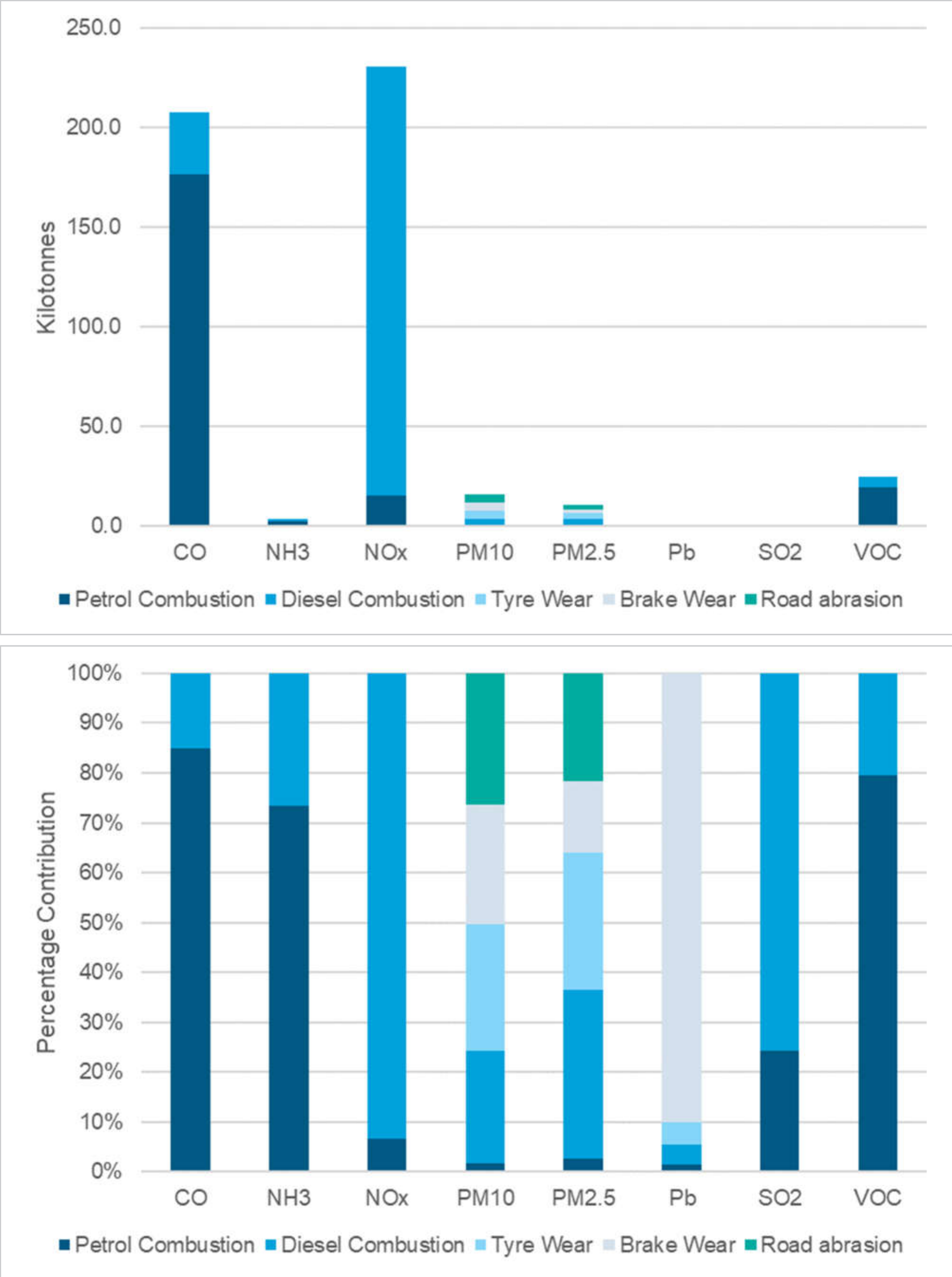
Vehicles emit differing amounts of pollutants under different driving conditions:

- Road emissions are greatest from roads with high vehicle activity i.e. motorways with large vehicle flow.
- Engine performance also influences emissions i.e. emissions tend to be greater at lower speeds.
- Geographic locations and certain conditions lead to elevated emissions, such as street canyons or congestion leading to slow moving traffic with a high frequency of stops.
- Emissions of particulates from brake and tyre wear are closely related to driving conditions, with higher emissions for stop start traffic, most common in urban centres.

The majority of pollutant emissions have declined over the last 40 years with emissions of PM_{10} and $PM_{2.5}$ stagnating in recent years. There are a number of policy interventions which have driven improvements in emissions such as Euro Standard regulations[102] and the ban on lead in fuel.

101 https://naei.beis.gov.uk/
102 https://ec.europa.eu/growth/sectors/automotive/environment-protection/emissions_en

Figure 7-1 - Total emissions from road transport sources in England in 2017 (NAEI)



7.2. Dispersion of Transport Emissions

The point of emission for transport sources is mobile as the vehicle moves along the road network. There are 2 effects here: 1) a moving emitting exhaust (either close to the ground for cars or above the cab for HGV) and 2) the constant stream of traffic creates “vehicle induced turbulence” which changes the way the air disperses close to the road (usually within the first 10m).

High total emissions (total amount of pollutant released by source i.e. a road with multiple vehicles) do not therefore necessarily correlate with poor air quality (the concentration of pollutant within the air we breathe).

The link between total emissions is heavily reliant on the rate of dispersion i.e. how well and how quickly that pollutant is mixed with ambient air. This rate of dispersion relates to many variables:

- Distance from source
- Nature of surface between emissions source and sensitive receptor
- Meteorology; wind speed, wind direction, temperature, precipitation and sunlight
- Atmospheric stability and turbulence

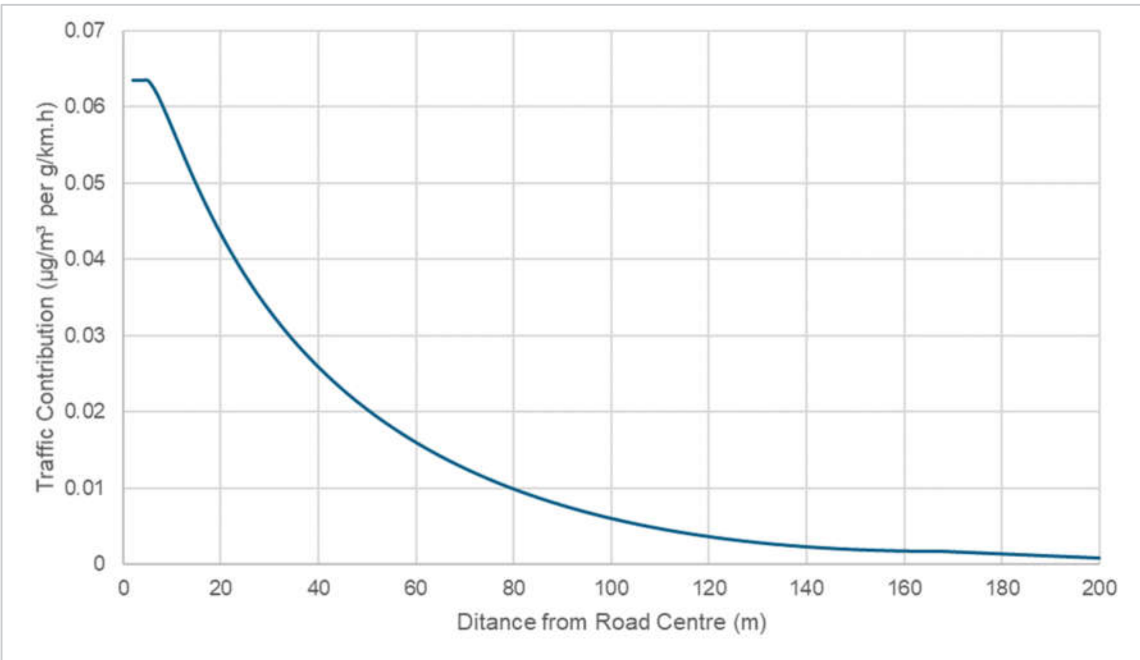
7.2.1. Distance from Emission Source

Pollutant concentration relative to a road source is driven by the distance from the road and the orientation of the road to typical wind direction.

Highways England have developed a simple screening model to show how road source emissions impact pollutant concentrations as distance increases from the road. The model assumes a relatively low wind speed and does not account for wind direction. The drop off in traffic contribution to pollutant concentrations as distance increases from the road edge as predicted by the Highways England screening model is shown in Figure 7-2. The traffic contribution as predicted by the model:

- is highest closest to the road centre (0 - 5m), it then rapidly falls from 5m as distance increases
- at 10m it is 10% lower compared to 5m and 32% lower at 20m compared to 5m.
- there is very little contribution to concentrations at receptors further than 100m from the road centre, with greater than 90% reduction compared to the contribution at 5m.
- contribution is negligible at 200m from the road centre and can be discounted.

Figure 7-2 – Highways England Screening Model - Fall-off with Distance Curve



Exceptions to this typical dispersion profile include if the road is elevated relative to receptor locations or if there is a physical barrier between the receptor and road (e.g. buildings or a wall).

7.2.2. Meteorology and Physical Environment

7.2.2.1. Meteorology

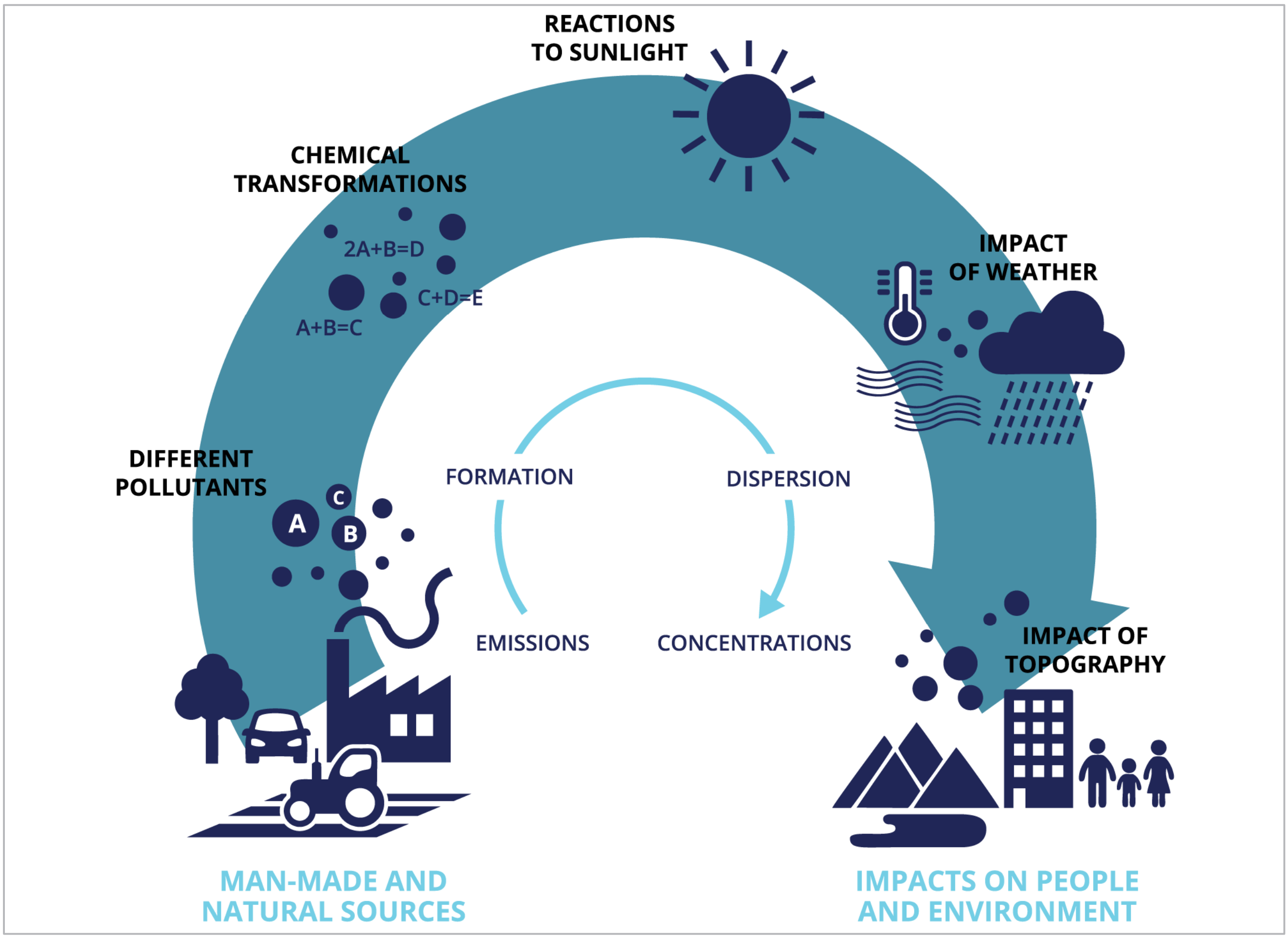
The rate at which pollutants disperse depends on atmospheric conditions; primarily wind speed and direction.

There are several meteorological factors which can impact the rate of dispersion, the different variables and the relationship with dispersion are summarised in Table 7-1 and Figure 7-3 below.

Table 7-1 - Meteorological Variables and Impact on Dispersion of Road Transport Pollutants

Variable	Description	Impact on dispersion
Wind Speed	Rate at which air moves from high to low pressure. Typically measured in metres per second (m/s).	Dispersion increases as the windspeed increases. The pollutant is transported away from the source faster when the wind speed is greatest. In calm conditions, pollutants are not dispersed from the source, allowing them to build up, increasing local concentrations.
Wind Direction	Direction from which wind originates. Typically reported in decimal degrees between 0 to 360.	The wind direction affects the direction in which the pollutant disperses toward. Impact at receptor depends on the location of the receptor relative to the source and wind direction (upwind or downwind). Influences the road source contribution to total pollutant concentration at the receptor.
Temperature	Degree of warmth of ambient air, measured in C.	Temperature influences atmospheric stability (discussed below). Emissions of some pollutants can also be elevated during cold temperatures when emission control technology has not reached the optimum operating temperature, known as cold starts.
Precipitation	Condensation of atmospheric water vapour that falls under gravity (rain, snow, hail etc), measured in mm.	Rain helps to 'wash out' some air pollutants from the ambient air as particles and gases react or are incorporated into water droplets.
Pasquill Stability Class	A measure of atmospheric stability influenced by temperature, wind speed, solar radiation and turbulence.	Influences dispersion through the movement of air, which can have a major impact on local air quality. Stable conditions act to reduce vertical mixing causing pollutants to be trapped near ground level, which can result in high pollution episodes.
Turbulence	The irregular motion of air resulting from eddies and vertical currents.	Turbulence increases the rate of mixing of pollutants with ambient air, therefore the greater the turbulence the higher the rate of dispersion. Turbulence can be caused by flow of air over buildings or could be induced by the movement of vehicles on roads.
Sunlight	Total amount of solar radiation reaching the earth's surface.	Solar radiation is used in a chemical reaction between NOx and ozone. High levels of UV radiation in the presence of readily available NOx and ozone can result in higher rates of formation of NO_2 from NO_X. Hampshire generally has some of the highest levels of total sunshine relative to the rest of the UK, particularly around the coast[103].

Figure 7-3 - Meteorological Variables and Impact on Dispersion of Pollutants[104]



7.2.2.2. Wind

Figure 7-4 shows wind data for three locations across Hampshire for a ten-year period between 2010 and 2019. Wind rose plots show the frequency of wind direction and speed. The data shows that the prevailing wind across Hampshire is from the south west. This suggests that if a road is orientated east to west in Hampshire, then emissions will typically be dispersed to the northern side of the road.

However, there are clear local variations, particularly in coastal areas where meteorological conditions vary due to local geography and the dominant effects of on-shore winds.

Local variations across the sites include:

- Middle Wallop and Farnborough Airport show similarities in distribution of winds from a westerly component, whereas Southampton has a higher frequency of winds from the south west.
- A second prevailing wind in Southampton from the north east which reflects the local geography in relation to the River Itchen estuary.

The sites presented in Figure 7-4 are located on airfields, which are flat and free from surrounding obstructions, but in urban environments, factors such as tall buildings can impact the wind distribution.

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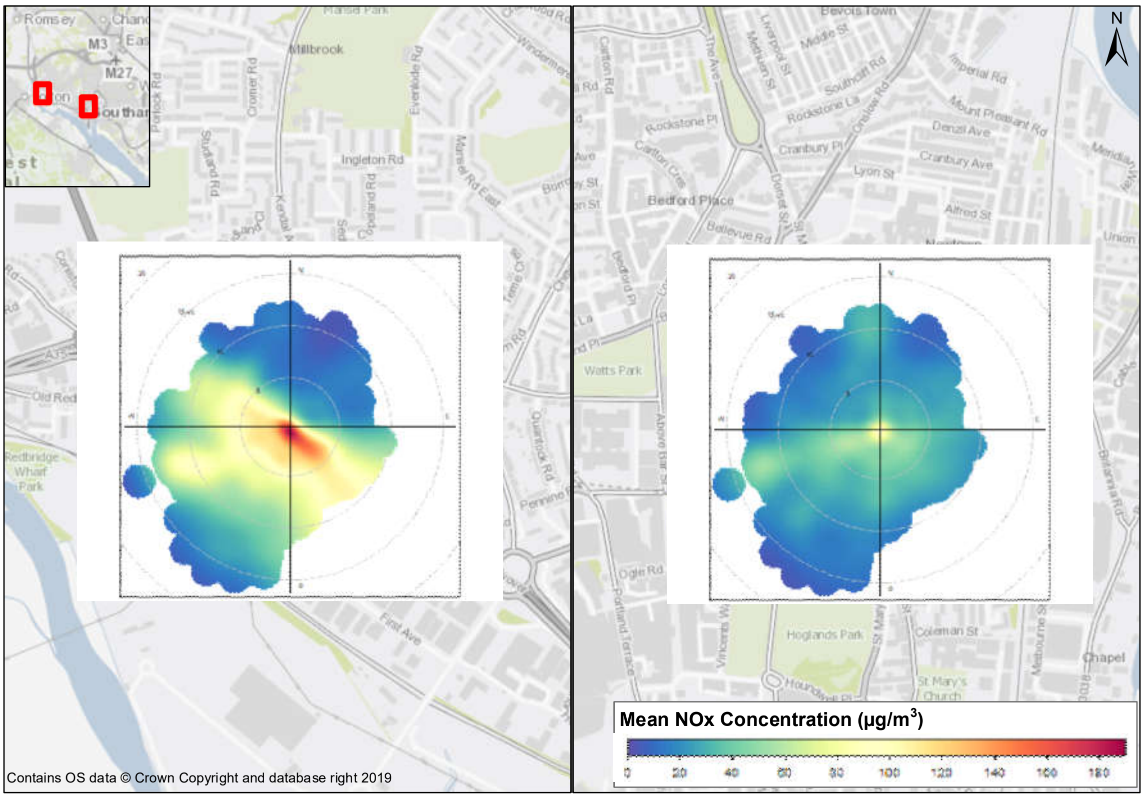
103 https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps
104 European Environment Agency (EEA). Air pollution: from emissions to exposure. https://www.eea.europa.eu/media/infographics/air-pollution-from-emissions-to-exposure/view. Accessed May 2020.

Figure 7-4 - Windrose Plots for Locations in Hampshire

Figure 7-5 - Polar Plots of Mean NOx at CMS Sites in Southampton



7.2.2.3. Polar Plot Source Identification

Figure 7-5 contains polar plots showing air pollutant concentrations (coloured scale) plotted by wind speed (concentric rings) and direction (grid). The centre of the grid can be assumed to be the location of the monitoring site. The polar plots show NOx concentrations measured at two Defra AURN monitoring sites adjacent to the A33 and within Southampton city centre. The A33 runs south east to north west at this location which is evident from the polar plot showing the highest concentrations along in the south east and north west quadrants:

- highest concentrations occur when the wind is blowing over the A33 i.e. 120 to 310 degrees;
- highest concentrations occur at relatively low wind speeds i.e. less than 5 m/s where the rate of dispersion is lower;
- lowest concentrations occur from the north and north east where there is no significant source of NOx emissions i.e. there are playing fields and some residential housing located in this direction.

This is a typical pattern at a roadside monitoring location, with the polar plot indicating a pollution signal representing the adjacent road source, i.e. the A33 monitoring site is 5 m from the kerbside of the A33.

For comparison, the Southampton Centre site is in a more urban location and is 20 m from the kerbside of the A3024. The plot shows:

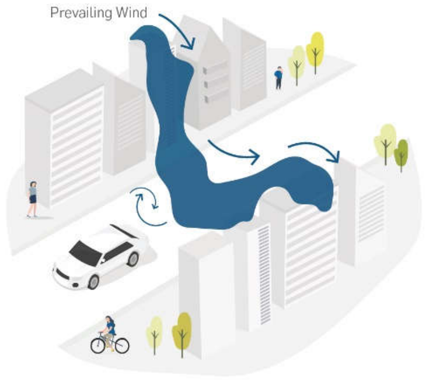
- lower concentrations relative to the A33, indicating that the site is far enough from significant pollution sources for sufficient pollutant mixing and dispersion to have taken place;
- weaker pollution signals i.e. elevated yellow colours from multiple directions indicating no one dominating pollution source; and
- highest concentrations occurring from lowest wind speeds.

7.2.3. Physical environment

The physical environment has a considerable impact on the way pollutants disperse, primarily due to the way it inhibits and disrupts air movement. A number of variables are demonstrated in Figure 7.

These will vary by the type of road i.e. street canyons may be more frequent within urban centres where buildings are tall and relatively close together, whereas high speed A-roads and motorways are more likely to have cuttings, flyovers and barriers than urban centre roads.

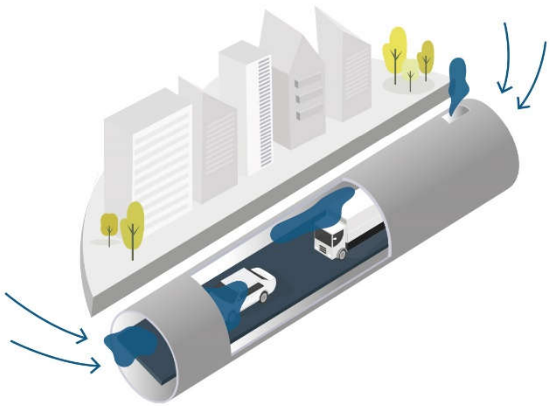
Figure 7-6 - Physical Environment Variables and Impact on Dispersion of Road Transport Pollutants



Street Canyon

Narrow streets with unbroken tall buildings on one or both sides of the road.

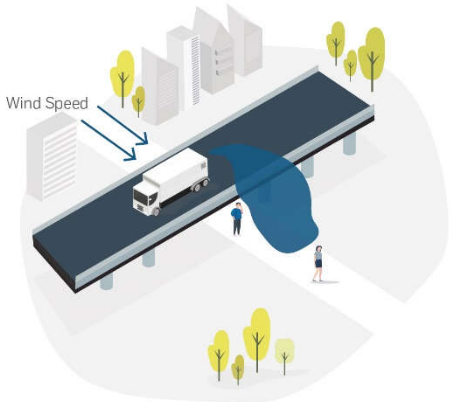
Obstacles such as buildings, trees and walls etc, can modify wind flow locally. Buildings on both sides of the road can lead to the formation of vortices and re-circulation of air that can trap pollutants allowing them to build up.



Tunnels

An enclosed road section on all sides.

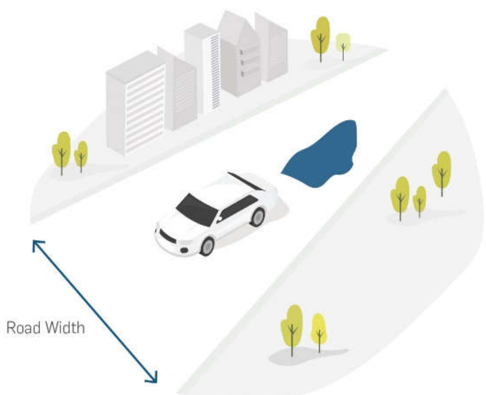
Essentially the same as a street canyon but fully enclosed. If the tunnel is incorrectly ventilated, pollutant concentrations can build up within the tunnel, around ventilation shafts and at the entrance and exit portals.



Flyovers / Elevated Roads

Roads built at height relative to receptors or other sections of road.

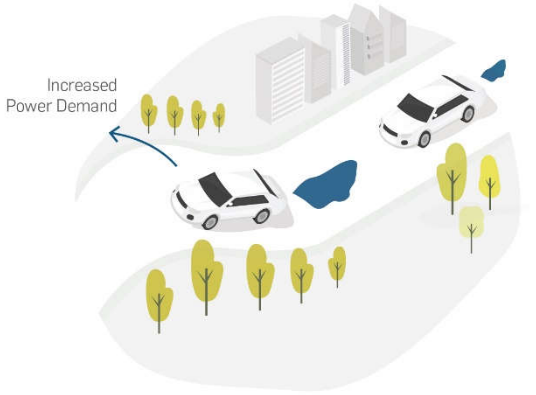
The highest contribution of road emissions is generally greatest closest to the road, however pollutant concentrations may be higher further from the source in the case of an elevated road. This is because the initial movement of pollutant is at height and therefore could be transported over the top of a sensitive receptor before it becomes grounded.



Road width

Distance between the kerbs (number of lanes on a road).

The greater the road width, the greater level of turbulence and mixing that act to disperse pollutants before they reach a receptor.



Gradient

Rate of incline / decline of a road measured in %.

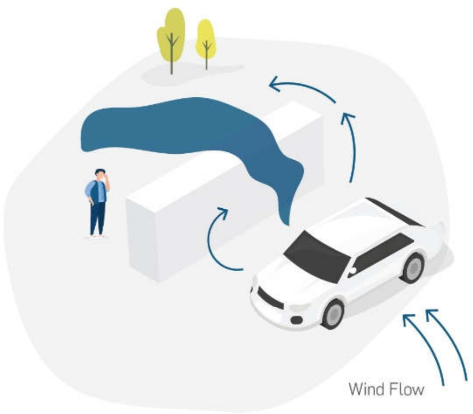
For vehicles travelling up a gradient, there is an increased level of power demanded from the vehicle engine, particularly in the case of HGVs, resulting in higher emissions.

The opposite is true for travelling down a gradient where engine load is reduced with a corresponding impact on emissions.

Vehicle Induced Turbulence

A measure of mechanical turbulence caused by moving vehicles.

The impact of vehicle induced turbulence is increased by both speed and the number of vehicles driving on the road. Increased turbulence increases the rate of dispersion.



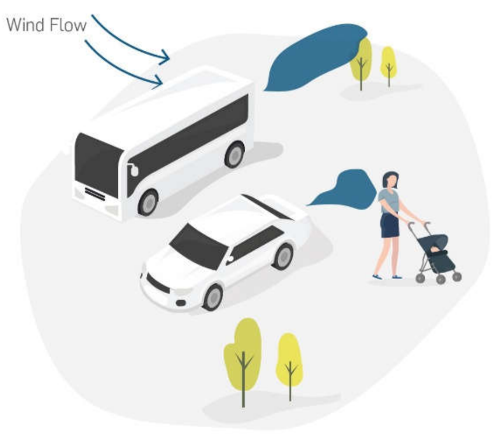
Barriers

Vertical physical obstructions, which can include noise and air quality specific barriers.

Barriers can be made of numerous man-made materials or consist of vegetation.

They disrupt the dispersion of pollution from a source to a receptor.

Barrier designs may act passively, by deflecting the polluted air upwards, or by containing pollutants close to the carriageway and using the momentum imparted by the traffic flow to draw the pollutant away from sensitive roadside receptors.



Height of Exhaust

Height at which vehicles emit pollutants to the atmosphere.

The exhaust system differs by vehicle. Cars usually have an exhaust positioned towards the rear at the car at near ground level.

HGV exhausts are generally located on the roof of the cab, which can be several meters high. Exhaust gases are hot and rise up and away from receptors. A low level exhaust will have a more direct impact on adjacent receptors and disperse less quickly relative to a higher-level emission source.

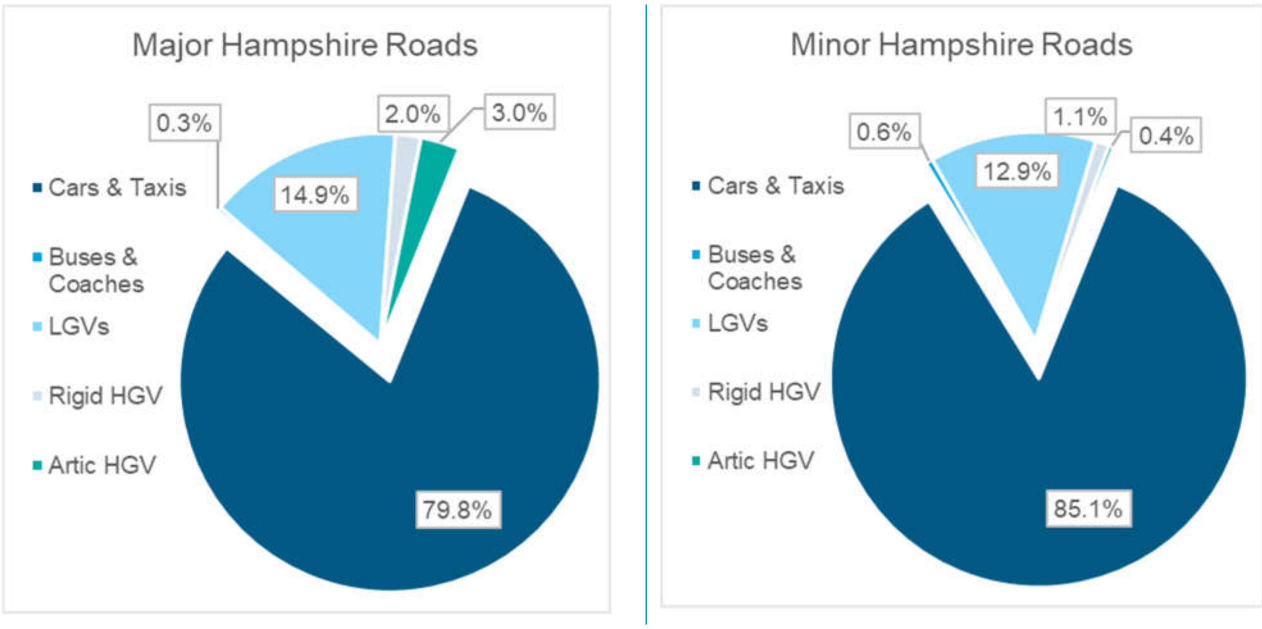
7.3. Vehicle Emission Comparisons

7.3.1. Vehicle Type

Different vehicle types emit pollutants in different quantities for a variety of reasons; weight, age, engine load and driving style.

Department for Transport (DfT)[105] traffic counts across Hampshire in 2018 (Figure 7-7) show the main vehicle class on the county's roads are cars & taxis, followed by light goods vehicles (LGVs) and heavy goods vehicles (HGVs). The proportions for larger vehicles vary slightly between major and minor roads due to longer distance transport of goods.

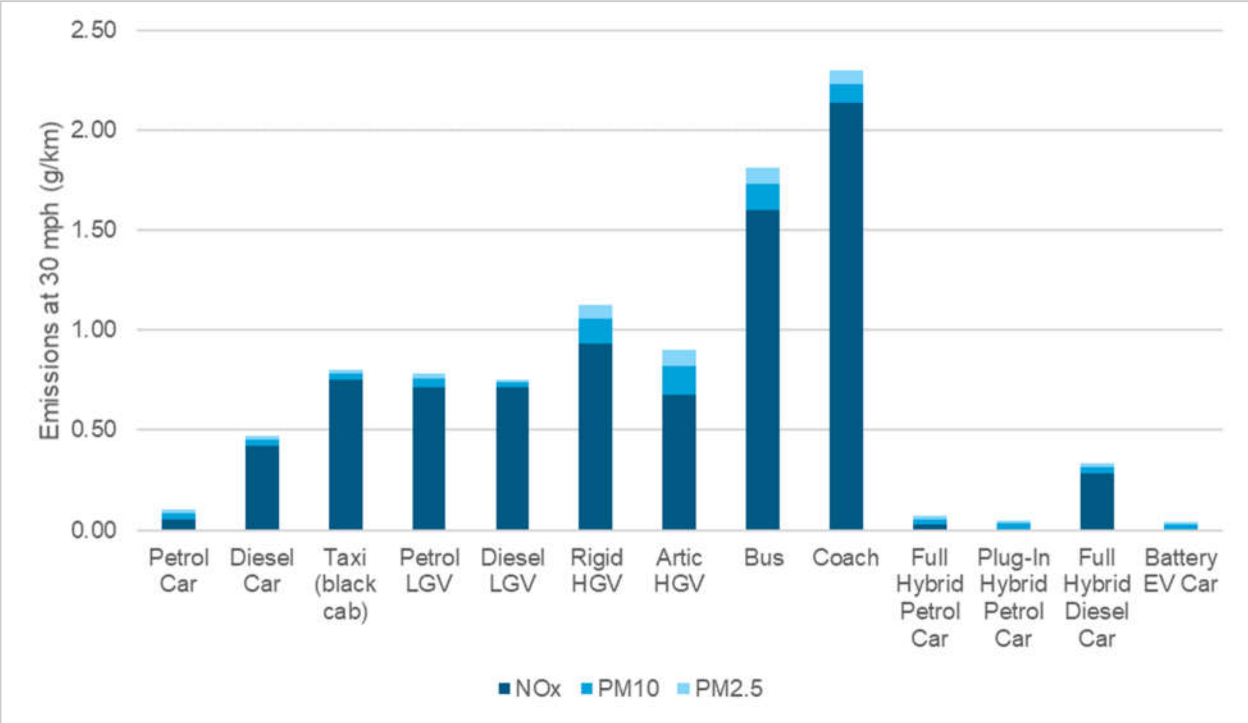
Figure 7-7 - Proportion of Average Fleet in Hampshire for Major and Minor Roads 2018



Larger, heavier vehicles emit more pollutants per kilometre travelled compared with smaller, lighter vehicles as demonstrated in Figure 7-8. This shows that diesel vehicles tend to produce the highest levels of pollutants per vehicle with larger, heavier vehicles producing the most NOx, PM_{10} and $PM_{2.5}$ on average. Petrol Car and Petrol LGV produce noticably smaller levels of pollutants than the other vehicle categories.

[105] https://roadtraffic.dft.gov.uk/#6/55.254/-6.053/basemap-regions-countpoints

Figure 7-8 - National Average Fleet Mix (2020) - Emission Rates for the Main Vehicle Types at 30mph



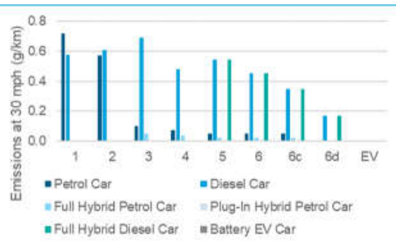
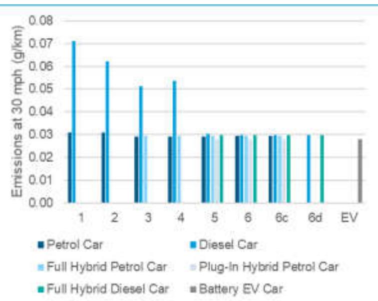
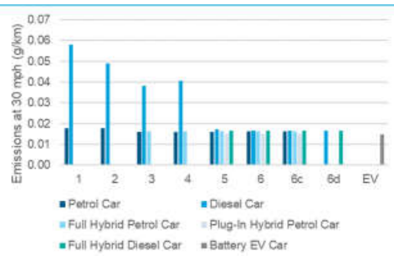
7.3.1.1. Euro Standard

The age of a vehicle also contributes to the amount of pollutant emitted. This is primarily driven by the Euro Standard of the vehicle at the time it was manufactured, with European Legislation dictating the improvement of emission performance.

The age of the vehicle itself also contributes to the rate of emissions with deterioration of performance over time as components age, and maintenance becomes less effective.

A comparison of emission rates for differing Euro classes for various vehicle types based on Defra's Emissions Factor Toolkit[106] is presented below.

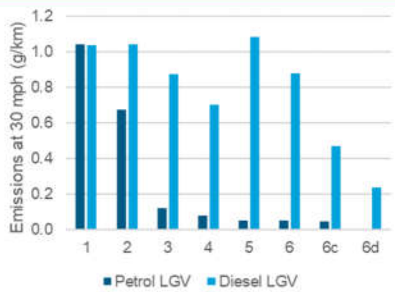
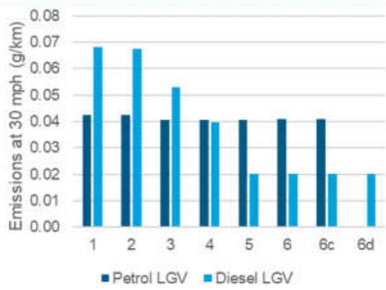
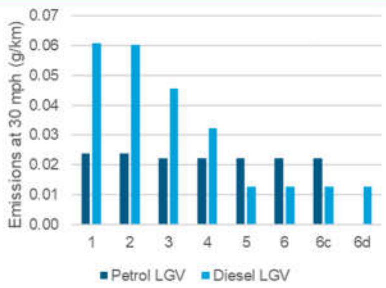
Petrol and Diesel Cars

NOx	**PM_{10}**	**$PM_{2.5}$**
		
• Consistent decrease in emissions for petrol cars with large reduction between Euro 2 and Euro 3	• Reasonably consistent emissions for petrol cars across the euro standards as PM emitted from the engine is relatively low	• Reasonably consistent emissions for petrol cars across the euro standards as PM emitted from the engine is relatively low • Between Euro 1 and Euro 4, diesel cars were consistenly

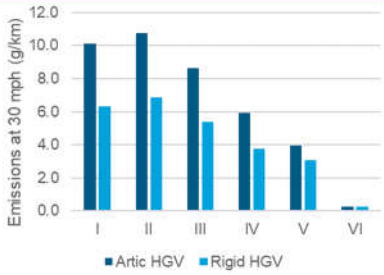
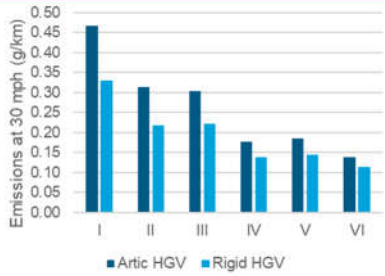
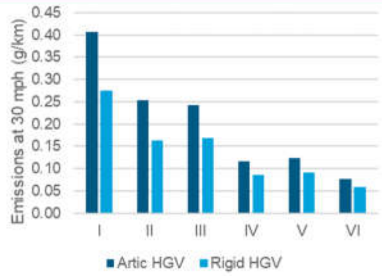
[106] Defra Emissions Factor Toolkit v9.0
Available at: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

• Increase in emissions between Euro 1 to Euro 3 for diesel cars before reducing in Euro 4. • There was an increase in Euro 5 car emissions before a reduction with the newer Euro 6 vehicles; • Diesel cars consistently emit more NOx relative to petrol cars with the exception of Euro 1; • Full Hybrid cars emit similar when compared with traditional internal combustion engines; • Plug-in hybrids emit significantly less than traditional internal combustion engines; • EV vehicles emit 0 g/km of NOx.	• Between Euro 1 and Euro 4, diesel cars were consistently higher emitters relative to petrol cars; • Large improvement in diesel car emissions between Euro 4 and Euro 5 due to emissions controls; • Post Euro 4, there is no measurable difference between petrol and diesel cars; • Full hybrids, plug-in hybrids and electric vehicles emit similar PM_{10} compared with traditional internal combustion engines.	higher emitters relative to petrol cars; • Large improvement in diesel car emissions between Euro 4 and Euro 5 due to emissions controls; • Post Euro 4, there is no measurable difference between petrol and diesel cars; • Full hybrids, plug-in hybrids and electric vehicles emit similar $PM_{2.5}$ compared with traditional internal combustion engines.

Petrol and Diesel LGVs

NOx	**PM_{10}**	**$PM_{2.5}$**
		
• Consistent decrease in emissions for petrol LGVs with large reduction between Euro 2 and Euro 3 • Decrease in emissions between Euro 2 to Euro 4 for diesel LGVs before increasing at Euro 5. • Consistent decrease in diesel LGVs since Euro 5; • Diesel LGVs consistently emit more NOx relative to petrol cars with the exception of Euro 1.	• Reasonably consistent emissions for petrol LGVs across the euro standards as PM emitted from the engine is relatively low • Between Euro 1 and Euro 3, diesel LGVs were consistently higher emitters relative to petrol LGVs; • Large improvement in diesel car emissions between Euro 4 and Euro 5 due to emissions controls; • Diesel LGVs emit less PM relative to Petrol LGVs since Euro 5.	• Reasonably consistent emissions for petrol LGVs across the euro standards as PM emitted from the engine is relatively low • Between Euro 1 and Euro 3, diesel LGVs were consistently higher emitters relative to petrol LGVs; • Large improvement in diesel car emissions between Euro 4 and Euro 5 due to emissions controls; • Diesel LGVs emit less PM relative to Petrol LGVs since Euro 5.

Articulated and Rigid HGVs

<table>
<tr><th>NOx</th><th>PM_{10}</th><th>$PM_{2.5}$</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>• With the exception of the minor increase between Euro I and Euro II, there has been a consistent decrease in emissions from Euro II to Euro VI for both Artic and Rigid HGVs;
• There is a significant reduction in emissions between Euro V to Euro VI due to introduction of improved emissions controls.</td><td>• Gerneral declining trend in emissions since Euro I with minor increases at Euro V for Artic HGVs and Euro III for Rigid HGVs.
• Declining improvements since Euro IV.</td><td>• Gerneral declining trend in emissions since Euro I with minor increases at Euro V for Artic HGVs and Euro III for Rigid HGVs.
• Declining improvements since Euro IV.</td></tr>
</table>

7.4. NEE (non-exhaust emissions)

7.4.1. Brake & Tyre Wear from combustion engine vehicles

Non-exhaust emissions make up a large contribution to total PM_{10} and $PM_{2.5}$ emissions from road vehicles.

Particulates are released from brake, tyre and road surface wear as well as resuspension of road dust and vary due to a number of factors including brake, tyre and road-surface material, as well as driving style with:

- over half of non-exhaust emissions occur on urban roads due to the greater frequency of braking[107].
- Tyre-wear emissions are estimated to be greatest on high-traffic trunk roads and motorways where there is a lower frequency of braking, but higher traffic flow and faster speed.
- Exhaust emissions make up a small proportion of total emissions for each vehicle.
- Braking is typically the largest contributor amongst the vehicle types.

Other much smaller sources of non-exhaust emissions exist including engine belts and clutch plates.

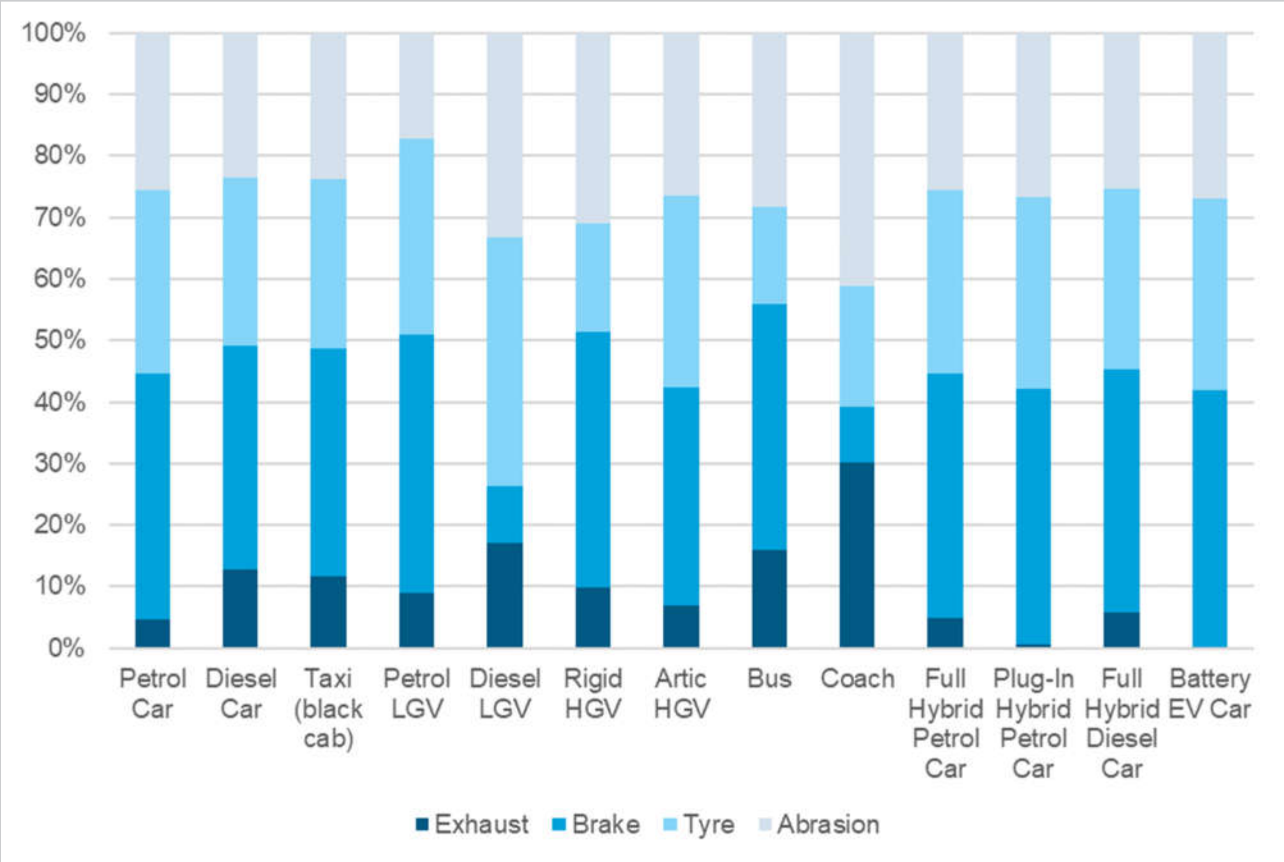
Legislation has been effective in reducing emissions direct from the exhausts of internal combustion engines, but now those reductions are becoming less and emissions from non-exhaust emissions are becoming more dominant, even in those vehicles without internal combustion engines.

Mitigation strategies[107] for reducing Non-Exhaust Emissions include:

- reduce the overall volume of traffic;
- lower the speed where traffic is free-flowing (e.g. trunk roads and motorways); and
- promote driving behaviour that reduces braking and higher-speed cornering.

[107] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf

Figure 7-9 – National Average Fleet Mix (2020) - Emissions of PM_{10} by Vehicle Type at 30 mph



7.4.2. Electric Vehicles and Regenerative Braking

Electric vehicles utilise regenerative braking systems which do not consist of traditional frictional wear of brake materials, and should lower brake wear emissions.

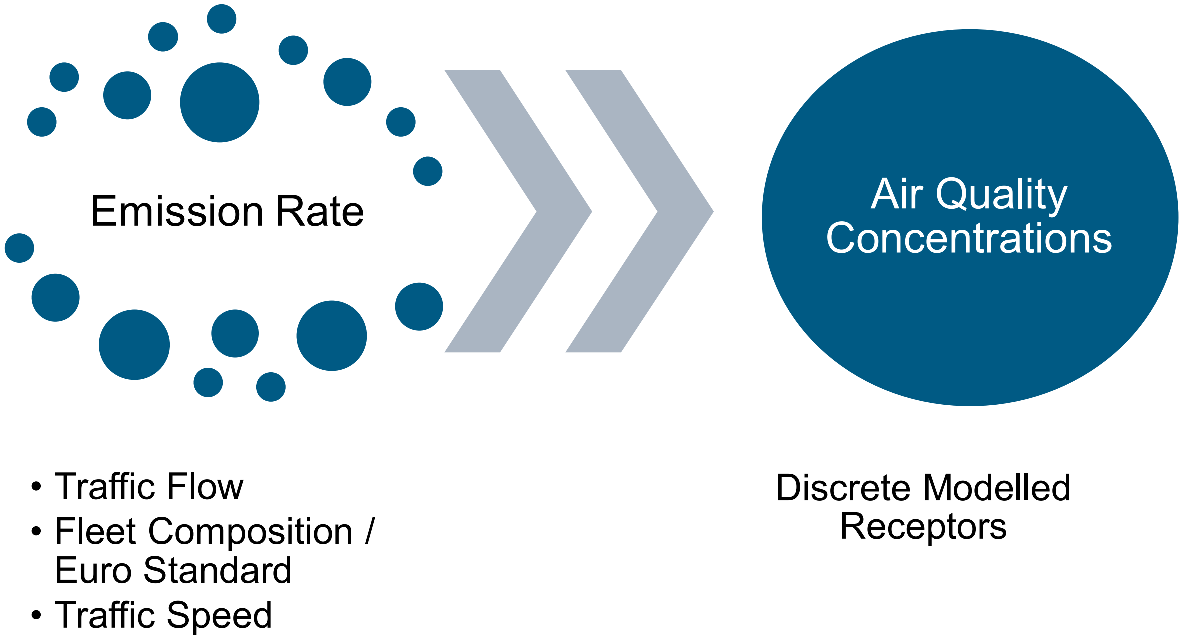
However, tyre and road wear emissions are higher with increased vehicle mass. As electric vehicles tend to be heavier than those with internal combustion engines (due to the weight of the batteries and associated hardware) there is a trade-off between the reduction in brake wear emissions and increase in tyre and road wear. The net balance is dependent on road type and driving mode and remains unquantified.

7.5. Road Transport Assessment Variables and Traffic Thresholds

7.5.1. Road Transport Assessment Variables

There are several variables impacting vehicle emissions, as indicated in Figure 7-10.

Figure 7-10 - Variables impacting Vehicle Emission Rates in Air Quality Modelling



7.5.1.1. Traffic Flow

Department for Transport geographical variation data for 2018[108], indicates that the South East is the region with the highest traffic volume in Great Britain with 55 billion vehicle miles travelled. Of these, **10 billion were estimated as travelled within Hampshire which would make it the busiest county in the UK for miles travelled.**

Traffic flow can be expressed in a number of ways depending on the level of detail required, demonstrated in Table 7-2. A simple assessment will rely on average annual daily traffic (AADT) and a representative 24-hour profile to account for variations over the course of the day.

Traffic flows need to be representative of typical conditions because flow can vary considerably by hour, day of the week and season. If AADTs are used to calculate a road source emission rate then a 24-hour profile is also required to factor flows to approximate the diurnal profile of hourly flows and emissions.

108 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/808555/road-traffic-estimates-in-great-britain-2018.pdf

Table 7-2 - Traffic Flow Variables

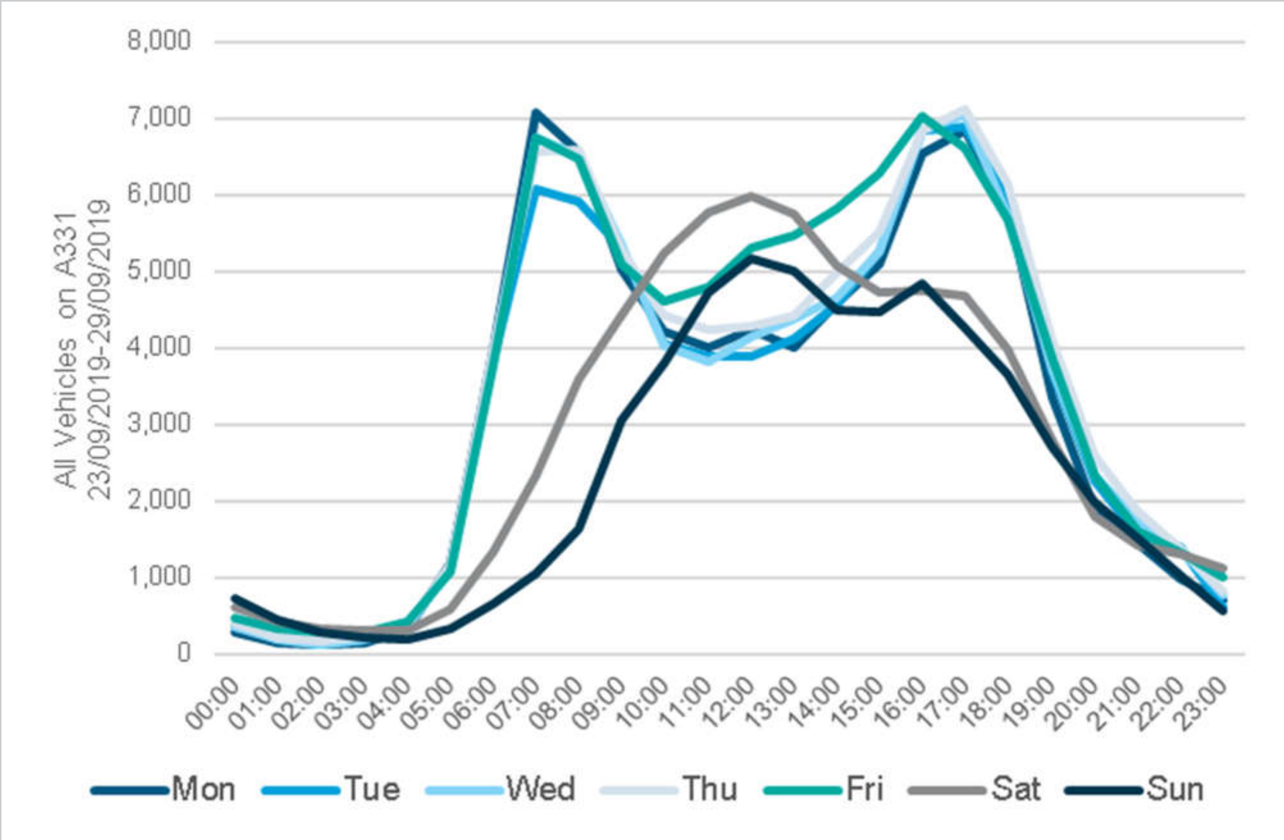
Traffic Variable	Description
Annual Average Daily Traffic (AADT)	Traffic flow in 24-hour average for each road link. These can be estimated from both traffic counts (manual or automatic) or traffic / transportation models. Depending on the format, the 24-hour average may need to be calculated e.g. from AM/PM periods, 12-hour counts or 18-hour Annual Average Weekday Traffic (AAWT). Council transport departments should be able to provide local conversion factors for calculations. Consideration should be given to the source data before calculating the AADT to ensure it is representative of typical conditions on the network.
Annual Average Hourly Traffic (AAHT)	Traffic flow in 1-hour average for each road link. These can be estimated from both traffic counts (manual or automatic) or traffic / transportation models. Consideration should be given to the source data before calculating the AAHT to ensure it is representative of typical conditions on the network. This may vary day to day, so it could be possible to provide an average hour for weekdays and weekends separately.
Peak Hour Flows	Maximum 1-hour flow within each of the AM and PM peak periods.
Period Average Flows	Average flow for each time period, typically: • AM – 07:00 to 10:00; • Inter-peak (IP) – 10:00 to 16:00; • PM – 16:00 to 19:00; and • Off-peak (OP) – 19:00 to 07:00. These flows are often calculated using expansion factors from the peak hour flows.

Note: As a minimum for an air quality assessment, the total flow of all vehicles and HGVs is required for each period average to derive a %HGV to be used in emission calculations

A typical 24-hour profile based on all vehicle miles in the UK in 2018[108] is shown in Chapter 2. A typical 24-hour profile using Automatic Traffic Count (ATC) data for a section of the A331 is presented in Figure 7-11. It shows:

- Clear AM and PM peaks on weekdays with reduced flows in the IP.
- The profile for Monday to Thursday is relatively consistent, with differences on Friday, Saturday and Sunday.
- For weekends there is a lack of AM and PM peak associated with the working week.
- On average the busiest hours are between 16:00 and 18:00 on weekdays and 11:00 to 13:00 at weekends.

Figure 7-11 – A331 Average Diurnal Profile



The total flow over a typical day can also vary by day of the week and month of the year. Average traffic distribution by day of the week at selected ATC sites within Hampshire is presented in Figure 7-12, and Figure 7-13 shows average traffic distribution by month for the UK in 2018 for a 5-year period between 2014 to 2018. It shows:

- Traffic flows increase slightly over the course of the working week from Monday to Friday before reducing considerably at the weekends.
- Friday is the busiest day on average for traffic flow.
- Daily traffic flows increase from January to the summer months, where flows peak in August before declining to December.

Figure 7-12 - Average Weekday Traffic Profile at selected ATC sites within Hampshire and National Average

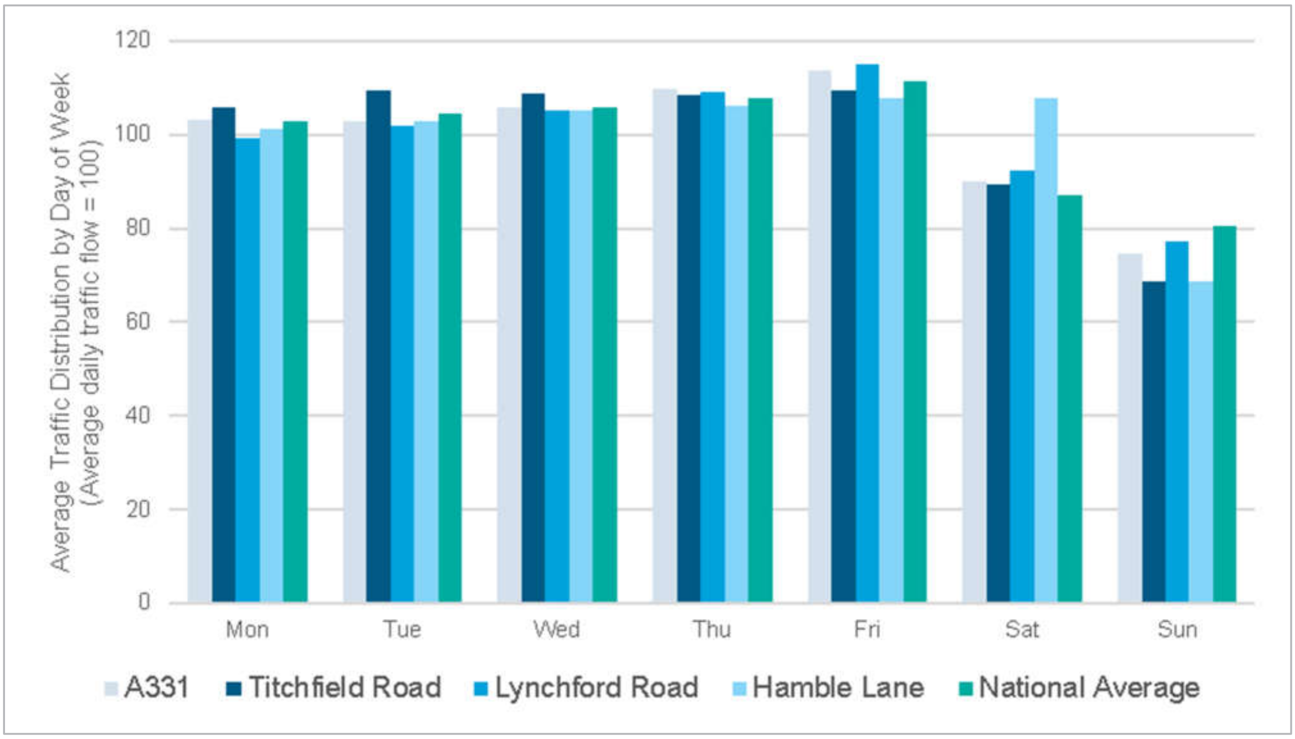
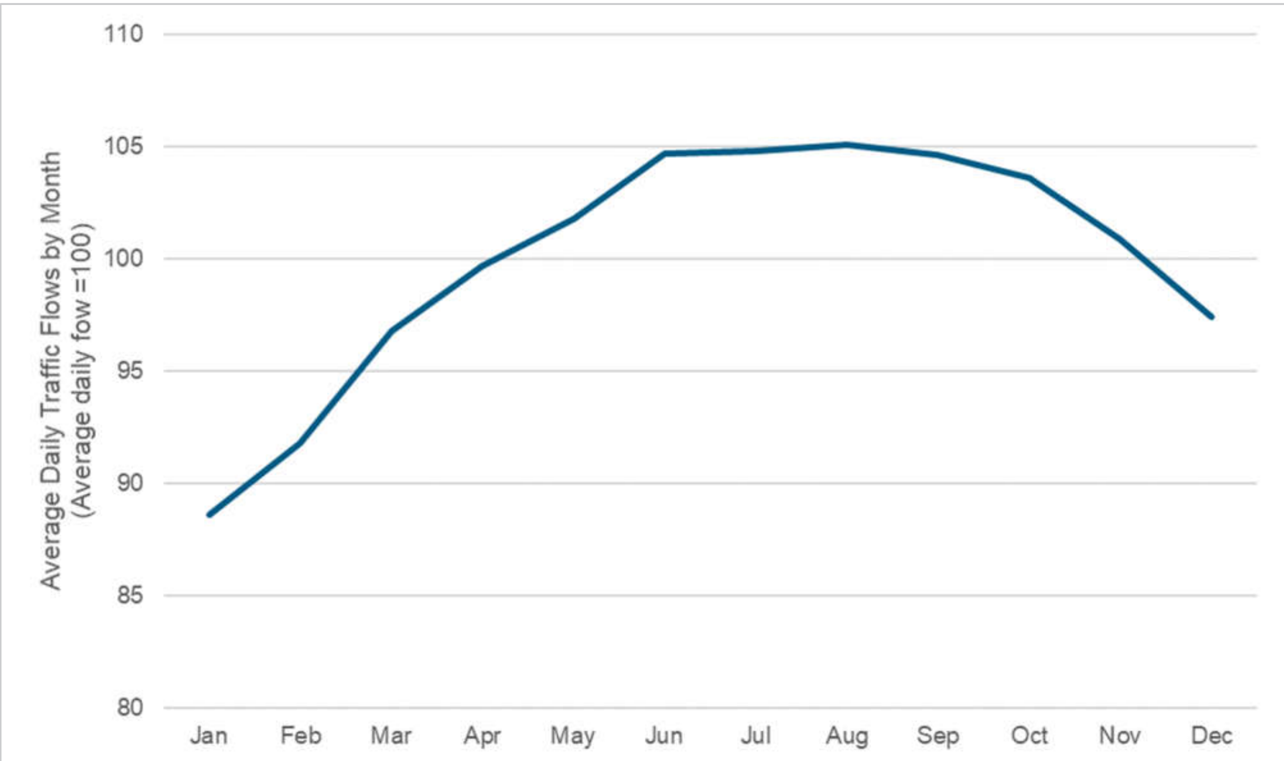


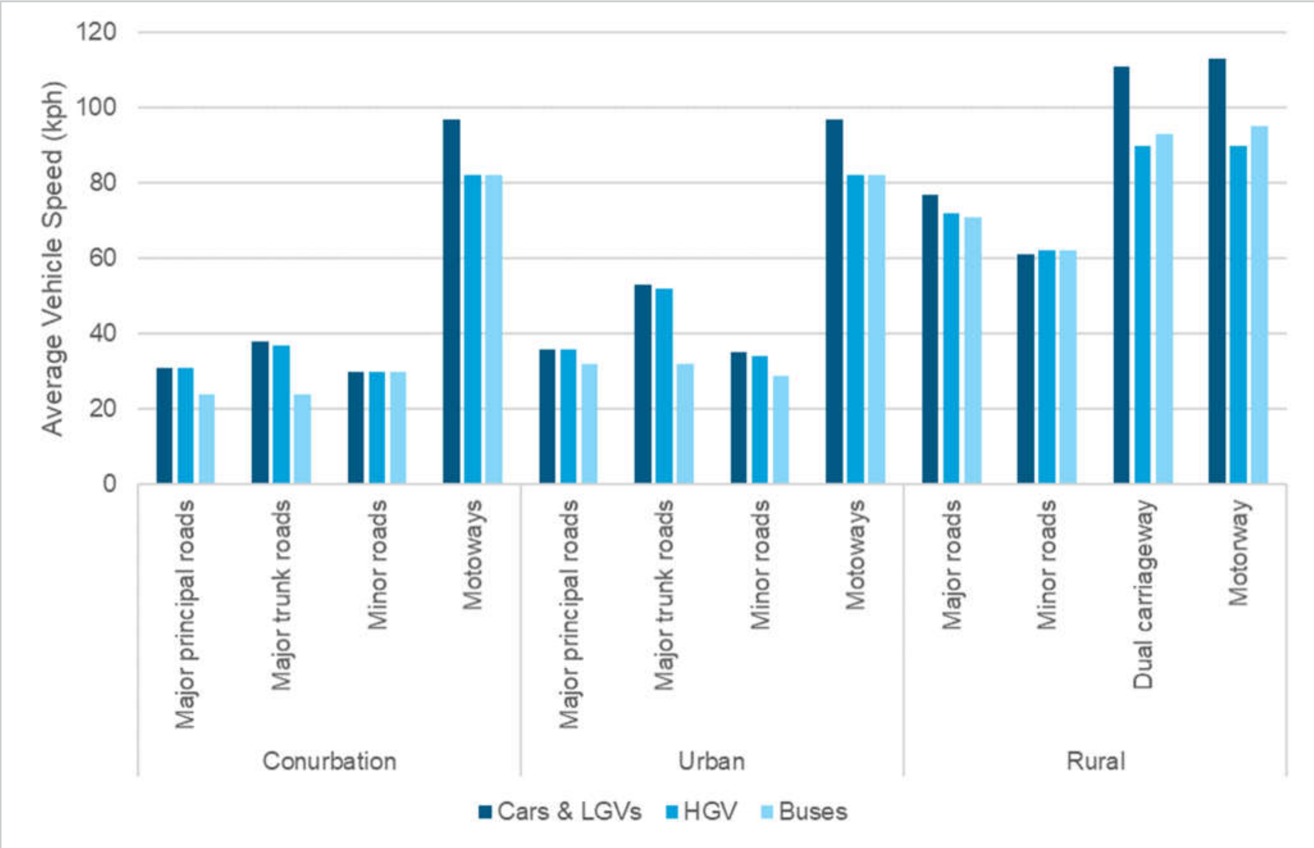
Figure 7-13 - Average Monthly Traffic Profile (National Average)



7.5.1.2. Traffic Speed & Composition

Vehicle speed varies across the country, with speeds typically being slower in urban areas compared to rural areas (Figure 7-14).

Figure 7-14 - Average Vehicle Speed (kph) by UK Road Type



The speed at which the vehicle is travelling strongly influences the amount of pollutant emitted by the vehicle.

This varies by vehicle type and fuel type, due to the load on the engine and internal combustion processes. Emissions profiles of NO_x and PM_{10} ($PM_{2.5}$ is very similar) are presented in Figure 7-15 below for standard vehicle types in 2020 using emission rates within the Defra emission factor toolkit[106] (EFT).

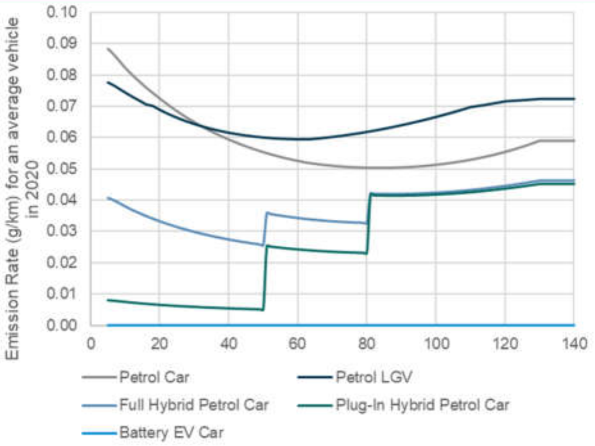
The speed emission profiles presented below show:

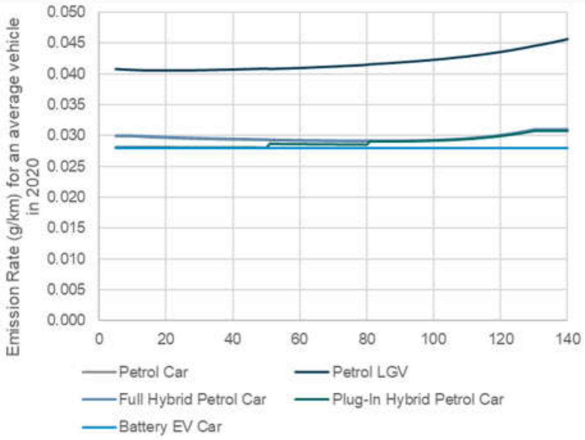
- A clear variation between petrol and diesel light duty vehicles and HGVs.
- A common relationship across all vehicle types for emissions to be higher at low speeds where they reduce to an optimum emission rate (which differs by vehicle) before increasing again as speed increases.
- The rate of decrease in emissions at low speeds is greater for NO_x relative to PM_{10}.

Figure 7-15 – Emission Rates for NOx and PM_{10} (g/km) by Vehicle Speed (kph)

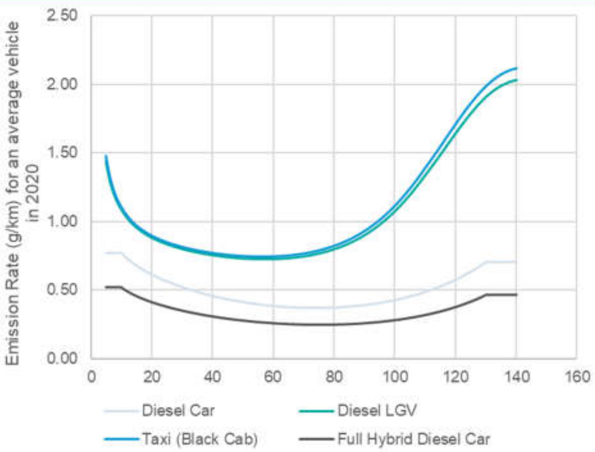
NOx	PM_{10}

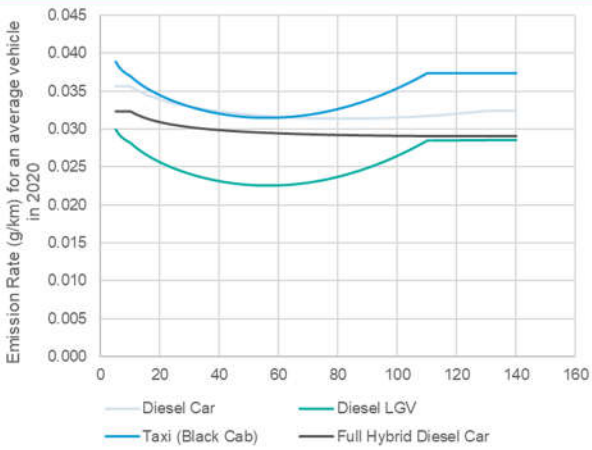
Petrol LGVs



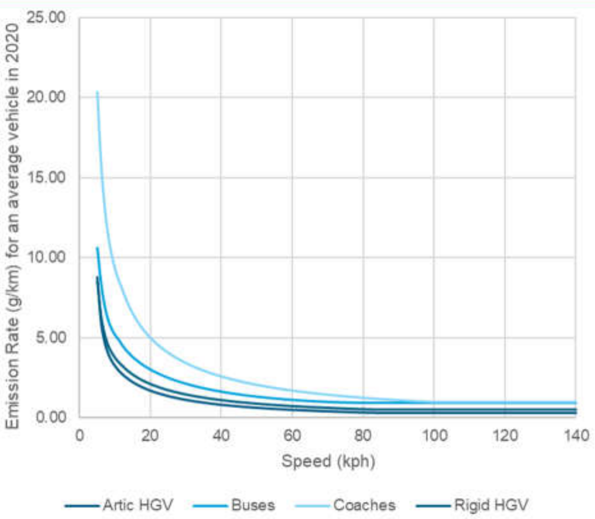


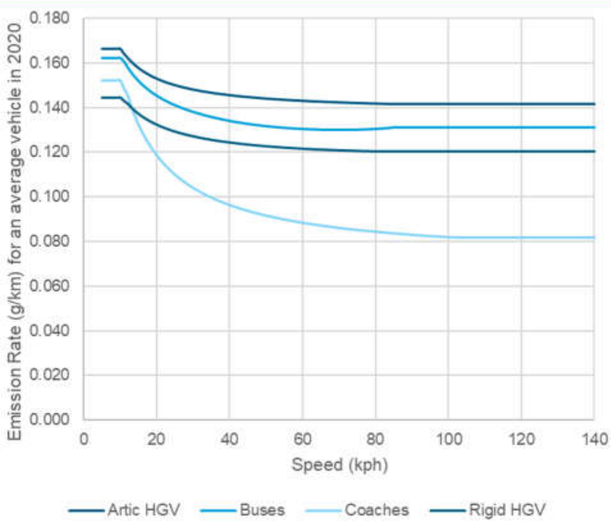
Diesel LGVs





HGVs





A standard air quality assessment will rely on the Defra EfT for emission factors for average vehicle speeds for each specific period. These speeds can be derived from observed values i.e. collected from a traffic survey or based on journey time GPS data.

Speeds can also be output from traffic models to allow for modelled future projections. For more complex micro-simulation traffic models, instantaneous emissions can be calculated based on individual traffic movements around the model network which correlate with flow conditions.

Another approach to calculating emission rates based on speed has been developed by Highways England, where a range of speed categories for traffic model outputs are grouped, known as speed bands[109]. Average emission rates are assigned to each speed band by year and vehicle type (HGV and LGV). There are four speed bands for both urban and motorway roads to represent differing flow conditions. The speed band categories for each road type are presented in Table 7-3.

Table 7-3 – Highways England Speed bands for Air Quality Assessment

Road Type	Category	Speed Range (kph)	Description
Motorway	Heavy congestion	5 – 48	Traffic with a high degree of congestion and stop: start driving behaviour, junction merges, slip roads with queuing traffic.
	Light congestion	48 – 80	Traffic with some degree of flow breakdown, typical volume/capacity (v/c) >80%. Normal operation on slip roads.
	Free flow	80 – 96	Motorway generally free flow driving conditions with little or no flow breakdown. Motorway busy but not congested, v/c <80%.
	High speed	96 - 140	Motorway unconstrained, typical of overnight conditions when traffic light.
Urban	Heavy congestion	5 – 20	Traffic with a high degree of congestion. Within a 100m radius of road junction with a high degree of congestion.
	Light congestion	20 – 45	Typical urban traffic with a reasonable degree of congestion. Within a 100m radius of road junction.
	Free flow	45 – 80	Typical urban traffic with limited or no congestion.
	High speed	80 – 112	High speed urban single or dual carriageway.

7.5.2. Transport Thresholds

There are several published methods which screen the potential for significant effects on local air quality due to changes in traffic flows. They are precautionary and do not indicate that there will be a significant effect - only that further assessment is required.

The most commonly used criteria are found in the following guidance documents:

- Highways England DMRB LA105 Air Quality[109]; and
- IAQM Land-Use Planning & Development Control: Planning for Air Quality[110].

Both methods incorporate traffic data screening against thresholds to define the affected road network (ARN), as detailed in Table 7-4.

This allows the geographic extent of the potential area where significant air quality effects from a proposed scheme might occur to be identified.

It can indicate which variable could be most important in determining air quality impact e.g. LGVs or HGVs or speed.

It can be useful to isolate and map the variable triggering the ARN criteria (traffic flow, HGV flow or speed).

[109] Design Manual for Roads and Bridges: Volume 11, Section 3 Environmental Assessment Techniques, Part 1, LA 105 Air Quality. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20105%20Air%20quality-web.pdf
[110] https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

The IAQM methodology also varies the criteria used to define the ARN when there are existing air quality constraints within the area i.e. AQMA where air quality effects may be more sensitive to changes to traffic.

Table 7-4 - Published Traffic Thresholds for Air Quality Assessment

Traffic Variable	DMRB	IAQM^
Total Annual Average Daily Traffic (AADT)	Greater or equal to 1,000	-
Light Duty Vehicles (LDVs) AADT	-	Greater than 100 within or adjacent to an AQMA Greater than 500 elsewhere
Heavy Duty Vehicles (HDVs) AADT	Greater or equal to 200	Greater than 25 within or adjacent to an AQMA Greater than 100 elsewhere
Speed	Change in speed band*	-
Physical space	Change in carriageway alignment by greater or equal to 5 metres	Realignment of roads of 5 metres or more and the road is within an AQMA

* Speed bands are a range of categories for which outputs from the traffic model are grouped to describe their emissions

^ There are additional criteria covering other developments such as introduction or change to a bus station and carparks.

7.6. Headroom Calculator

In addition to the screening criteria provided in the DMRB and IAQM guidance it can be important for decision makers to understand the potential 'headroom' in-terms of the number of vehicles required before an air quality objective is achieved or exceeded.

The 'headroom' concentration is calculated by comparing expected concentrations against the air quality objective.

As the total flow of vehicles share a linear relationship with emissions, the percentage of concentration remaining before achievement or exceedance of the objective can be applied to the road traffic on the nearest road link to provide an estimate of 'headroom' in the traffic flow.

NO_2 concentrations do not share a linear relationship with NOx concentrations due to complex atmospheric chemistry which can vary by local authority, therefore the 'headroom' must be calculated in terms of road-NOx emissions to obtain a comparison with traffic flows.

This approach provides a useful estimate but relies on all other variables remaining constant i.e. traffic speed and fleet composition. So for example would be of limited use in a CAZ study where the primary purpose is to change the nature of the fleet.

Example 1 – Headroom before NO_2 objective is exceeded

The Fareham BR1 monitoring site measured an annual mean concentration of 31 µg/m^3 in 2018. This is 9 µg/m^3 lower than the air quality objective of 40 µg/m^3 i.e. a 'headroom' of 22.5% of the objective.

The monitored road NO_x can be calculated from the total monitored NO_2 using background air quality concentrations using readily available calculation tools[111]. The contribution of calculated road-NOx is then compared with this figure.

[111] Defra NOx to NO_2 calculator v7.1

Table 7-5 - Headroom Calculator Example 1

Monitor ID	Monitored annual mean NO_2 (µg/m^3)	Background NO_2 (µg/m^3)	Annual mean NO_2 air quality objective	Equivalent annual mean NOx of NO2 annual mean objective*	Monitored road NOx^	Road NOx 'headroom'
BR1	31.0	17.9	40.0	47.2	22.7	43.5%

* calculated using NO_2 to NOx calculation tool

If all variables remain constant there is 'headroom' at this receptor for an increase in average annual daily traffic by 43.5%. DfT count data for the road adjacent to the monitor suggests the AADT in 2018 is 20,807 vehicles, therefore the road has enough 'headroom' for approximately 9,100 additional AADT.

Example 2 – Reduction in Traffic required to achieve compliance

The Winchester St George's Street monitor recorded an exceedance of the annual mean NO_2 air quality objective in 2018 with 41.0 µg/m^3. This is an exceedance of the annual mean objective by 2.5%. DfT count data suggests the 2018 AADT on the adjacent road is 8,714 vehicles.

Table 7-6 - Headroom Calculator Example 2

Monitor ID	Monitored annual mean NO_2 (µg/m^3)	Background NO_2 (µg/m^3)	Annual mean NO_2 air quality objective	Equivalent annual mean NOx of NO2 annual mean objective*	Monitored road NOx^	Road NOx 'headroom'
St George's Street	41.0	16.2	40.0	50.7	53.1	-4.8%

* calculated using NO_2 to NOx calculation tool

If all variables remain constant, AADT would need to reduce by 4.8% to meet the objective at this monitor. Using the indicative AADT recorded at the nearest DfT count site on this link, the traffic flow would need to reduce by approximately 420 vehicles per day to achieve compliance.

8. The cost of poor air quality & benefits of action

8.1. UK wide costs of air pollution

It is estimated that between 28,000 and 36,000 premature deaths may be linked to air pollution in the UK each year (combining impacts from $PM_{2.5}$ and NO_2)[112].

The economic cost of which is estimated at over £20 billion per year[113]. This is an estimate of the total cost to society, and incorporates health and social costs, loss of earnings, as well as reflecting society's 'willingness to pay' for reduced levels of morbidity and mortality.

For example, recent research commissioned by Public Health England showed that the health and social care costs alone ($PM_{2.5}$ and NO_2) in England only could be £5.3 billion by 2035 looking only at $PM_{2.5}$ and NO_2 and only for diseases with a strong association with air pollution (such as coronary heart disease; stroke; lung cancer; and childhood asthma).

Defra has set out a framework and guidance for use of three different methods to appraise the cost of poor air quality, and the economic benefits of action to improve it [114]:

- **Damage cost approach:** for proposals where the effects are less than £50 million and do not affect compliance with legal limits. The simplest approach using costs defined per tonne of emission.
- **Impact pathway approach:** for proposals where the effects are greater than £50 million and which do not affect compliance with legal limits. The impact pathway approach is a more detailed method of valuing air quality changes. It uses location-specific modelling to assess changes in air quality concentrations, then applies factors to the concentration change to estimate the effects and their associated costs.
- **Abatement cost approach**: for proposals that change emissions in a way that affects compliance with legal obligations (i.e. affecting compliance with European Limit Values)[115]. Abatement costs recognise that changes in emissions may affect the extent and the cost of measures required to achieve compliance. (NB: relevant to Hampshire transport schemes affecting PCM roadside non-compliance locations subject to Ministerial Directions)

8.2. The damage cost approach

Damage costs are 'impact values', which estimate overall societal costs associated with changes in pollutant emissions, defined per tonne of emission by pollutant:

Damage cost (£/tonne) x Change in emissions (tonnes) = Economic valuation of air quality impact (£)

Defra guidance provides a step by step guide to the application of damage costs[116] along with an excel based tool (air quality damage cost appraisal toolkit), which is also available online[114].

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[112] Committee on the Medical Effects of Air Pollutants (2018) Associations of long-term average concentrations of nitrogen dioxide with mortality. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf. Accessed Feb 2020.

[113] Royal College of Physicians (2016) Every breath we take: the lifelong impact of air pollution. Available online: https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution. Accessed Jan 2020.

[114] Defra (2019) Air quality: economic analysis. Available online: https://www.gov.uk/guidance/air-quality-economic-analysis. Accessed Jan 2020.

[115] Defra (2013) Abatement cost guidance for valuing changes in air quality. May 2013. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/197898/pb13912-airquality-abatement-cost-guide.pdf. Accessed Jan 2020.

[116] Defra (2019) Air quality damage cost guidance. January 2019. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770576/air-quality-damage-cost-guidance.pdf. Accessed Feb 2020.

For land development schemes, a basic method to calculate damage costs from the transport to/from them is set out in IAQM Guidance (Paragraph 5.12)[117]. Other local and regional authorities have developed similar approaches[118], based around the same broad method:

1. Identify trip rates (as trips/annum) generated by the proposed development (either provided via a Transport Assessment, or estimated through TRIPS database, or equivalent);
2. Identify average trip distance for the development. Some methodologies assume a blanket 10 km/trip. More detailed information specific to the development type can be obtained from the National Travel Survey.
3. Calculate the additional emissions of NO_X and $PM_{2.5}$ (kg/annum), using emission factors in Defra's Emission Factor Toolkit (either with scheme specific speeds, or assuming an average speed of 50 km/h)
4. Multiply the calculated annual emissions by the appropriate timeframe for the development. Some methodologies assume five years;
5. Use Defra's damage cost approach to provide a valuation of the excess emissions using the applicable values for each pollutant; and
6. Sum the NO_X and $PM_{2.5}$ costs.

Higher damage costs for particulate matter reflect the relatively greater health impacts, compared with other pollutants[119] -see chapter 4 for more details

Low / Central / High, refers to the range of estimates of health impacts that are included within sensitivity analyses and reflects the varying levels of certainty of the underlying epidemiological evidence:

- Low sensitivity scenarios take account of the core, well known health impacts
- High sensitivity scenarios include health impacts which may have only weak or emerging evidence of an association with air pollutants
- Central damage costs are typically used in assessments

Table 8-1 - 2018 Defra national damage costs (at 2017 prices), alongside high and low sensitivities[120]

Pollutant	Central Damage Cost (£/t)	Low Sensitivity Damage Cost (£/t)	High Sensitivity Damage Cost (£/t)	$PM_{2.5}/PM_{10}$ Conversion Factor
NO_x	6,199	634	23,153	
SO_2	6,273	1,491	17,861	
NH_3	6,046	1,133	18,867	
VOC	102	55	205	
$PM_{2.5}$	105,836	22,588	327,928	0.642

- For NO_X and $PM_{2.5}$ only, Defra also provides damage costs for a range of emission source sectors.
- For road transport, NO_X and $PM_{2.5}$ damage costs are also provided for different types of geographic location (with different values reflecting varying levels of population density)[120] where:
  - urban big >250,000 population; urban large >100,000 population; urban medium >25,000 population; and urban small >10,000 population.
- Different cost factors are provided for different locations, to reflect higher costs in areas of dense population. Schemes in Hampshire, for example, could choose to apply damage cost factors relevant to the description of the specific geographical location – ranging from rural through to inner/outer conurbation in the case of Southampton or Portsmouth.

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[117] IAQM (2017) Land-use planning and development control: Planning for air quality. January 2017. Available online: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf. Accessed Feb 2020.
[118] Low Emission Partnership (2016) Local Policy Guidance for Low Emission Planning. Available online at: http://lowemissionstrategies.org/les_planning_guidance.html. Accessed February 2020.
[119] Defra notes that there is a potential overestimation of PM impacts through damage costs, due to the overlap in effects between NO_X and PM. Whilst NO_X damage costs are adjusted for this, there is no such adjustment factor available for PM emissions.
[120] Defra (2019) Air quality damage cost guidance. Published January 2019. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770576/air-quality-damage-cost-guidance.pdf. Accessed Jan 2020.

Table 8-2 – 2018 Defra $PM_{2.5}$ damage costs for road transport (at 2017 prices)[116]

Pollutant Source	Central Damage Cost (£/t)	Low Sensitivity Damage Cost (£/t)	High Sensitivity Damage Cost (£/t)	$PM_{2.5}/PM_{10}$ Conversion Factor
Road Transport	203,331	42,713	625,927	0.673
Road Transport Central London	1,111,831	230,582	3,430,456	0.673
Road Transport Inner London	1,132,776	234,913	3,495,112	0.673
Road Transport Outer London	602,201	125,195	1,857,233	0.673
Road Transport Inner Conurbation	420,523	87,626	1,296,397	0.673
Road Transport Outer Conurbation	250,221	52,409	770,676	0.673
Road Transport Urban Big	305,377	63,815	940,942	0.673
Road Transport Urban Large	247,045	51,753	760,871	0.673
Road Transport Urban Medium	203,359	42,719	626,014	0.673
Road Transport Urban Small	152,694	32,242	469,611	0.673
Road Transport Rural	69,745	15,089	213,548	0.673

Table 8-3 – 2018 Defra NO_x damage costs for road transport (at 2017 prices)[116]

Pollutant Source	Central Damage Cost (£/t)	Low Sensitivity Damage Cost (£/t)	High Sensitivity Damage Cost (£/t)
Road Transport	10,699	980	40,896
Road Transport Central London	57,517	4,576	225,472
Road Transport Inner London	58,967	4,688	231,189
Road Transport Outer London	31,326	2,564	122,215
Road Transport Inner Conurbation	22,005	1,848	85,468
Road Transport Outer Conurbation	13,200	1,172	50,754
Road Transport Urban Big	16,010	1,388	61,834
Road Transport Urban Large	12,994	1,156	49,940
Road Transport Urban Medium	10,844	991	41,465
Road Transport Urban Small	8,343	798	31,605
Road Transport Rural	4,191	480	15,237

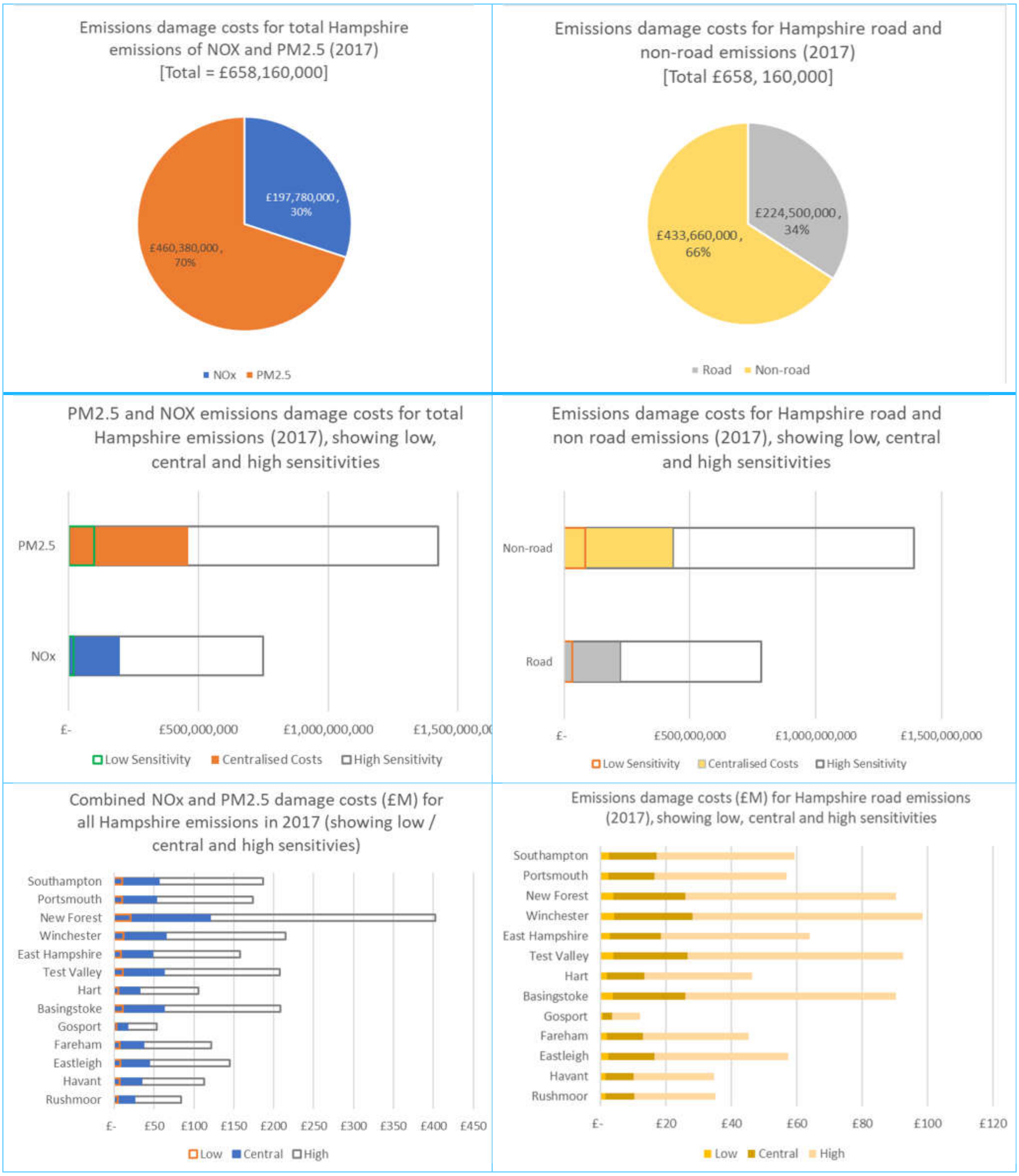
8.3. Valuing Hampshire emissions using damage costs

The following figures (Figure 8-1) have been calculated by multiplying Hampshire 2017 emissions[121] by relevant damage cost factors for NO_X and $PM_{2.5}$.

- The total cost of emissions across Hampshire is estimated at £658 million per annum (2017 prices).
  - Low sensitivity: £117 million per annum / High sensitivity >£2 billion per annum
- $PM_{2.5}$ emissions account for 70% of total damage costs, compared with 30% from NO_X emissions (reflecting the stronger associations between $PM_{2.5}$ and health impacts)
- Road transport emissions (both $PM_{2.5}$ and NO_X) account for 34% of total damage costs (£225 million per annum)

[121] Hampshire road and non-road emissions for 2017 downloaded from the National Atmospheric Emissions Inventory (NAEI): https://naei.beis.gov.uk/emissionsapp/

Figure 8-1 – 2018 calculated damage costs for Hampshire emissions of NO_x and $PM_{2.5}$, using centralised cost factors (at 2017 prices)[116122]



[122] Emission damage cost for road transport sector applies road transport sector central damage costs whereas non road emissions calculated using the national central damage costs. This approach may underestimate the cost of the non-road sector and thus overestimate the proportion of total costs associated with road emissions.

8.4. Emerging Issues

Evidence of health effects is constantly emerging. Basis for calculation of damage costs will likely change over coming years, as research develops.

PHE (2018) has published a tool[123] for councils to calculate potential costs to the NHS and social care system i.e. actual monetary costs, rather than incorporating full damage costs of mortality, loss of earnings, etc. This could provide Hampshire specific costs and the ability to test reduction scenarios.

Further work could include full Health and Economic Impact assessment, to include 'business as usual', baseline, and assessment of future emissions reductions, e.g. through Hampshire proposed schemes/actions. A similar study has been carried out for Birmingham City by Kings College London[124].

[123] PHE (2018) Air pollution: a tool to estimate healthcare costs. May 2018. Available online: https://www.gov.uk/government/publications/air-pollution-a-tool-to-estimate-healthcare-costs. Accessed Jan 2020.
[124] Kings College London (2019) Birmingham City Health and Economic Impact Assessment study. Available online: https://www.uk100.org/wp-content/uploads/2019/05/KCL-UK100-Birmingham-City-Health-and-Economic-Impact-2019.pdf. Accessed Feb-2020.

9. Tackling causes, not symptoms

By the time AQMA or CAZ designations are triggered, it is already too late. Even once designations are revoked, pollution hotspots often persist, at lower levels.

Furthermore, frequent engagement with residents and elected representatives regarding air quality & transport shows the few micrograms per m³ difference which triggers designations is widely considered immaterial amongst the public.

In a loose health analogy, action at these locations (urgent CAZ designations) are the equivalent of emergency surgery where prevention (greater active or public travel choice) could have avoided or reduced the severity of the illness significantly.

This analogy has precedent in wider UK public policy, but reflects an emerging best-practice philosophy, increasingly applied when developing policy and strategies across multiple public disciplines including urban design and tackling knife crime, to take a 'public health approach'.

Public health policies aim to provide the maximum benefit for the largest number of people. Programmes for primary prevention based on this public health approach target measures at the broadest possible share of the population to reduce and prevent issues at a population-level.

The approach consists of four steps:

1. Define the problem through the systematic collection of information about the magnitude, scope, characteristics, and consequences of incidents.
2. Establish why incidents arise using research to determine the causes, the factors that increase or decrease risk of incident, and factors that could be modified through interventions.
3. Find out what works to prevent incidents by designing, implementing, and evaluating interventions.
4. Implement effective and promising interventions in a wide range of settings. The effects of these interventions on risk factors and the target outcome should be monitored, and their impact and cost-effectiveness should be evaluated.

In the context of tackling transport emissions, the prevalence of air pollution hotspots could be argued to ultimately be a failure of the planning system, compounded by societal and cultural prejudices and commercial interests.

New housing growth is often planned to be delivered in isolation, without accompanying diverse employment space, or in remote locations. Where new settlements are built without local key services communities rely on, this increases the need to travel.

Similarly, where new employment sites & services are built far from existing residential areas intended to serve them or without public transport connectivity, these constraints also increase the need to travel. Planning for increased travel therefore drives higher levels of air pollution than is desired or necessary.

Inefficient and environmentally unsustainable use of the wider transport network is represented by air quality designations at pollution hotspots. Most roadside emissions at these sites are shown to be caused by private vehicles at peak times, moving people from home to places of work or leisure.

People make these choices because distances are too great for active travel and because public transport services are frequently perceived as (and often are) less reliable and convenient, or simply are not available / viable.

Therefore, a public health approach to tackling transport related air pollution would not focus exclusively on traffic control measures at locations where air quality is worst, but equally seek to affect long-term, permanent behaviour change across the widest geographic area possible to manifest positive change at a population level. This would likely have to include a multi-agency agreement that all planning decisions accept, are informed by, and address this causal relationship appropriately and at the earliest possible opportunity.

10. Protecting the most vulnerable

10.1. Discussion of 'vulnerability'

Air pollution effects everyone to an extent but depending on the pollutant there are demonstrated health impacts for the population (fine particles) or a fraction of it (NO_2). Certainly, for NO_2 the air quality thresholds are set based on the vulnerable element of the population shown to be affected by it, but then applied on a precautionary basis to all in assessments of impacts.

There is a significant overlap between some specific, well-evidenced health vulnerabilities and clearly defined, legally protected characteristics covered by the public sector equality duty under the Equality Act2010, such as age and pregnancy.

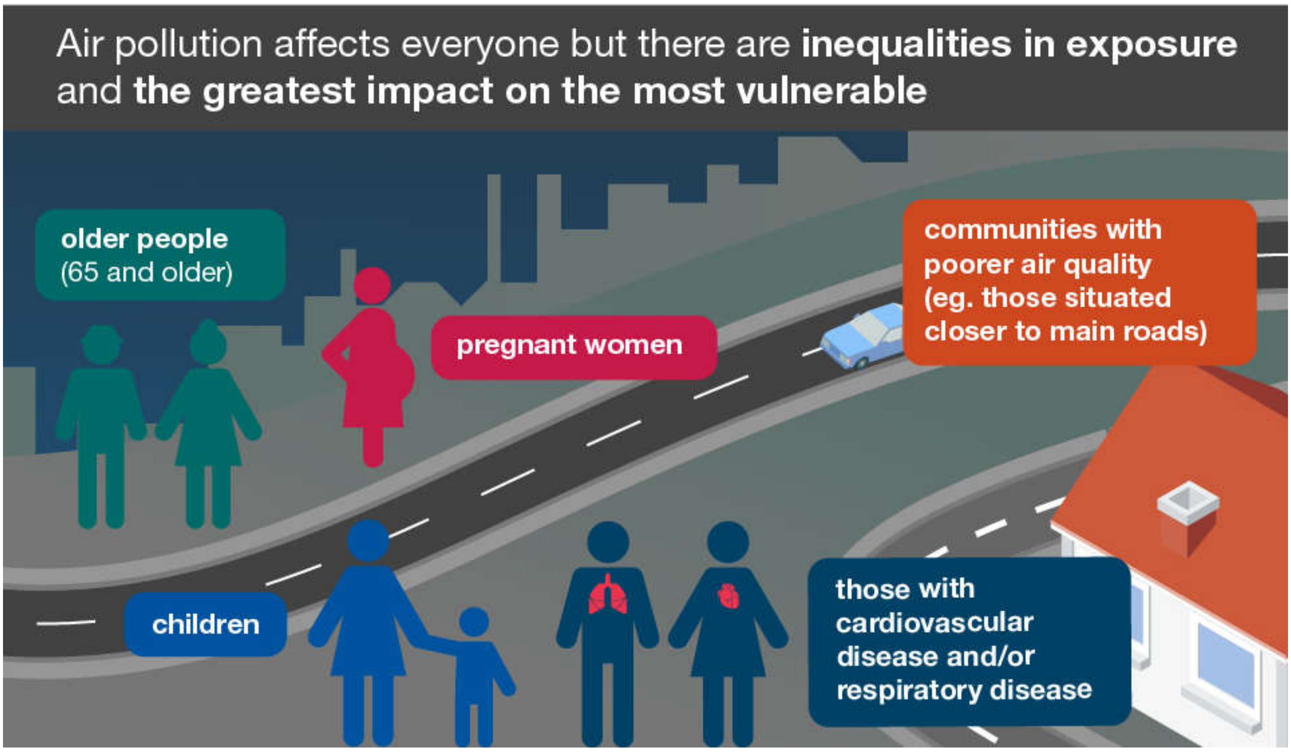
Disability is another protected characteristic, but more complex. The Equality Act states a person has a disability if he or she has a physical or mental impairment which has a substantial and long-term adverse effect on his or her ability to carry out normal day-to-day activities.

According to the Equality Act impairments include underlying health conditions including respiratory conditions such as asthma, and cardiovascular diseases including stroke and heart disease.

Table 10-1 - Factors affecting vulnerability to air pollution include

Vulnerability	Effect	Children	Older People	Pregnant Women	Disability
Health	Pre-existing medical conditions may be worsened by poor air quality. Individuals with heart or lung diseases are likely to be particularly affected.	✓	✓	✓	✓
Age	Children, whose lungs are not fully developed may suffer more than adults from poor air quality. Exposure to air pollution at a young age can hinder lung growth and brain development and increase the risk of conditions such as asthma. Older people are also more vulnerable to air pollution as they are more likely to have pre-existing medical conditions worsened by poor air quality.	✓	✓		✓
Pregnant Women	Poor air quality can contribute toward low birth weights, premature births, organ damage and stillbirth			✓	✓
Economic Deprivation	Deprived areas often have high levels of air pollution, situated in densely populated urban centres and/or adjacent to busy roads or industry. Poor air quality in deprived areas often affects the most vulnerable people as deprived communities suffer from poor health, exacerbated by poor housing and restricted access to green space and healthy lifestyle choices (diet, exercise). Deprivation can affect individuals throughout their lives from prenatal through to old age.	✓	✓	✓	✓

Figure 10-1 – Air Pollution and Vulnerability[125]



10.2. Relevance of exposure period to each vulnerable group

Objectives in the UK Air Quality Strategy (AQS) and European Directive Limit and Target Values exist for the protection of human health. They are set by expert groups and informed by Guidelines published by the World Health Organisation (WHO)[126], set *"with regard to scientific and medical evidence on the effects of the particular pollutant on health as minimum or zero risk levels."*[127]

The WHO examine evidence of health effects from epidemiological studies on vulnerable groups, as well as healthy people, applying uncertainty factors to give confidence in the suggested guideline values.[128]

The risk of adverse effects on an individual depends on the individual's current health status, age, the pollutant type and concentration, and the length of time exposed to the polluted air.

[125] Public Health England, "Health matters: air pollution", November 2018, accessed 20/02/20 https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution
[126] WHO (2005) Air quality guidelines – global update 2005. Available online: https://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/. Accessed Jan 2020.
[127] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf
[128] http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf?ua=1

Figure 10-2 – Health Effects of Air Pollution[125]

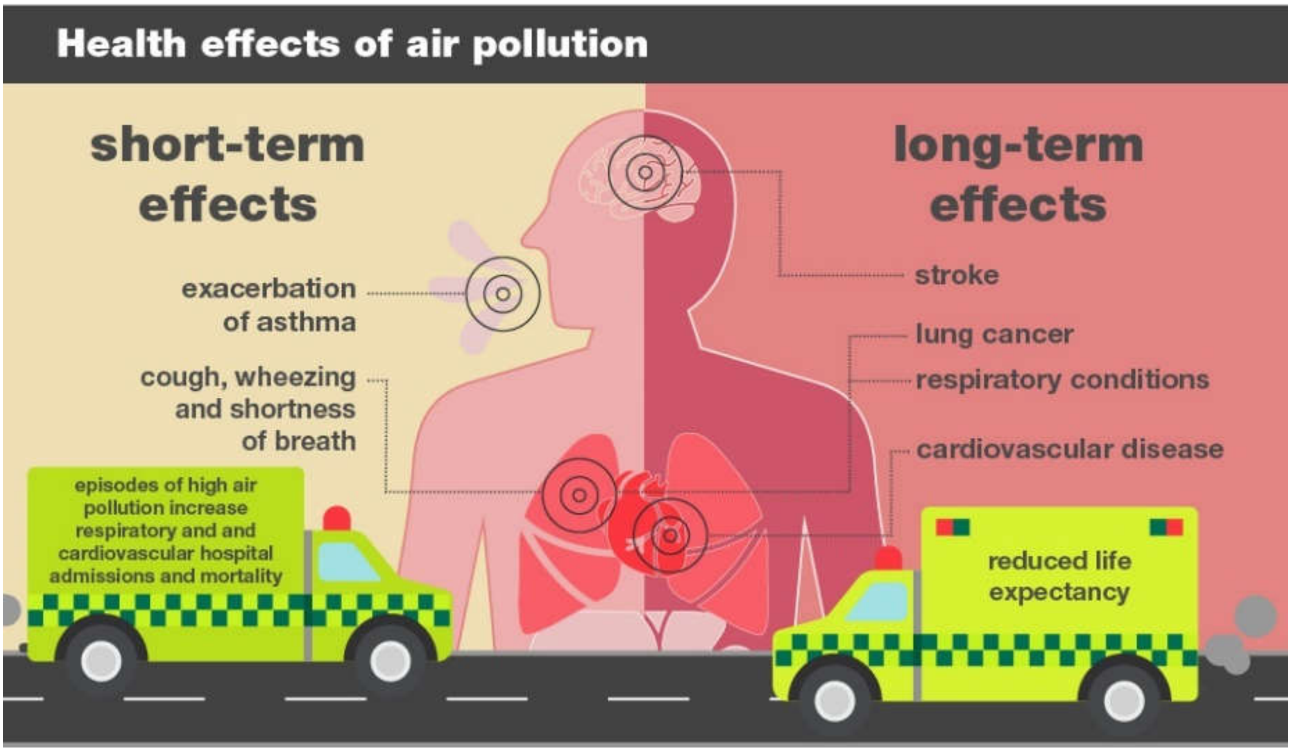


Figure Notes:

- **Short term** high air pollution episodes (in an hour or day timeframe) can put pressure on the heart and lungs and cause immediate health problems, particularly for those with pre-existing medical conditions.
- **Long term** exposure to air pollution (i.e. averaged over a year) can cause permanent health effects, such as poor lung development in children, heart and respiratory diseases, and cancers associated with particulate pollution entering the lungs and blood stream.

AQS objectives apply where individuals would be expected to be present for the exposure period of the standard:

- **short term**: outdoor seating at cafes, school playgrounds, residential gardens, public parks and
- **long term**: residential properties, schools.

The elderly and those with pre-existing medical conditions are more likely to suffer adverse effects from high short-term pollution events.[129]

In reality, the elderly tend to spend more time indoors, i.e. in one location, so may additionally be affected by changes in the long-term exposure criteria, such as the annual average objectives. However, when outdoors, the elderly also tend to move more slowly as pedestrians, often spending longer periods moving through heavily trafficked areas, increasing exposure to short term objectives.

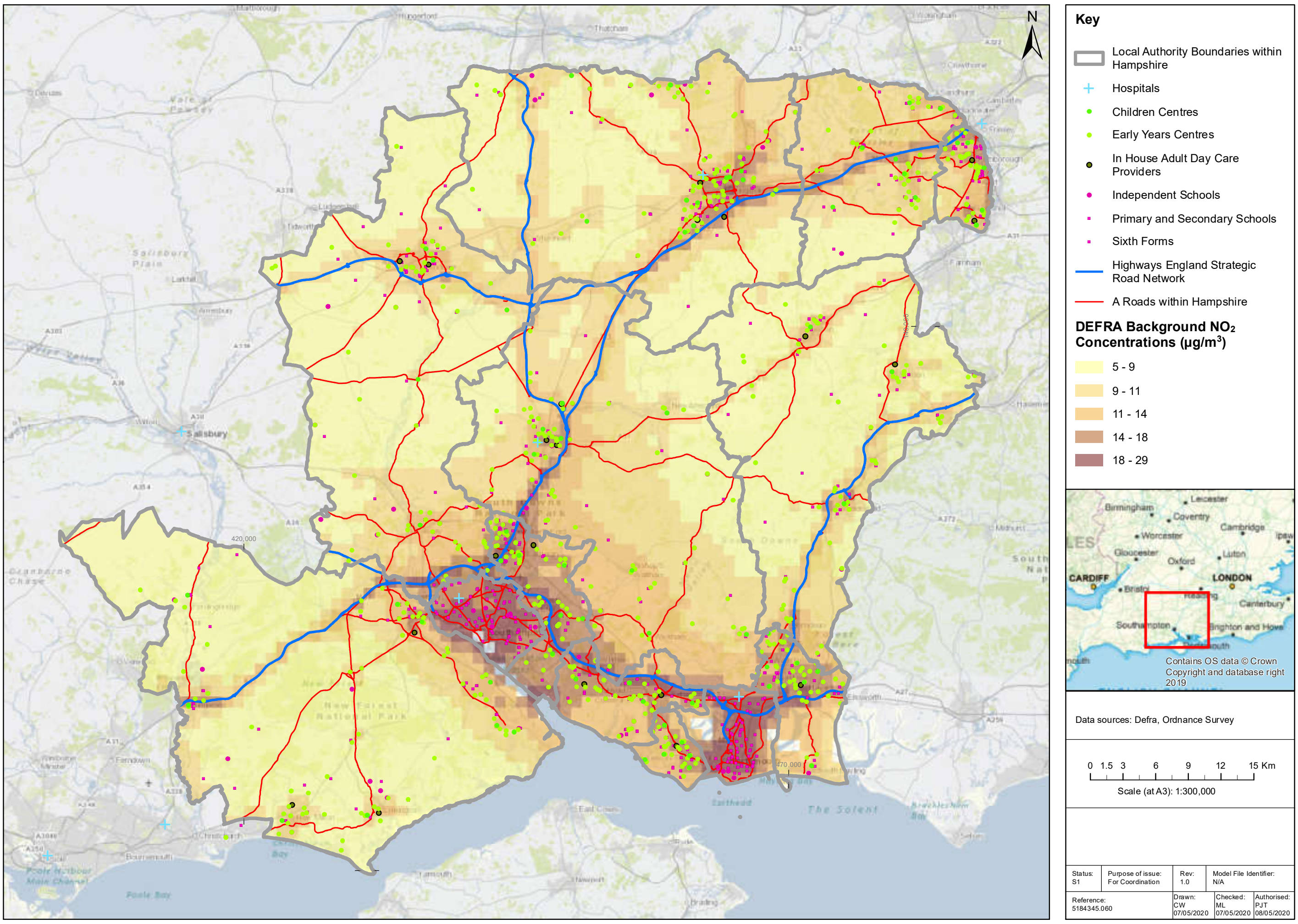
10.3. Mapping of the location of the vulnerable in Hampshire

Mapping sensitive locations across Hampshire shows clusters of schools and day care centres around major roads and within the areas of highest background NO_2 concentrations.

Action could be prioritised not just where concentrations are highest, but also where these areas coincide with the most vulnerable groups.

[129] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

Figure 10-3 – Vulnerable locations across Hampshire



Project: \\wsatkins.com\project\GBEMB\Mandl\Air&Sustainability\Jobs\519\5194345.060 HCC AQ Manual\06 GIS\CH10\Figure 10.3-Vulnerable_v1.1.mxd

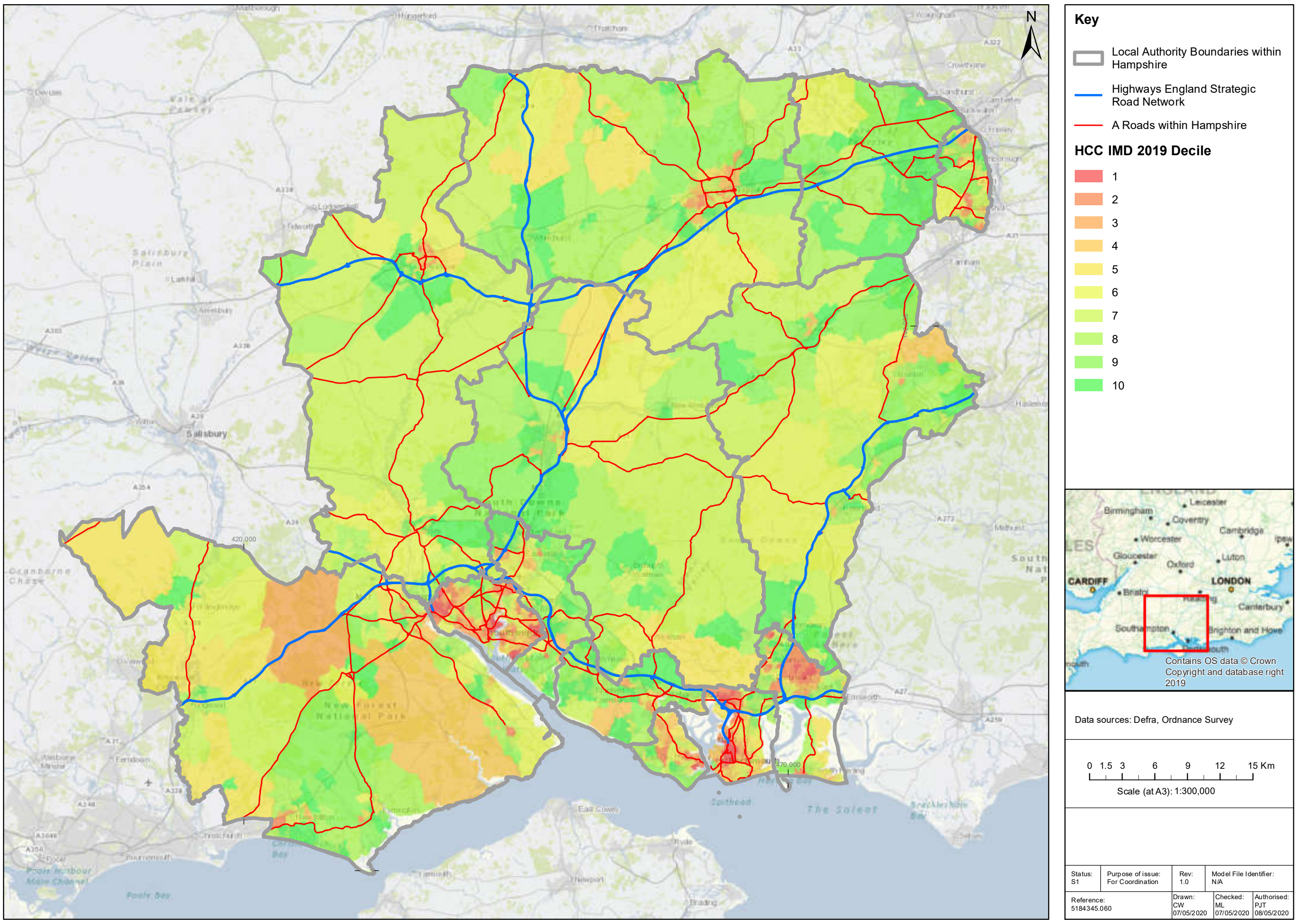
Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW.
www.atkinsglobal.com

Figure Notes:

- 4 early years centres (day care, nursery, preschool) within AQMAs
- 3 primary schools within AQMAs
- 1 secondary school within an AQMA
- 4 GP surgeries within an AQMA
- 3 primary and secondary schools within 100m of HE strategic road network
- 53 primary and secondary schools within 100m of A roads

Urban centres with a high density of major roads also experience some of the worst deprivation, specifically areas within Portsmouth, Southampton, Gosport and Havant.

Figure 10-4 - Deprivation ranking across HCC



Project: \\wsatkins.com\project\GBEMB\MandI\Air&Sustainability\Jobs\519\5194345.060 HCC AQ Manual\06 GIS\CH10\Figure 10.4-IMD_Deciles_v1.1.mxd

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As shown in Table 10.1, Hampshire experiences less deprivation, when compared to the country as a whole, with the majority (67%) of the population within the four least deprived deciles. Notable exceptions are areas of relative high deprivation in Havant and Gosport. These areas, as shown on Figure 10.1, also have higher background NO_2 concentrations.

Table 10.1 – Proportion of LSOA areas in each decile by Local Authority area

Local Authority	Index of Multiple Deprivation (IMD) Decile (1=most deprived 10% in country; 10=least deprived 10% in country)									
	1	2	3	4	5	6	7	8	9	10
Basingstoke and Deane	0%	1%	7%	10%	7%	6%	11%	15%	17%	25%
East Hampshire	0%	0%	1%	7%	3%	10%	11%	17%	31%	21%
Eastleigh	0%	1%	4%	4%	4%	10%	8%	13%	21%	35%
Fareham	0%	1%	4%	3%	4%	7%	4%	18%	26%	33%
Gosport	2%	11%	13%	9%	17%	6%	15%	4%	15%	8%
Hart	0%	2%	0%	2%	0%	5%	2%	9%	14%	67%
Havant	8%	22%	5%	5%	8%	12%	9%	12%	12%	9%
New Forest	0%	3%	4%	6%	11%	14%	11%	18%	12%	19%
Rushmoor	0%	5%	9%	7%	14%	7%	19%	7%	19%	14%
Test Valley	0%	1%	4%	6%	7%	8%	24%	11%	8%	30%
Winchester	0%	0%	1%	4%	9%	6%	14%	13%	19%	34%
Total Hampshire	**1%**	**4%**	**5%**	**6%**	**8%**	**9%**	**12%**	**13%**	**17%**	**26%**

Distributional impacts of changes to local air quality from strategic transport schemes on children, the elderly and deprived communities can be assessed following DfT's WebTAG appraisal methodology[130]. The TAG appraisal method provides a high-level assessment method suitable for scoping and option comparison. The data needed is readily available from HCC Demographics and GIS teams.

10.4. Protection policy

Action on transport emissions should prioritise not just those locations where there are high pollutant concentrations, but also where the most vulnerable are co-located.

10.5. Emerging issues

An inquest will be heard in 2020 into the death of a 9 year old girl in 2013, to consider whether her right to life was breached by London's poor air quality. The girl, who lived adjacent to one of London's busiest A-roads died following an asthma attack having suffered poor respiratory health for several years. The case may lead to air quality being listed as the direct cause of death and thus pave the way for further action from national and local government where legal limits are breached and a risk to health is therefore evident.

[130]https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal

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