Suffolk County Council

Public Health Suffolk

Suffolk Air Quality Profile

June 2021

Report author:

Sara Dunling-Hall, Speciality Registrar in Public Health, Public Health Suffolk, Suffolk County Council

Report co-author:

Jane Hallinan, Health Protection Manager, Suffolk County Council

Consultant lead:

Dr Padmanabhan Badrinath - Consultant in Public Health Medicine, Public Health Suffolk, Suffolk County Council

Acknowledgements:

Matthew Axton, Environment Officer, West Suffolk Council
Andrew Coleman, Environmental Health Officer, Ipswich Borough Council
Kit Day, Lead Analyst, Public Health Suffolk, Suffolk County Council
Sharon Payne, Principle Transport Planner, Growth, Highways and Infrastructure, Suffolk County Council
Marc Rolph, Health Protection Manager, Public Health Suffolk, Suffolk County Council
Ricardo Energy and Environment

1. Executive Summary

Air pollution is associated with several harmful health impacts and disproportionally affects the most vulnerable members of Suffolk's population. Breathing poor quality air from a young age can adversely affect children's development and impact their health as an adult.

The aim of the Suffolk Air Quality (AQ) profile is to increase local knowledge and to act as a catalyst for further action. This will be achieved by describing:

1) the impact of poor air quality on the public's health
2) identifying areas of concern within Suffolk
3) what can be done to mitigate the harmful impact of poor air quality

Air pollution causes diseases of the heart and lungs, contributes to poor public health, shortens life and is recognised as a contributing factor in the onset of heart disease and cancer. There is also often a strong correlation with inequalities, as areas with poor air quality are also often less affluent. Air pollution is harmful for human health at all levels, even when levels fall below the legal limits. However, there is limited knowledge across the population of its harmful effects and measures that can be taken individually and across sectors to improve air quality (1).

Therefore, it is not only important to improve air quality overall but also to improve population knowledge and data knowledge on the scale of the problem and the various measures that can be put in place to support the improvement of air quality across Suffolk.

Air pollutants are emitted from a range of both man-made and natural sources. Many everyday activities such as transport, industrial processes, farming, energy generation and domestic heating can have a detrimental effect on air quality. Two of the key pollutants are Particulate Matter (PM) and Nitrogen Dioxide (NO2). These have the greatest impact on health at levels currently seen in the UK (2).

Air quality across most of Suffolk is reasonably good, however there are areas where air pollutant concentrations are high and breach the Air Quality Objectives particularly in and around Ipswich. The majority of data available related to AQ is gathered from either diffusion tubes or sensors capturing emissions for localised areas or from models developed with data gathered outside Suffolk. Although monitoring is important, especially when looking at localised emissions, the key focus should be on actions which help to mitigate air pollution in Suffolk.

A considerable number of schemes and campaigns are already in place across Suffolk which support active and green travel, reduce emissions from vehicles and improve the knowledge of the population and professionals, but more can be done. A database of the schemes, the locations, impact and potential funding sources would allow local residents to replicate successful schemes - as well as local authorities, councils and larger employers - without duplicating the work required to develop protocols and reducing the cost.

There is responsibility at every level to improve air quality from national and county legislation to individual school campaigns such as anti-idling and personal choice on the use log burners as an example. Everyone has the opportunity to make positive changes to improve Air Quality, however, as it covers such a vast area it can be overwhelming to know where to start and if personal changes made will have an impact. By improving the general populations baseline knowledge of Air Quality, the impact it has on health and how personal choice can improve it, a legacy can be made. Small changes, by many, add up.

Suffolk's Air Quality Profile supports continued efforts to increase understanding of the public health impact of poor air quality on health in Suffolk. The following actions set out to strengthen the system and the county council's response to poor air quality:

1) Providing training and resource to increase the technical knowledge of officers such as transport, spatial planners, elected members and wider partners on impact of air quality on health and the actions which can be taken to mitigate.
2) Strengthening wider communication to the public on health impacts of air quality.
3) Undertaking further research at local level on links between air quality and health in Suffolk.
4) Mapping and sharing current interventions and good practice.
5) Developing a County council strategy to describe the levers Suffolk County have to positively impact on AQ and consider how to optimise.

Contents

2. Introduction

Poor air quality is the largest environmental risk to public health in the UK, with estimates showing that long-term exposure to man-made air pollution reduces life expectancy in the UK by an average of seven to eight months and up to 50,000 people a year may die prematurely because of it.

Long-term exposure to air pollution can result in a reduction in life expectancy, mainly due to associated contributions to the development of cardiovascular and respiratory diseases, including lung cancer. Short-term exposure (over hours or days) to air pollution can also cause a range of health impacts, including lung function and complications with asthma. It is also linked to increases in respiratory and cardiovascular hospital admissions and deaths.

As well as having a negative impact on health, there are also significant cost implications of air pollution. The Environment Audit Committee estimates the cost of health impacts of air pollution in the UK likely to exceed to £20 billion (1).

The aim of the Suffolk AQ profile is increase local knowledge, and to act as catalyst for further action. This will be achieved by describing:

1) Highlighting the impact of poor air quality on the public's health,
2) identifying areas of concern within Suffolk
3) identifying what can be done to mitigate the harmful impact of poor air quality

1.1.1. Understanding the Issue

Air pollutants are emitted from a range of both man-made and natural sources. Many everyday activities such as transport, industrial processes, farming, energy generation and domestic heating can have a detrimental effect on air quality.

Historically, the main air pollution problem in the UK has included high levels of smoke and sulphur dioxide emitted from fuels such as coal used for domestic and industrial purposes. In recent years, evidence has emerged that particles emitted to the air from various sources, such as road transport, industry, agriculture, and domestic fires, are still having a considerable effect on health. This type of air pollution is so small that it cannot be seen by the naked eye but can get into the respiratory system and cause harm.

Two of the key pollutants are Particulate Matter (PM) and Nitrogen Dioxide (NO2). These have the greatest impact on health at levels currently seen in the UK (2). The following section provides further detail on these and other pollutants affecting air quality.

1.1.1. Monitoring Air Quality

Monitoring of air quality in Suffolk focuses on NO2 and is predominately undertaken using diffusion tubes and a small number of real time continuous monitors. Diffusion tubes are small plastic test tubes that contain a chemical that reacts with the air and are often mounted on lamp posts. They passively monitor the air for approximately a month before being sent to a laboratory for analysis. Continuous monitoring equipment are larger devices which can monitor a number of pollutants providing regular live data. While the diffusion tubes provide information on the local area, they are not sufficient to provide information on air quality across the county. A lot of the information currently available on AQ across Suffolk is based on models developed with local and national data with information on PM2.5 gathered from sensors that are set up in areas outside Suffolk. While the models provide evidence on some high-risk areas, data from sensors within Suffolk would provide a better baseline on areas that haven't yet been identified by the models in order to develop targeted interventions.

1.1.1. Particulate matter (PM)

Particulate Matter (PM) is a generic term used to describe a complex mixture of solid and liquid particles of varying size, shape, and composition. Some particles are emitted directly (primary PM), while others are formed in the atmosphere through complex chemical reactions (secondary PM). The composition of PM varies greatly and depends on many factors, such as geographical location, emission sources and weather. While the effects of PM can be seen locally, they do not always originate from local sources as they can travel vast distances. This creates difficulties when developing measures to reduce the volume of PM locally.

The main sources of man-made PM are the combustion of fuels (by vehicles, industry and domestic properties) and other physical processes such as tyre and brake wear. Natural sources include wind-blown soil and dust, sea spray particles, and fires involving burning vegetation.

PM is often classified according to aerodynamic size and referred to as:

- coarse particles (PM_{10}; particles that are less than 10 microns (µm) in diameter)
- fine particles ($PM_{2.5}$; particles that are less than 2.5 µm in diameter)
- ultrafine particles ($PM_{0.1}$; particles that are less than 0.1 µm in diameter)

The size of particles and the duration of exposure are key determinants of potential adverse health effects. Particles larger than 10 µm are mainly deposited in the nose or throat, whereas particles smaller than 10 µm pose the greatest risk because they can be drawn deeper into the lungs. The strongest evidence for effects on health is associated with fine particles ($PM_{2.5}$).

Evidence shows that long-term exposure to PM increases mortality and morbidity from cardiovascular and respiratory diseases [4]. There is some evidence that ultrafine particles may also pass through the lungs into the bloodstream [4].

1.1.2. Nitrogen dioxide (NO_2)

NO_2 is a very localised gas that is produced along with nitric oxide (NO) by combustion processes. Together they are often referred to as oxides of nitrogen NO_2).

The Department for Environment, Food & Rural Affairs (Defra) estimates that 80% of NO_2 emissions in areas where the UK is exceeding NO_2 limits are due to transport, with the largest source being emissions from diesel light duty vehicles (cars and vans) (3). Other sources include power generation, industrial processes, and domestic heating.

The Committee on the Medical Effects of Air Pollutants (COMEAP) has established that short-term exposure to NO_2, particularly at high concentrations, is a respiratory irritant that can cause inflammation of the airways leading to coughing, production of mucus and shortness of breath (4). Studies have shown associations of NO_2 with reduced lung development, and respiratory infections in early childhood and effects on lung function in adulthood [5].

Studies have also shown associations of NO_2 with adverse effects on health, including reduced life expectancy (5). It has been unclear whether these effects are caused by NO_2 itself, or by other pollutants emitted at the same time by sources such as road traffic.

1.1.3. Sulphur dioxide (SO2)

SO_2 is produced when sulphur-containing fuels, such as coal, are burned. It is an invisible gas with a sharp smell and can dissolve in water. Chemical reactions of SO_2 can also produce sulphates, which remain in the air as secondary particles, contributing to the PM mix.

SO_2 has an irritant effect on the lining of the nose, throat and airways, and the effects are often felt very quickly. Due to the increased use of gas and electricity, coal-burning is now relatively uncommon, and levels of SO_2 have steadily declined over the last 50 years. Most SO_2 in the UK now comes from industrial sources, such as coal and oil-burning power stations, as well as domestic sources such as boilers and stoves.

1.1.4. Ammonia (NH_3)

Ammonia is a gas released into the atmosphere from natural and man-made sources. Once emitted into the atmosphere, the subsequent accumulation of NH_3 can be a major source of pollution, causing nitrogen (N) enrichment (eutrophication) and acidification of soil and water sources. Atmospheric NH_3 also reacts with acid gases, such as sulphuric and nitric acid, to form secondary $PM_{2.5}$.

The main health impacts of NH_3 arise through its role in secondary $PM_{2.5}$ formation and health effects associated with exposure to PM, as described above. Agricultural emissions of NH_3 have been reported to be a key contributor to some short-term episodes of high PM pollution in recent years [6].

1.1.5. Ozone (O_3)

Ozone is a gas and occurs both in the earth's upper atmosphere and at ground level. Ground level, or tropospheric (lower atmosphere) O_3, is not emitted directly into the air but is created by photochemical reactions involving the pollutants NO_x and volatile organic compounds (VOCs).

The effects of short term exposure to O_3 are predominantly respiratory, but adverse effects on the cardiovascular system have also been reported (6). Less convincing evidence exists for an association between long-term exposure to O_3 and impacts on human health [6].

1.1.6. Carbon monoxide (CO)

CO is a colourless, odourless and tasteless gas, produced when fuels such as gas, oil, coal and wood burn without enough oxygen. These are sources of fuel used in many household appliances, including boilers, central heating systems, gas fires, water heaters, cookers and open fires. Burning charcoal, running cars and the smoke from cigarettes also produce CO gas. Exposure to high indoor levels can be fatal, while exposure to lower levels can result in symptoms that resemble flu, viral infections or food poisoning.

1.1.7. Non-Methane Volatile Organic Compounds (NMVOCs)

NMVOCs consist of a large variety of chemically different compounds that are created both naturally and through human activity. Although NMVOCs originating from human activity in the UK did see a decrease of 68% between 1970 and 2016, mainly due to the decline in coal mining, this decrease has slowed in recent years.

NMVOCs are emitted from a wide variety of sources including industrial processes and agriculture, and they also form a significant component of indoor air pollution emitted from household products.

Outside, NMVOCs react with NO_x in the presence of sunlight to form ozone, known to be harmful to health and the environment.

Indoors, VOCs emitted from consumer products are not thought be to a significant public health issue when homes are well ventilated and when products are used according to the manufacturers' instructions. However, some people may suffer irritation of the eyes, nose and throat, headaches and dizziness if they are exposed.

Figure 1 shows a Public Health England diagram detailing the sources of air pollution such as energy industries, non-road transport, road transport, agriculture, industrial processes and residential and small-scale commercial combustion. Fugitive emissions, which are unintentional leaks emitted from sealed surfaces, such as packings and gaskets, or leaks from underground pipelines resulting from corrosion or faulty connections, also contribute to overall levels of air pollution. As this shows, policies to improve air quality must be multi-factorial and cover action at both the individual and collective level.

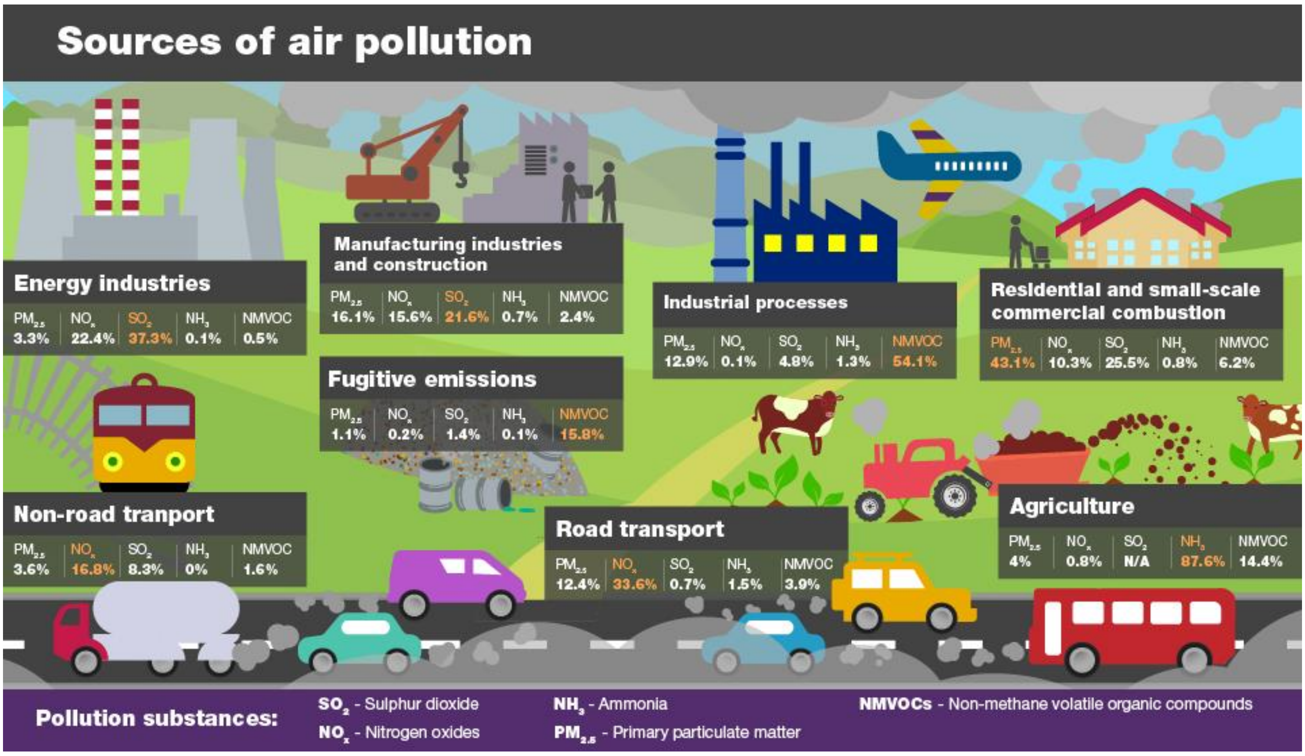

Figure 1 Sources of Air Pollution, Public Health England (7)

1.1.8. Indoor air pollution

As well as outdoor air pollution there are multiple sources of indoor air pollutants that can harm health. These include:

- Carbon monoxide, nitrogen dioxide and particulates from domestic appliances (boilers, heaters, fires, stoves and ovens), which burn carbon containing fuels (coal, coke, gas, kerosene and wood)
- Volatile Organic Compounds from cleaning and personal care products, building materials and household consumer products (paints, carpets, laminate furniture, cleaning products, air fresheners, polishing)
- Environmental tobacco smoke (ETS) and secondhand smoke (SHS)
- Radon is a colourless, odourless radioactive gas. It is formed by the radioactive decay of the small amounts of uranium that occur naturally in all rocks and soils. Suffolk is a low risk area for this. It can accumulate in buildings and there is an increased risk of lung cancer if exposed to high levels of radon for a long time.

1.1.2. Air Pollution and Health – Impact of Air Pollution across a Lifetime

When air pollutants enter the body, they can have effects on various organs and systems, not just the respiratory system.

This includes:

- the eyes, nose and throat
- the lungs and respiratory system
- the heart – heart and blood vessel diseases, including strokes and hardening of the arteries, are one of the main effects of air pollution
- Emerging evidence suggests that air pollution may also affect the brain and is possibly linked to dementia and cognitive decline. There is also emerging evidence associating air pollution with early life effects such as low birth weight

Air pollution can affect everyone, and air in all areas of the UK contains some proportion of human-made air pollutants. Exposure to air pollution has numerous health effects, which come about at every stage of life, from the first weeks in the womb all the way through to old age. The health effects of air pollution are complex, and range in severity of impact. In some cases, damage can be gradual and may not become apparent for many years.

The three main conditions associated with air pollution are respiratory conditions (such as asthma), cardiovascular disease (CVD), and cancers including lung cancer. There is also emerging evidence for associations with dementia, low birth weight and type 2 diabetes [6]. COMEAP has highlighted that exposure to air pollution contributes to many thousands of deaths in the UK each year, through increasing the risk of CVD, respiratory disease and cancers [6]. There is therefore a strong case for action to tackle air pollution and improve air quality.

Figure 2 is a Public Health England diagram that summarises the various health effects and conditions that air pollution can cause at different stages of life. This is based on the Royal College of Physicians' report, 'Every breath we take: The lifelong impact of air pollution' (8) which presents the findings of multiple international studies regarding each of these health effects.

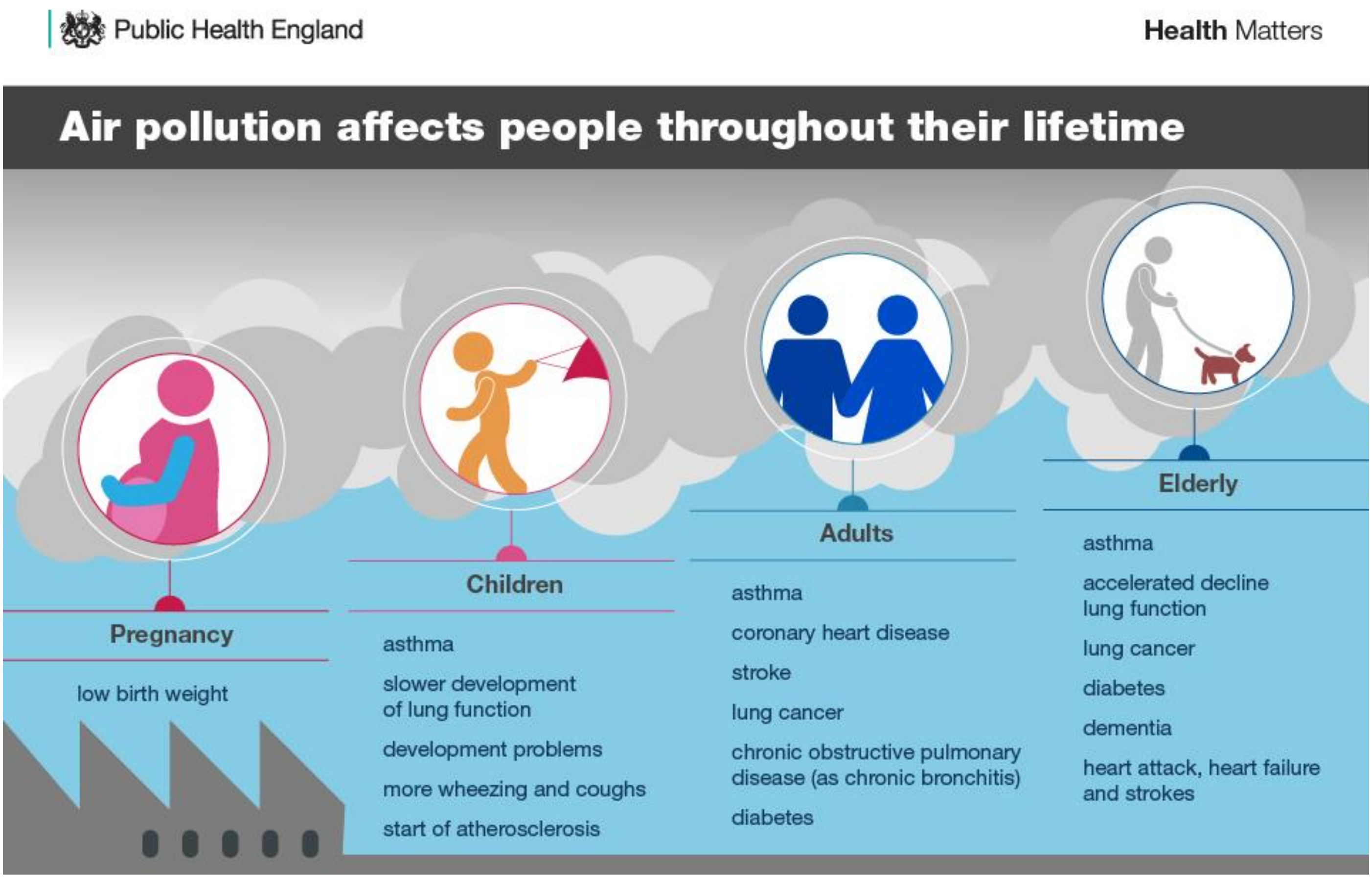

Figure 2 Major Health Impacts of air pollution, Public Health England (7)

1.1.3. Air Pollution and Health – Future Impact of Air Pollution

'Estimation of costs to the NHS and Social Care due to the health impacts of air pollution' (9) is a report and toolkit developed by Public Health England that models:

- future cases of air pollution related diseases
- the NHS and social care costs: specifically, primary care, prescription, secondary care, and social care, associated with air pollution.

The modelling in this report estimates that within the UK there will be:

- 2,248 new cases of different diseases per 100,000 people attributable to $PM_{2.5}$ between 2017 and 2035, with the highest number of cases predicted to be in the form of coronary heart disease.

- 1,933 new cases of disease per 100,000 attributable to NO_2, with the highest number of cases thought to be from diabetes and asthma. It should be noted that the evidence associating NO_2 and diabetes is weaker than that linking NO_2 and asthma.

1.1.4. Air Pollution and Inequalities

Although air pollution can be harmful to everyone, some people are more affected because they live in a polluted area, are exposed to higher levels of air pollution in their day-to-day lives or are more susceptible to health problems caused by air pollution. The most vulnerable may face all of these disadvantages.

Groups that are more affected by air pollution include:

- older people
- children
- individuals with existing CVD or respiratory disease
- pregnant women
- communities in areas of higher pollution, such as close to busy roads
- low-income communities

1.1.5. Responsibilities to Improve Air Quality

Improvements to air quality can be made at various levels from individual personal choices, through to national legislation. However more locally it is important to know where responsibilities lie with regards to improving air quality across Suffolk. Table 1 outlines this for district and borough councils and county council with further information on responsibilities below. The role of Public Health & Communities is to provide information and support on the health-based implications of air quality at a population level. We facilitate this by bringing together the key stakeholders who may not normally meet for air quality issues or may only be considering the environmental aspects.

Responsibility	District Councils	County Council
Local Air Quality Management (LAQM) process		
Review and assessment of local air quality	District councils should carry out periodic review and assessment of air quality within their area. The results of this review and assessment should be set out in the Annual Status Report (ASR).	County councils have a number of obligations under LAQM including proactively engaging with the district council as soon as an air quality issue is identified.
Designation of Air Quality Management Area (AQMA)	District councils are required to designate an AQMA when, as a result of the review and assessment, it appears that any of the air quality objectives are not being achieved.	Where a district council is preparing an action plan, county councils are obliged to submit measures related to their functions (i.e. local transport, highways and public health) to help meet air quality objectives in their local area.
Preparation of air quality action plans	Once an AQMA has been designated the district council should prepare an action plan that sets out how it will achieve the	There is now strong evidence about the significant contribution of transport emissions to air pollution in urban areas

	air quality standards or objectives for the area that it covers.	and the government expects county councils to bring forward measures in relation to addressing the transport impacts in its area for inclusion in any action plan.
Engagement and consultation	Engagement with the county council should take place at the start of the process. In reviewing and assessing air quality in a local authority area, or preparing an action plan, the district council should take into account any recommendations made by the county council. The district council should consult on its action plan, and is expected to make a copy of the plan and ASR freely available for public inspection.	The county council is a consultee to ASRs and action plans. The county council may make recommendations to the district council in relation to any review and assessment of air quality - or development or amendment of - action plans in the local authority area.
Local Transport Plan and Local Plans		
Local plan and development control	Local plans can affect air quality through the location, types of development proposed and the level of encouragement given to sustainable transport. In plan making, it is important to consider AQMAs and other areas where there could be specific requirements or limitations on new development because of air quality. The local plan may need to consider: • cumulative impact of a number of smaller developments on air quality as well as the effect of more substantial developments; • the impact of point sources of air pollution; • ways in which new development would be appropriate in locations where air quality is or likely to be a concern and not give rise to unacceptable risks from pollution • Air quality can be a material consideration in planning decisions, normally relating to pollution from additional traffic but also point sources	
Local Transport Plan		Integrating Air Quality Action Plans with Local Transport Plans (LTP) is strongly encouraged and will need partnership working in two-tier and metropolitan areas. It is important that LTPs are effectively coordinated with air quality, climate

		change and public health priorities – measures to achieve these goals are often complementary. New road schemes require assessment for their AQ impacts using prescribed methodologies.
Other Controls	Vehicle idling is an offence against the Road Traffic (Vehicle Emissions) (Fixed Penalty) (England) Regulations 2002. The law states that is an offence to idle your engine unnecessarily when stationary. If you fail to turn your engine off after being spoken to you may be issued with a fixed penalty notice of £20. This can be enforced by the police but local authorities can also apply to take up this power	
Other Regulators		
Industrial pollution - regulators (Environment Agency, Local Authorities) have a duty to consider Local Air Quality Management when discharging their pollution control functions under: vironmental Permitting Regulations egrated Pollution Prevention and Control cal Authority Pollution Prevention and Control cal Authority Integrated Pollution Prevention and Control		

Table 1. Responsibilities of AQ matters at administrative levels

Local Authorities

Local authorities have a statutory role in assessing and improving local air quality, and the cumulative effects of this local action are significant. A strategic approach involving a combination of legislative, policy, behavioural and technological interventions is required to realise the greatest benefits.

Councils can:

- invest in infrastructure and public transport, and promote active travel and cycle routes
- implement measures to reduce air pollution caused by road traffic and other sources
- design healthy environments, bringing in spatial planning, urban design, road and building layouts, and green spaces

Public Health England suggest that pedestrians, cyclists, and users of other modes of transport that involve physical activity should have the highest priority when developing or maintaining streets and roads (7).

This can mean:

- reallocating road space to support walking and cycling
- restricting motor vehicle access
- introducing road-user charging and traffic-calming schemes
- creating safe routes to schools

- improving or adding green spaces and tree cover improves air quality, as well as making spaces feel more welcoming
- implementing small-scale improvements, such as good street lighting or improved road crossings

Taking effective local action to reduce air pollution and improve public health requires an inclusive, multi-disciplinary approach across local authority functions involving planning, transport, environmental and public health teams, local political and community leaders and the public. Coordination between local areas is also vital to align approaches and avoid displacement of pollution from one populated area to another.

1.4.2. The Health Service and Healthcare Professionals

The causes of air pollution and climate change are often the same, and with the health and care system in England responsible for an estimated 4-5% of the country's carbon footprint, the NHS has an important role in improving air quality as well (25).

Health professionals and local government have an important part to play in helping the public to understand the health effects of air pollution and offering their patients advice on managing their conditions, as well as actions they can take to reduce their day-to-day and lifetime exposure to air pollution.

To avoid exposure to high levels of air pollution, it is important to be aware of air quality. People can do this by keeping an eye on online updates from relevant organisations, such as Defra's Pollution forecast (10) and air quality updates on social media through Defra's twitter feed (11) . Defra's Daily Air Quality Index (DAQI) (12) provides recommended actions and health advice for both the general population and for at-risk individuals. The index is numbered 1 to 10 and divided into 4 bands (low [1] to very high [10]) to explain air pollution levels in a simple way.

1.1.8. The Public

There are many actions that can be taken at an individual level, and although these may seem small, the collective impact on air pollution could be substantial.

One of the many actions people can take, to reduce both their exposure and how much they contribute to air pollution, is to consider their travel options. Even using a petrol car rather than a diesel can make a big difference, especially in towns and cities where NO_2 levels are likely to be highest.

The Department for Transport reported that in 2016, 67% of the usual mode of travel to work was by car or van. If the journey is less than a mile, walking or cycling are preferable, especially as active travel has the additional benefits of improving physical and mental health and quality of life. Using public transport also makes a difference, as it reduces the number of cars on the road.

If driving is the only option, congestion can be reduced if people are able to avoid travelling during morning and evening rush hours. Driving economically, such as accelerating gently, adhering to speed limits, and ensuring tyre pressures are correct, saves money by using less fuel, reduces the number of road collisions and reduces air pollution. People can also reduce pollution by turning off their engines when waiting, especially when other people are nearby or when waiting for children during the school run.

Improving our environment and health is not just about day-to-day travel choices. There are lots of day-to-day actions that can reduce emissions. Defra has provided practical guidance on the best use of open fires and wood-burning stoves (13), and turning down central heating and turning off appliances when they are in standby or not in use can all make a difference that adds up over time.

In the longer-term, people can consider lower-emission alternatives when they are buying their next car, updating their home heating system, or carrying out other home improvements. In many cases, the government provides grants or other incentives and installing energy-saving measures and home electricity generation using solar panels or wind turbines can help to reduce our dependence on fossil fuels over time.

1.1.9. Why Invest?

PHE's cost of air pollution project (9) quantified the potential costs to the NHS and social care system due to the health impacts of $PM_{2.5}$ and NO_2 in England. It estimated that between 2017 and 2025, the total cost of air pollutants for which there was more robust evidence for an association, was £1.69 billion for $PM_{2.5}$ and NO_2 combined (£1.54 billion for $PM_{2.5}$ and £60.81 million for NO_2). A tool to estimate the cost of air pollution for each local authority was made available, as part of this project.

Air pollution can impact people of working age, which can also have economic effects, for instance, if they have to take days off work. Defra estimated that in 2012, poor air quality cost the economy £2.7 billion through its impact on productivity (14) .

An example of the cost impact of $PM_{2.5}$ per year in Ipswich, based on this tool, can be found in figure 3. If a do-nothing approach is taken, the cost of $PM_{2.5}$ on health will effectively double from £1.8m/100,000 population in 2021 to £2.2m/100,000 population by 2027.

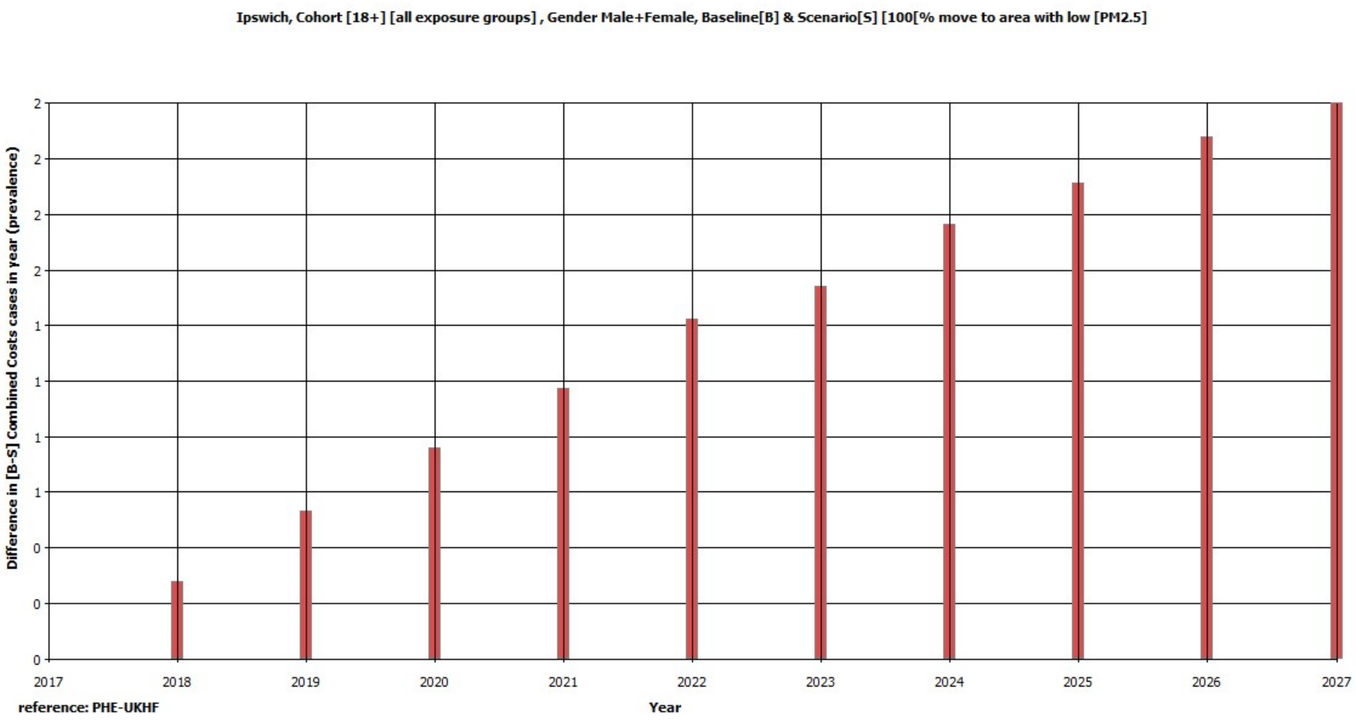

Figure 3. Cost impact of $PM_{2.5}$ per year in Ipswich

Dealing with poor air quality in all its forms is a priority for the government, with the UK having signed up to tougher legally binding national emission ceilings for five major pollutants (PM, NO_2, SO_2, NMVOCs and NH_3). In the recently published Clean Air Strategy (15), the government has committed to reducing the harm to human health from air pollution by halving the population living in areas with concentrations of fine PM above World Health Organization (WHO) guideline levels (10µg/m^3) by 2025.

Air pollution is not an issue that occurs in isolation. Pollution can be associated with other environmental hazards that affect health, and it can contribute to health inequalities. However, measures that improve air quality can also offer wider public health and wellbeing co-benefits, including an improvement in overall environmental quality, increased physical activity, noise reduction, greater road safety and climate change mitigation. Multiple interventions, each producing a small benefit, can act cumulatively to produce significant overall benefits.

2. Air Quality in Suffolk

The majority of information on air quality in Suffolk and UK is modelled. This reflects the fact that it is not cost effective to install monitors across the whole of Suffolk. Models are driven by data on emissions e.g. transport and congestion, industrial sources etc which are then used to identify potential at risk locations for local monitoring.

While air pollution models are inevitably weaker at determining the precise concentrations of pollutants at any given location, they are very good at capturing the variation of different sources of pollution from place to place. This is essential in understanding the problem.

Pollution is also strongly affected by weather patterns, so models allow different weather scenarios to be considered.

To provide an overview of air quality in Suffolk, the following section captures data from various sources:

2.1.1. Overall Air Quality - Indices of Deprivation 2019

The Indices of Deprivation (IoD) 2019 provides a set of relative measures of deprivation for small geographical areas (Lower-layer Super Output Areas - approximately 2000 people or 650 households) across England based on a collection of different domains of deprivation. One of these domains is 'Living Environment Deprivation' which contains a collection of indicators to measure indoor and outdoor living environment.

Data from the air quality indictor from this domain have been used to provide an overview of air quality across Suffolk. This indicator compares the emission rate of four pollutants (nitrogen dioxide, benzene, sulphur dioxide and particulates) for each area to target values set nationally and across Europe (16). In simple terms a value of 1 for a single pollutant means that levels of that pollutant are modelled to be at a level equivalent to the national target value. Full guidance on the composition of this indictor can be found in the IoD 2019 Technical Report (17).

The objective of presenting these heat maps is to provide a comparison of areas across Suffolk rather than give specific details about levels of pollutant. For this information, please see section 2.2.

Figure 4 shows a combined indictor for four of the pollutants examined - modelled to Lower-layer Super Output Area level. In theory, values for the combined indicator range from zero to infinity. However, in practice, values are unlikely to exceed 4: the equivalent of a site where concentrations of all four pollutants are at their respective national standard thresholds.

As Figure 4 shows, some areas have higher levels of air pollution than others within Suffolk. As expected, these tend to be seen in the busier towns within the county (primarily Ipswich, Felixstowe and Bury St. Edmunds). However, it should be noted that there are very localised issues with air quality at smaller geographical areas that will not be identified when looking at data at this level.

Figures 5 and 6 show maps based on IoD data for the single pollutants of nitrogen dioxide and particulates. These individual pollutants follow a similar pattern to that seen in overall IMD concentration scores seen in Figure 4, with the highest levels generally being seen in the busier towns within the county.

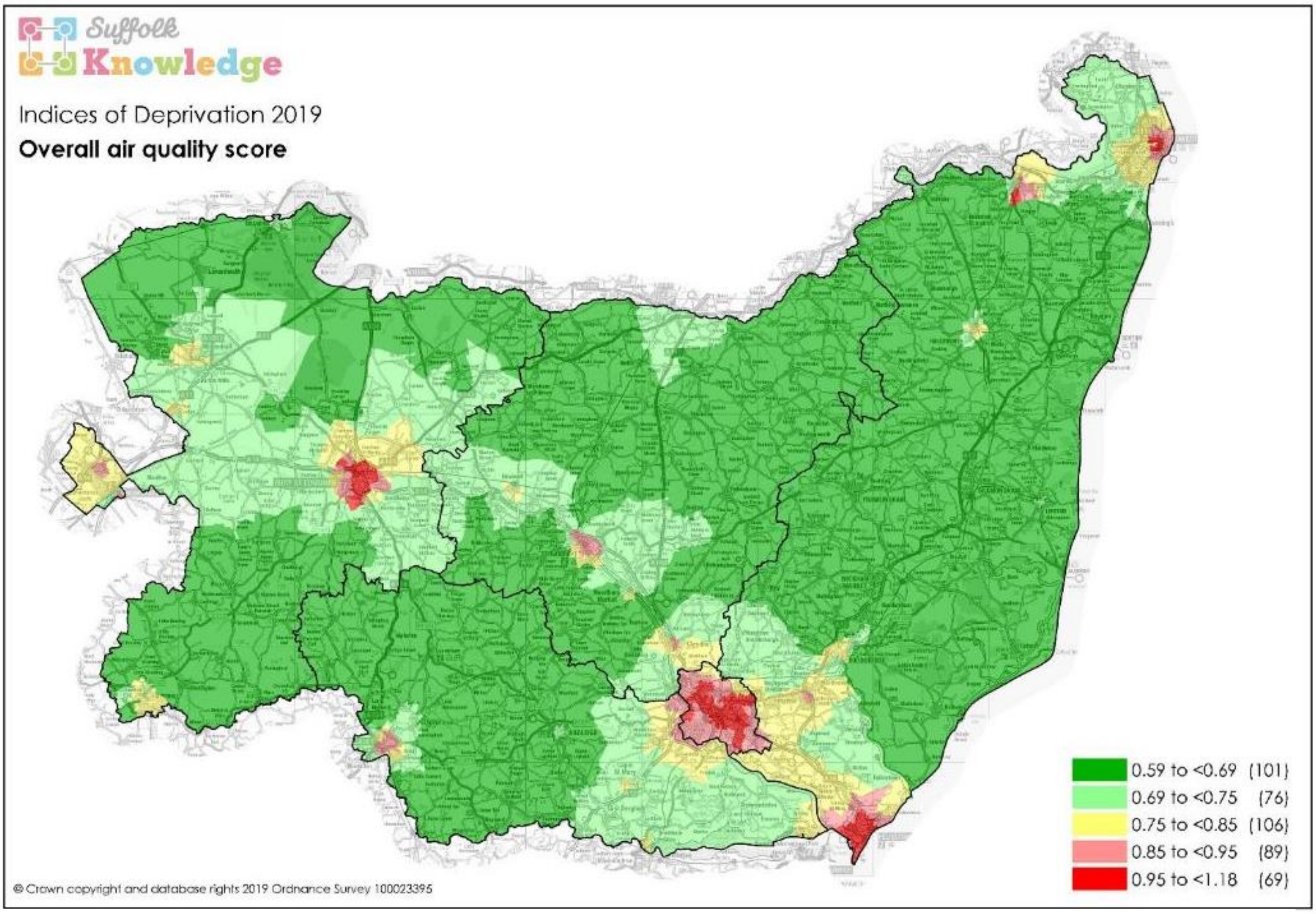

Figure 4 Indices of Deprivation 2019: Overall air quality Score (based on concentrations of four pollutants: nitrogen dioxide, benzene, sulphur dioxide and particulates) data published by the UK Air Information Resource (18)

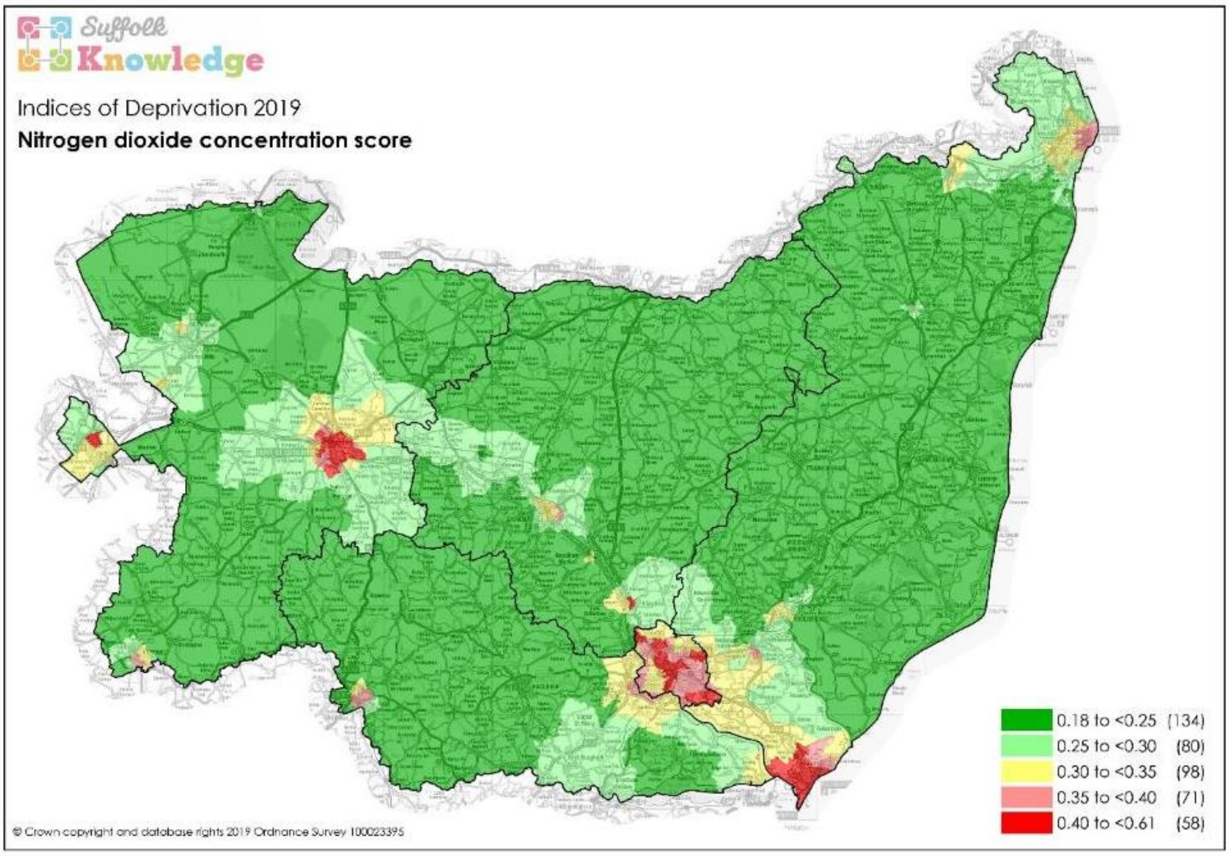

Figure 5 Indices of Deprivation 2019: Nitrogen Dioxide Concentration score (based data published by the UK Air Information Resource (12)

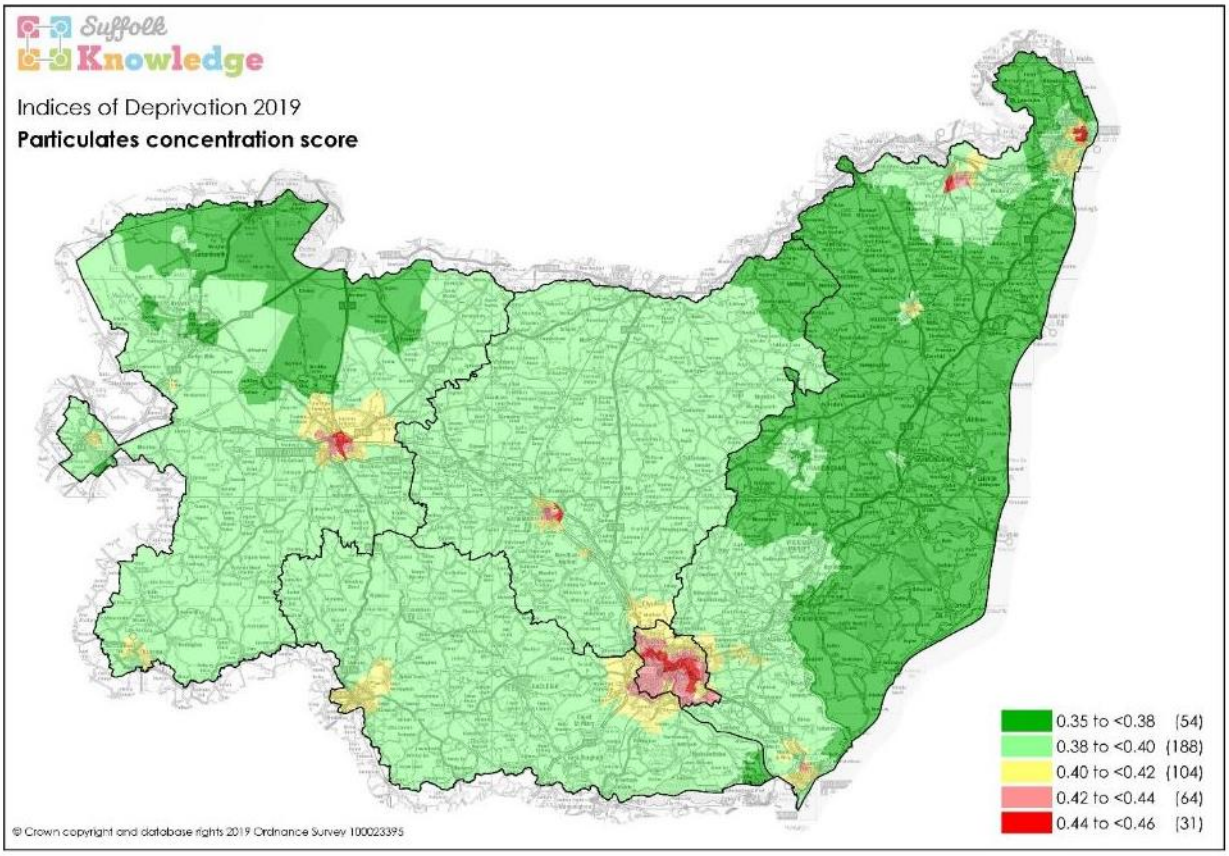

Figure 6 Indices of Deprivation 2019: Particulates Concentration score (based data published by the UK Air Information Resource (12)

2.1.2. Emissions of Oxides of Nitrogen and Particulate Matter (PM_{10})

The major human sources of air pollution are the combustion of fuels for heat, electricity and transport. Road transport accounts for 31% of nitrogen oxides (NOx), 19.5% of $PM_{2.5}$ and 18% of PM_{10} of UK emissions. It frequently accounts for more than 64% of air pollution at urban monitoring sites. This comes from exhausts and other sources such as the wear of tyres, brakes and the road. Non-exhaust sources account for around 21% of $PM_{2.5}$ from vehicles (2).

The UK compiles and reports an annual air pollutant emissions inventory known as the National Atmospheric Emissions Inventory (NAEI) (19). This provides a database of national emissions estimates for air pollutants and greenhouse gases. This data has been used to provide maps of air pollutant emissions and air pollutant concentrations across Suffolk based on a 1kmx1km grid.

Figure 7 shows the modelled emissions of oxides of nitrogen (NO_x) across Suffolk with the highest emissions clearly following the major transport routes.

Figure 8 shows the modelled emissions of Particulate Matter (PM_{10}) across Suffolk with highest emissions mainly based in the larger towns and following the path of the A14: a major connective road across the county.

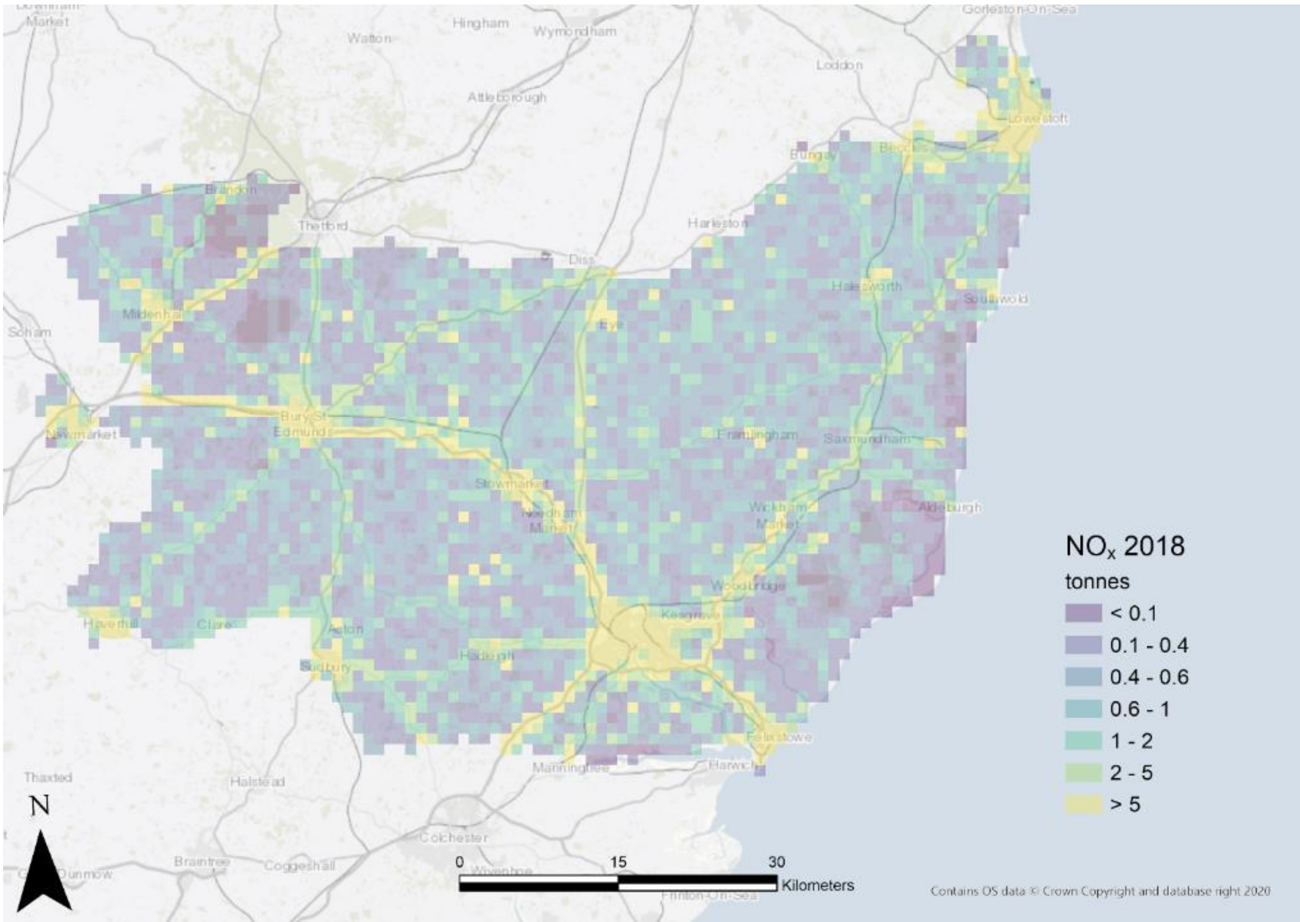

Figure 7 Oxides of Nitrogen emission levels across Suffolk (based on a 1km x1km grid), compiled from NAEI data

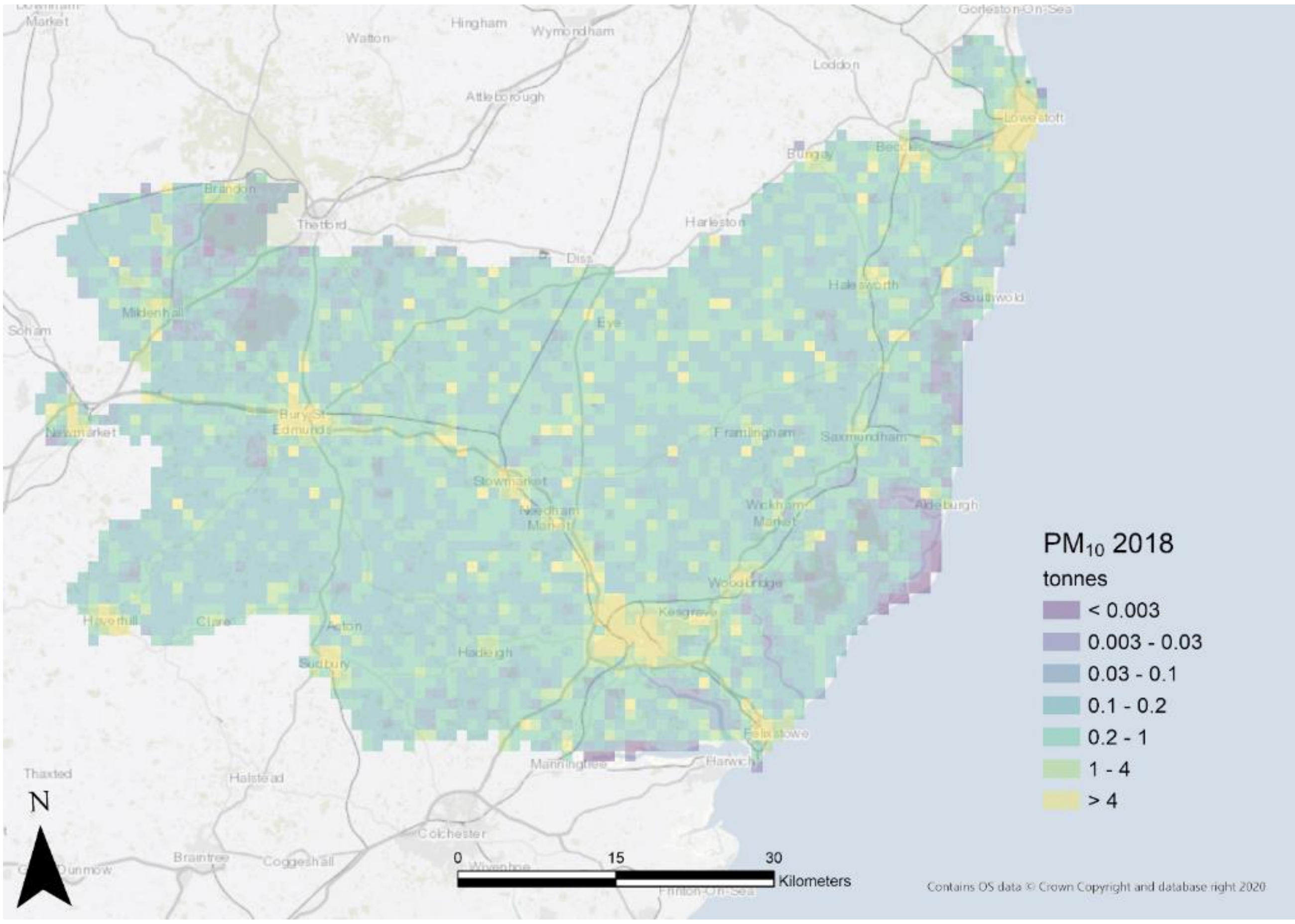

Figure 8 Particulate Matter (PM10) levels across Suffolk (based on a 1km x 1km grid), compiled from NAEI data

2.1.3. Concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10})

In addition to emissions, it is also useful to look at pollutant concentrations in the air. This is because some pollutant particles can travel long distances, meaning there may be air quality issues that need to be considered in areas with low emissions. Particulate matter can travel very large distances and up to 33% of $PM_{2.5}$ originates from non-UK sources and around 15% from natural sources. Strategies to protect human health need to consider both emissions and concentration levels to have the greatest impact.

Figure 9 shows the modelled concentration levels of nitrogen dioxide (NO_2). This demonstrates that concentrations of the NO_2 are typically found near the source and therefore higher levels are evident where higher emissions are recorded, along major transport routes and within Suffolk's main towns. Highest modelled concentration areas are evident at Felixstowe and Lowestoft.

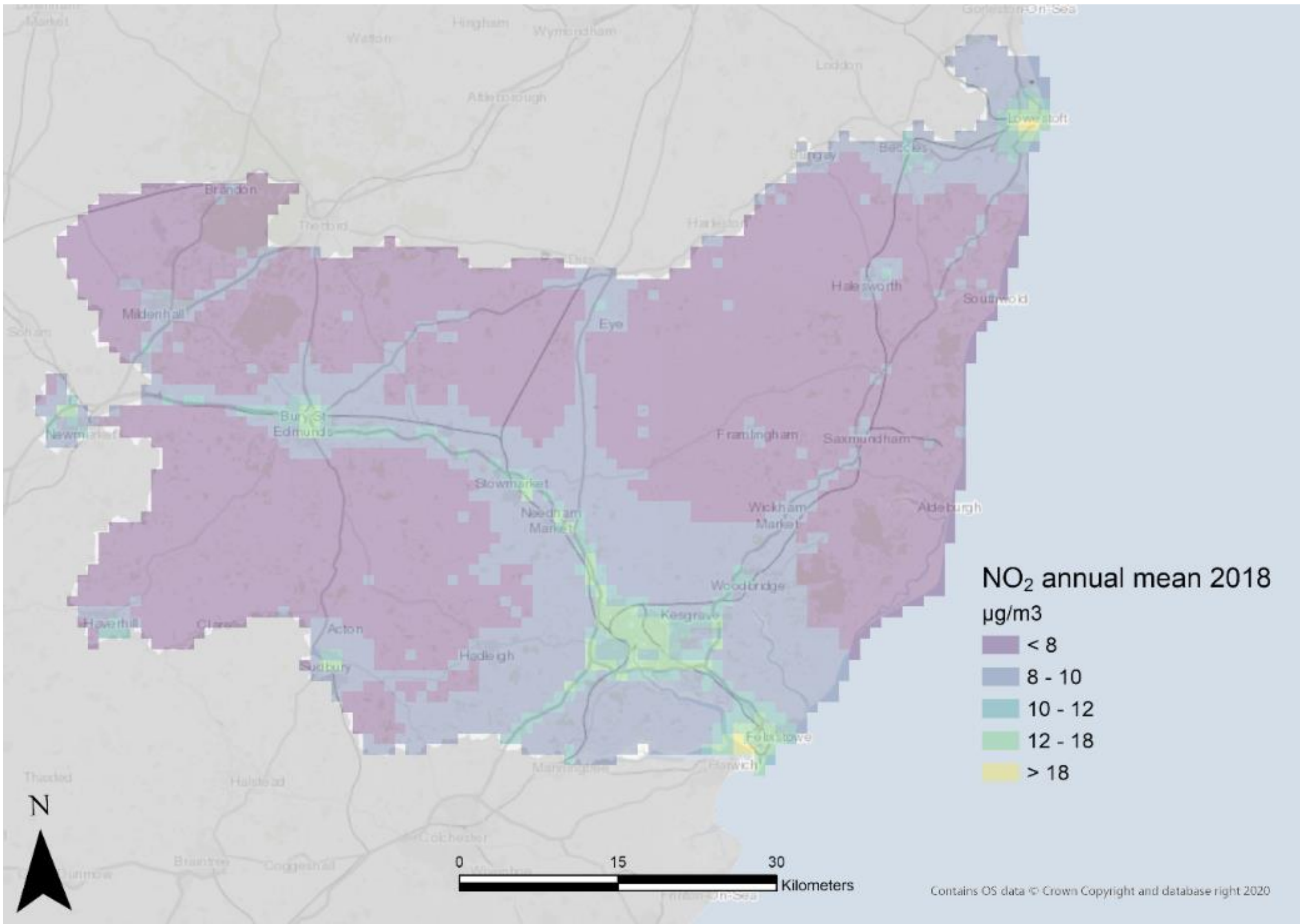

Figure 9 Nitrogen Dioxide Annual Mean 2018 Concentration levels across Suffolk (based on a 1km x 1km grid), compiled from NAEI data

Figure 10 shows that concentrations of Particulate Matter (PM_{10}) are higher along the major transport routes, however the distribution of higher concentration areas does not directly follow emissions patterns. The Lowestoft area is a clear example of this with higher emission levels of PM but lower concentration levels. This may be due to off-shore winds dispersing/carrying the pollutant to other areas.

Contributing factors to the higher concentration levels in Felixstowe and Lowestoft could be the major infrastructures in the local area as shipping is known to be contributing factor to poor air quality. While a great deal of work has been done in both areas to monitor and improve mitigation measures related to NO_2 & PM_{10} it is evident from these figures that there is scope for further work to be done. An example around the work the Port of Felixstowe is doing is reviewed below.

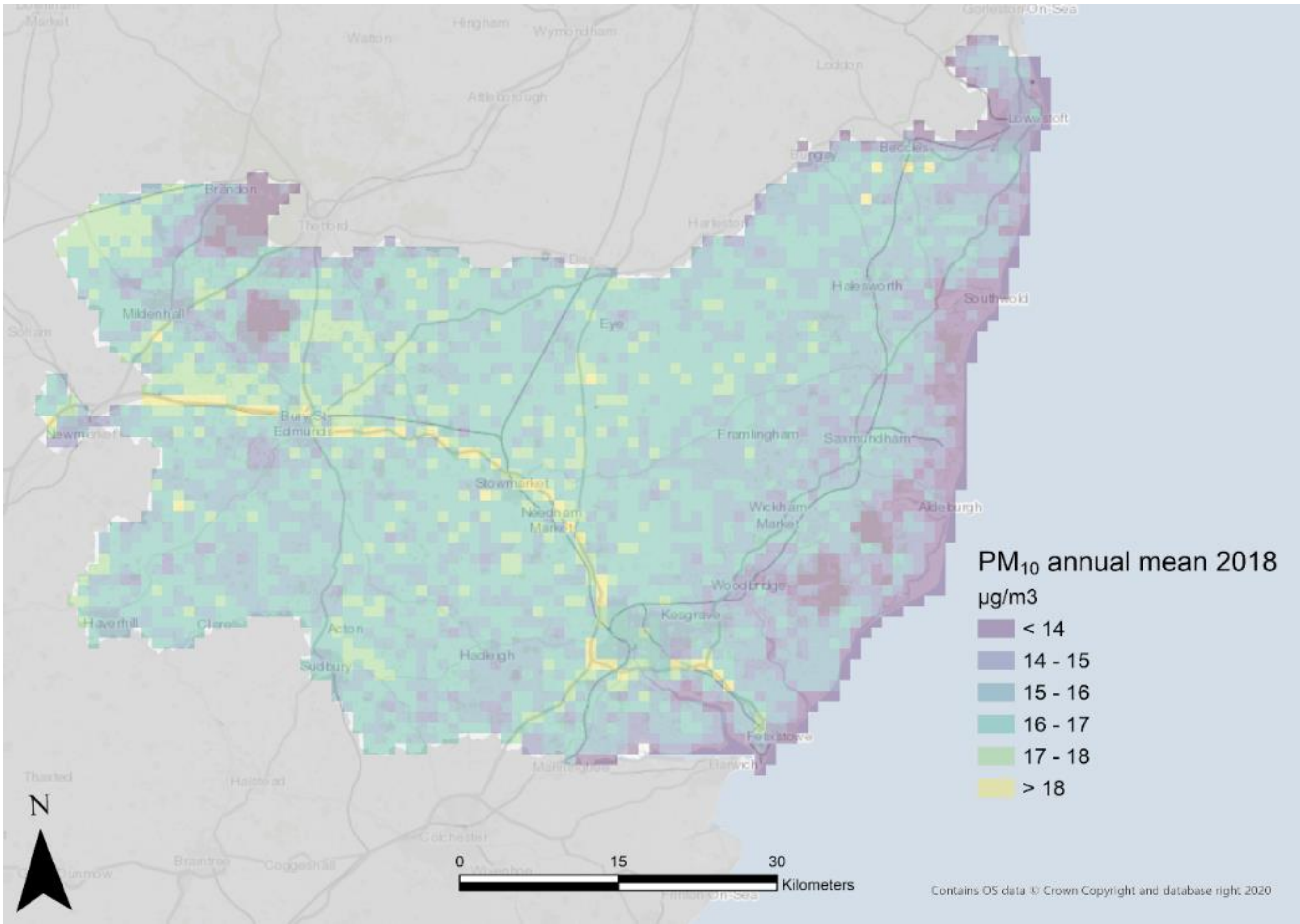

Figure 10 Particulate Matter (PM10) Annual Mean 2018 Concentration levels across Suffolk (based on a 1km x 1km grid), compiled from NAEI data

2.1.4. Emissions Breakdown by Sector

Strategies to improve air quality must be targeted appropriately. To do this, it is important to understand the sources of the key pollutants. Figure 11 shows the different localities across Suffolk with table 2 presenting the breakdown of emissions by different sectors in those areas, summarised by Ricardo with data captured by DEFRA(19, 24). The main pollutants across all district and boroughs from transport and industrial emissions are oxides of nitrogen. However, there is variation across the different geographical areas, with East Suffolk showing a greater proportion of industrial emissions being from particulate matter. The different types of industry across Suffolk will affect the different levels of pollutants.

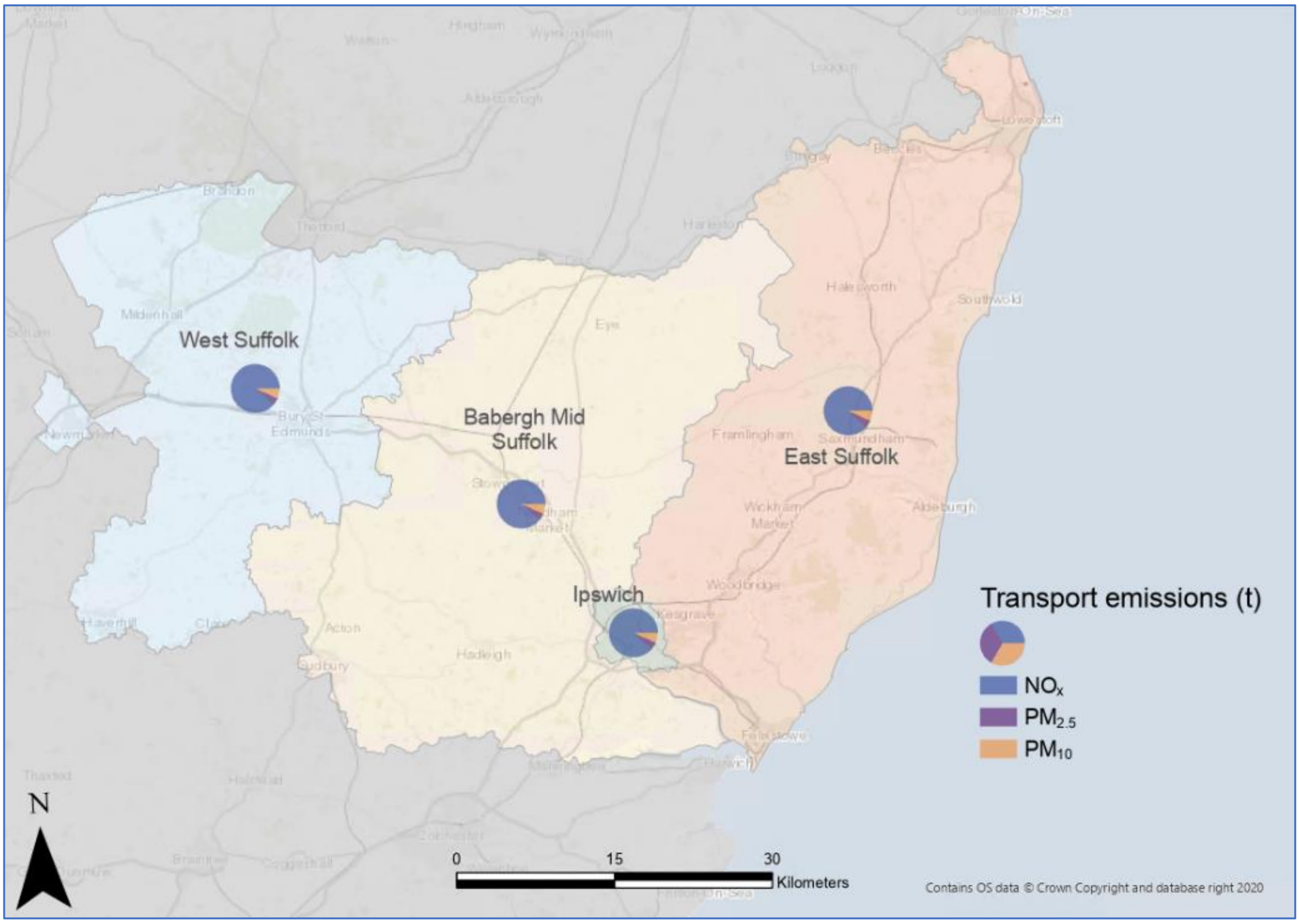

Figure 11 Emission breakdown from transport emissions

Table 2 shows that pollutants released from domestic emissions across Suffolk tend to be a greater proportion of particulate matter than NO_x although there is slight variation across the different district and boroughs. Work is being undertaken to understand what drives the differences in emission across the county, particularly the domestic emissions.

Source	Matter	Ipswich	West Suffolk	East Suffolk	Babergh	Mid Suffolk
Emission breakdown from transport emissions (kt)	NOx	0.322646	1.163977	1.188473	0.630062	0.707713
	PM2.5	0.017604	0.062606	0.067504	0.033205	0.037123
	PM10	0.024639	0.088295	0.091598	0.047342	0.053355
Emission breakdown from industrial emissions (kt)	NOx	0.150593	0.666809	0.425424	0.19587	1.033321
	PM2.5	0.003404	0.04858	0.06774	0.017819	0.032631
	PM10	0.003521	0.05206	0.0723	0.018823	0.033775
Emission breakdown from domestic emissions (kt)	NOx	0.054337	0.092877	0.140348	0.057636	0.067697
	PM2.5	0.106572	0.109204	0.218806	0.069766	0.082207
	PM10	0.10996	0.111655	0.218806	0.071091	0.083597

Table 2. Emission breakdown and sources

2.1.4.1. Example Industry Contributions – The Port of Felixstowe

Activities associated with the Port of Felixstowe contribute to the industrial emissions seen in East Suffolk. An AQMA was declared in 2009 due to exceedances of the air quality objective for annual mean nitrogen dioxide (NO2) at the Dooley Inn public house, Ferry Lane, Felixstowe. An action plan was set out with responsibilities shared by the district council and the Port of Felixstowe.

Since the declaration in 2009, measured annual mean concentrations declined in the AQMA.The results of diffusion tube monitoring undertaken in 2016 confirmed that annual mean nitrogen dioxide concentrations within the Felixstowe AQMA boundary continued to reduce and were below the Air Quality Objective for five years running at 34µg/m3. Despite an increase in throughput in the port, the implementation of the measures has assisted to reduce NO2 concentrations. Furthermore, a similar decline in measured levels is occurring at other locations around the port. As a result, the AQMA was revoked in 2016.

While activities associated with the Port of Felixstowe will continue to be a major contributor to air quality across Suffolk, it is important to note that the work already done and future plans will contribute to improvements across Suffolk. The Port of Felixstowe highlights that with monitoring, cooperation and appropriate mitigation measures between stakeholders, it is possible to drive positive change.

2.1.1. Air Quality Management Areas

Every lower tier local authority in the UK has to carry out a review and assessment of air quality in their area. This involves measuring air pollution and trying to predict how it will change in the next few years to ensure that the national air quality objectives will be achieved. An outline of the air quality objectives is outlined in table 3.

Pollutant	Air Quality Objective	
	Concentration	Measured as
Nitrogen Dioxide (NO2)	200 µg/m3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m3	Annual mean
Particulate Matter (PM10)	50 µg/m3 , not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m3	Annual mean
Sulphur Dioxide (SO2)	350 µg/m3 , not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m3 , not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m3 , not to be exceeded more than 35 times a year	15-minute mean

Table 3. National Air Quality Objectives

If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area (AQMA). This area could be one or two streets, or it could be much larger. Once an AQMA is declared the local authority must put together a Local Air Quality Action Plan to address the issue.

There are currently 11 AQMAs across Suffolk, which can be seen in Table 4. Further details can be found on the DEFRA UK Air resource (20) or by clicking on the hyperlinks in Table 4. Further details of the local Air Quality Action Plans can be found on individual district and borough council websites.

Table 4. Air Quality Management Areas in Suffolk. Data taken from Department for Environment Food & Rural Affairs UK Air data (20)

AQMA	Description	Date Declared	Pollutants
	Babergh and Mid Suffolk Councils		
Sudbury AQMA	An area encompassing part of Cross Street, Sudbury	21/11/08	NO_2
	East Suffolk Council		
AQMA Order No. 1 2006 - Woodbridge	Properties on the Western side of the Thoroughfare and Melton Hill arm of the junction with Lime Kiln Quay Road, in Woodbridge, Suffolk.	03/04/06	NO_2
The Suffolk Coastal District Council	The designated area incorporates the four properties situated within 1-5 Long Row, Main Road, in Stratford St Andrew, Suffolk.	18/06/14	NO_2
	Ipswich Borough Council		
Ipswich AQMA No.1	An area encompassing the land in and around the junction of Norwich Road, Chevallier Street and Valley Road, extending along Chevallier Street to beyond the junction with Waterloo Road	11/04/06 (Amended 12/09/17)	NO_2
Ipswich AQMA No.2	An area from the junction with Peel Street, extending along Crown Street, St Margarets Street and St Helens Street to the junction with Palmerston Road, and from St Margarets Street extending up Woodbridge Road to just beyond the junction with Argyle Street.	11/04/06 (Amended 12/09/17)	NO_2
Ipswich AQMA No.3	An area following the route of the Star Lane / Key Street / College Street gyratory clockwise from the junction with Lower Orwell Street, extending along Star Lane, Grimwade Street, Fore Street, Salthouse Street, Key Street and College Street, terminating at the junction with Bridge Street.	11/04/06 (Amended 12/09/17)	NO_2
Ipswich AQMA No. 4	Incorporating the Bramford Road/Yarmouth Road/Chevallier Street junction and part of Chevallier Street.	14/12/10	NO_2

Ipswich AQMA No.5	An area incorporating the land in or around St. Matthews Street / Norwich Road between the Civic Drive roundabout and Bramford Road.	12/09/17	NO_2
	West Suffolk District Council		
Newmarket AQMA	The designated area incorporates Old Station Road from the Clock Tower roundabout to the junction with Rous Road, Newmarket, Suffolk.	06/04/09 (Amended 18/04/17)	NO_2
Great Barton AQMA	The designated area incorporates Gatehouse Cottage and 1 to 8 The Street (A143), in the Parish of Great Barton, Suffolk	18/04/17	NO_2
Sicklesmere Road Bury St Edmunds	The designated area incorporates 2 and 7 Sicklesmere Road and 28 Southgate House, Rougham Road, in the Parish of Bury St Edmunds (Southgate Ward)	13/04/2018	NO_2

Not all AQMAs experience exceedances and it takes a few years of data to de-declare them. Detailed information on each AQMA is contained within the individual district status reports linked in table 4 with a summary outlined in table 5.

Table 5. Air Quality Management Areas in Suffolk and corresponding Air Quality Objective Exceedance information. Information taken from District and Borough Councils linked in table 4.

Area	AQMA and exceedance information
East Suffolk	Woodbridge AQMA: AQMA was declared in 2006. NO2 concentrations within the AQMA have reduced since 2014 and have now been below the objective level for six consecutive years, with the average for 2019 being 32.2µg/m3. The concentrations at all monitoring locations within the AQMA have not been within 10% of the NO2 annual mean objective of 40µg/m3 (below 36µg/m3) for three consecutive years. Stratford St Andrew AQMA, AQMA was declared in June 2014. NO2 concentrations fell below the objective for the first time in 2017 (39.0 µg/m3) and have continued to fall in 2018 (37.7 µg/m3) and 2019 (36.2 µg/m3). There is a general trend of reducing concentrations over time.
Mid Suffolk Sudbury	At Cross Street, Sudbury, exceedances of the annual mean objective for Nitrogen dioxide, led to the designation of an Air Quality Management Area (AQMA) in 2008. During 2019, the annual mean at three monitoring locations on Cross Street exceeded the objective. These three monitoring locations have all exceeded the objective for the past five years and are within the AQMA.

	At these locations, there was little variation in the measured nitrogen dioxide concentration between 2015 and 2017, but there has been a noticeable reduction between 2017 and 2019. There is one other monitoring location that has shown exceedances of the objective during the past five years, but did not in 2018 or 2019
West Suffolk	The only exceedance of the annual mean objective in 2019 is within Great Barton AQMA. No sites were over 60µg/m3, which would indicate that an exceedance of the one-hour mean objective is unlikely to occur at any of these sites. Newmarket AQMA continues to show clear compliance with the annual mean AQO for nitrogen dioxide and will be revoked.
Ipswich	NO2 concentrations were exceeded at eight of Ipswich Borough Council's 81 monitoring locations:two were located within AQMA 2, four were located in AQMA 5 and two of which fall just outside of the current AQMA boundaries. No exceedances were noted in AQMAs 1, 3 & 4 following bias adjustment and distance correction. However, it should be noted that the two exceedances which fall outside the current AQMA boundaries were just outside AQMAs 3 and 4

2.1.2. The Impact on Health

The Public Health Outcomes Framework (PHOF) (21), estimates the fraction of all-cause adult mortality attributable to man-made fine particulate (PM2.5) air pollution for each lower tier local authority area. Figure 12 shows these estimates for areas within Suffolk, compared to other lower tier authorities within the East of England.

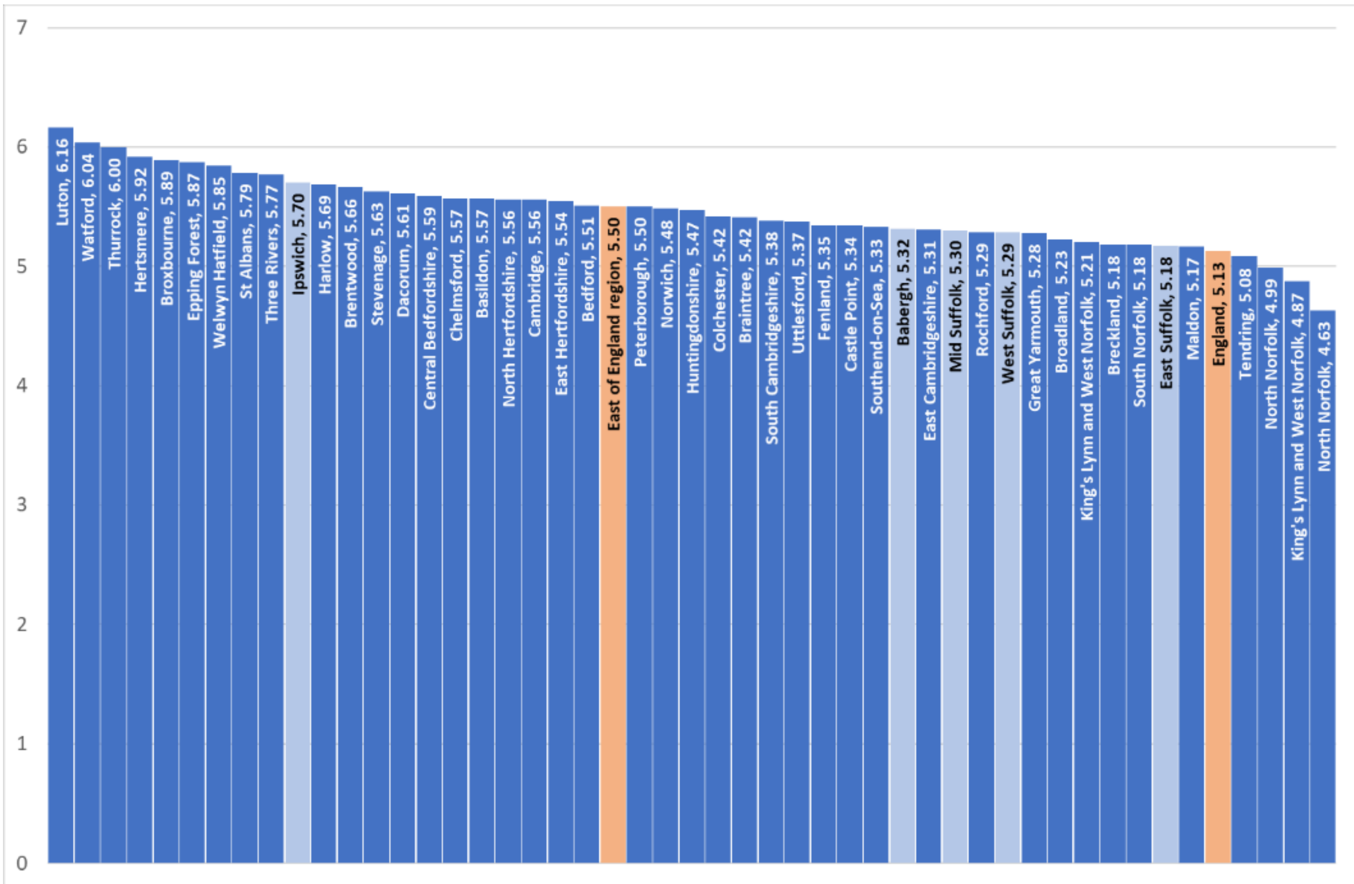

Figure 12 Fraction of mortality attributable to particulate air pollution - % (2019) - Source: DEFRA (Via Public Health Fingertips)

There are currently no local or national measures of health service usage that can be directly attributed to air pollution. Whilst local information exists for conditions that poor air quality contributes to or exacerbates, such as asthma and COPD, it is difficult to quantify links with air pollution. The recently published Clean Air Strategy (15) identifies the need to gather better information on where, when and how patients report and are treated for air quality related health conditions.

Following the recent inquest where air pollution was ruled as the cause of death of a child in London, Suffolk County Council and local authorities are working to improve the knowledge of health professionals to support diagnosis and identification of health issues caused by air pollution.

3. What Can Be Done Locally to Improve Air Quality?

Responsibility to improve air quality lies at individual and collective level and across different organisations. The following section explores the evidence available on interventions to improve air quality.

Public Health England produced a report (22) in March 2019 that reviewed interventions to improve outdoor air quality and public health. This was a comprehensive review of interventions that national government, local authorities, and others could take to improve air quality and health. The review focussed on the following five areas: vehicles and fuels, spatial planning, industry, agriculture and behavioural change.

The key interventions highlighted from each of the five areas that may be applicable to Suffolk are detailed in the following sections. One of the key recommendations from the report is that interventions need to be planned and tailored to local circumstances and developed collectively to have the greatest impact. In doing this, local plans should consider the intervention hierarchy shown in Figure 13. The hierarchy provides a simple way of prioritising interventions to address pollution through the follow approaches:

- Prevention (polluting activities): Prevent or reduce emissions of pollutants to air (reduce emissions)
- Mitigation (polluting concentrations): Take steps to reduce air pollution (reduce concentrations)
- Avoidance (individual exposure): Avoid exposure to air pollution (reduce exposure)

Interventions that prevent or reduce polluting activities (emission reduction) are preferable to taking steps to reduce air pollution once it has occurred (concentration reduction) or relying on avoidance (exposure reduction).

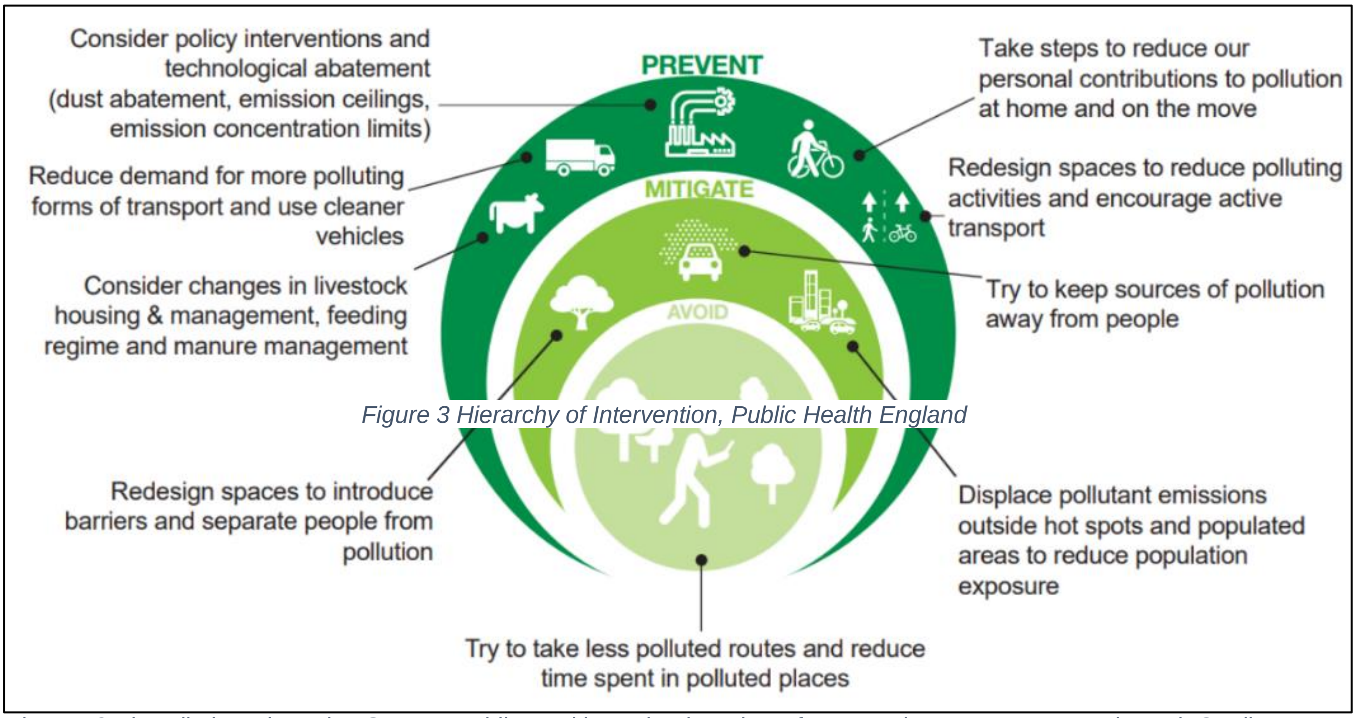

Figure 13 Air Pollution Hierarchy, Source: Public Health England Review of Interventions to Improve outdoor Air Quality

3.1.1. Vehicle & Fuel Interventions

Evidence suggests that the greatest impact on reducing emissions from road transport and improving public health outcomes is from the implementation of a package of policy measures (transport and non-transport related interventions) designed according to a local area's requirements. For example, a low emission zone is likely to be more effective if implemented alongside interventions investing in and promoting active travel and public transport.

Air quality within urban areas is likely to be improved by any intervention that promotes the uptake of low and zero-exhaust emission vehicles, particularly electric vehicles. However, it should be noted that there is a lack of evidence about the generation and health impact of non-exhaust particulate matter (PM) emissions (i.e. tyre/brake wear), which remain a potential issue [19].

Traffic management interventions, such as national road pricing and access restrictions, have the potential to improve air quality and encourage the public to consider travel behaviour change and active travel. Although active travel interventions on a small scale do not generally improve air quality significantly, they are very effective at improving public health outcomes through increased levels of physical exercise.

Transport interventions assessed by Public Health England as having potential to deliver overall health benefits, are presented in Figure 14.

In the evaluated public health impact charts, 'National effectiveness' (the blue bar) shows potential to improve air quality public health outcomes on a wider scale (i.e. countywide) whereas 'Local effectiveness' (the red bar) shows the potential to improve air quality public health outcomes at a specific locality (i.e. hot-spots/single site level) which may be best considered in strategies targeted at Air Quality Management Areas (AQMAs).
As this shows, some of the most effective interventions are likely to be those best implemented at pan- Suffolk level, however there are also approaches that could be explored at smaller area level.

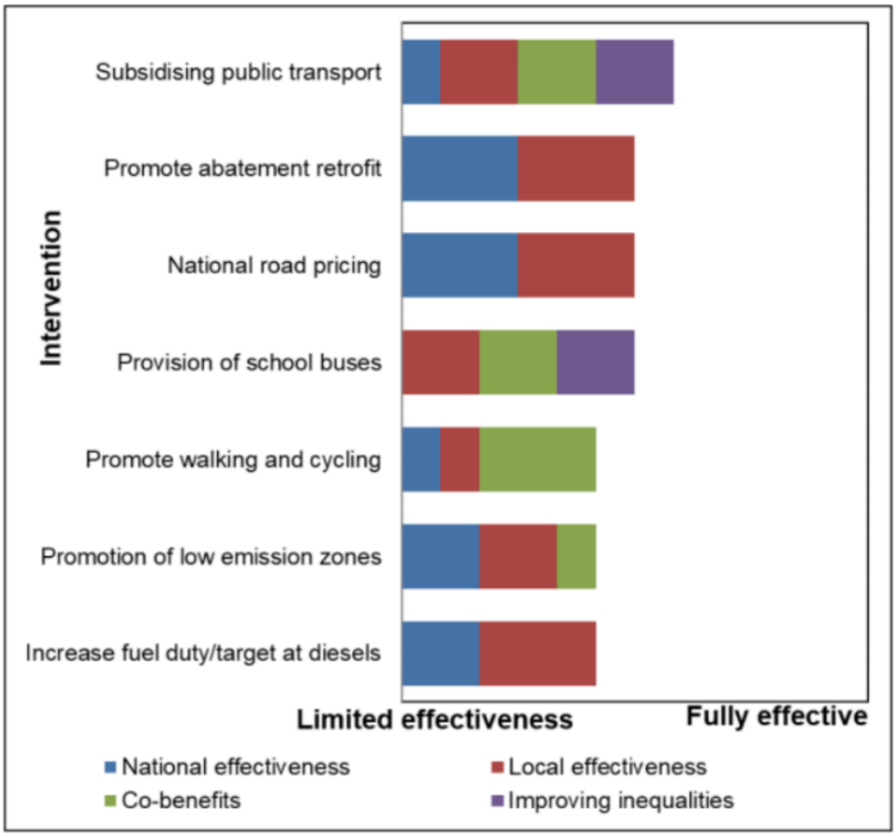

Figure 14 Transport Interventions - Evaluated public health impact,
Source: Public Health England Review of Interventions to improve Air Quality
Abatement retrofit = fit vehicles with new exhausts which reduce air pollutants

3.1.2. Planning

Many of the planning interventions shown to have the greatest public health impact through improvements to air quality are related to traffic.

Low emission zones and road pricing/congestion charges produce reductions in traffic, but not necessarily major improvements in overall air quality. This may be because the issue is moved elsewhere or dispersed into other areas. There is evidence that Low Emission Zones are potentially effective at reducing air pollutant levels in specific areas (such as cities) and they are expected to work better if combined with interventions that incentivise the use of lower emission vehicles [19].

A mix of measures that provide or improve green and active travel infrastructure, prioritise road safety, provide public transport and discourage travel in private cars have potential to improve air quality and public health outcomes. These can be supported by policies that focus on reducing the emissions of vehicles. Green infrastructure (car charging, public transport, cycle lanes etc) is also potentially effective in improving health inequalities in urban areas and promoting health and wellbeing.

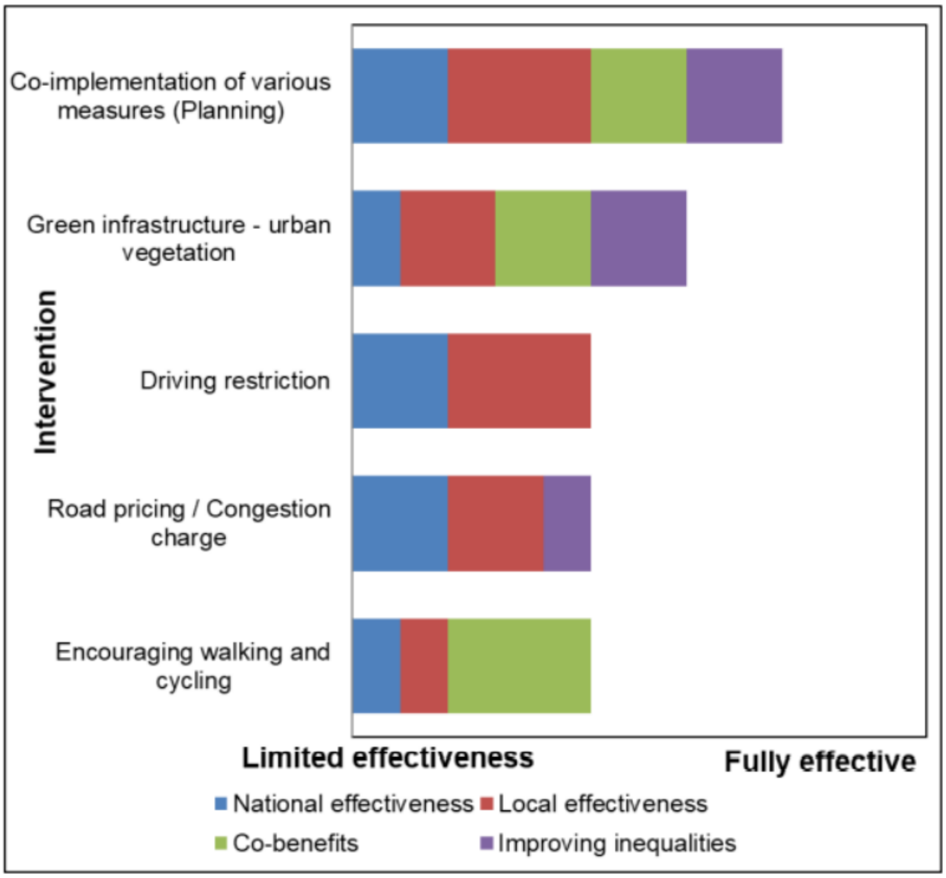

Figure 15 Planning Interventions - Evaluated public health impact, Source: Public Health England Review of Interventions to improve Air Quality

The benefits to health of traffic calming measures and active transport are larger than benefits associated with reduction of exposure to air pollution alone. Co-benefits include a reduced risk of injury and traffic collisions and increased physical activity levels, which are associated with multiple public health benefits (improved cardiovascular outcomes and improved weight status among children, adults and older adults).

Planning interventions assessed by Public Health England as having potential to deliver overall health benefits, are presented in Figure 15.

3.1.3. Industrial Interventions

The current emphasis to improve air quality across industry tends to focus on adherence to national limits for emissions, However, benefits to public health can continue to occur when air pollutant levels are reduced below these standards. Approaches that account for changes in population-level exposure rather than changes in emissions are desirable. This means that efforts to reduce exposure by smaller amounts may be justified if larger numbers of people are affected.

Technological interventions implemented at the individual installation level have potential benefits for local and national air quality if implemented at scale.

Industrial interventions, assessed by Public Health England as having potential to deliver overall health benefits, are presented in Figure 16, with definitions in table 6. However, evidence mainly relates to evaluations of effects on emissions (sources) as information about impacts on air quality and health outcomes in this area is limited.

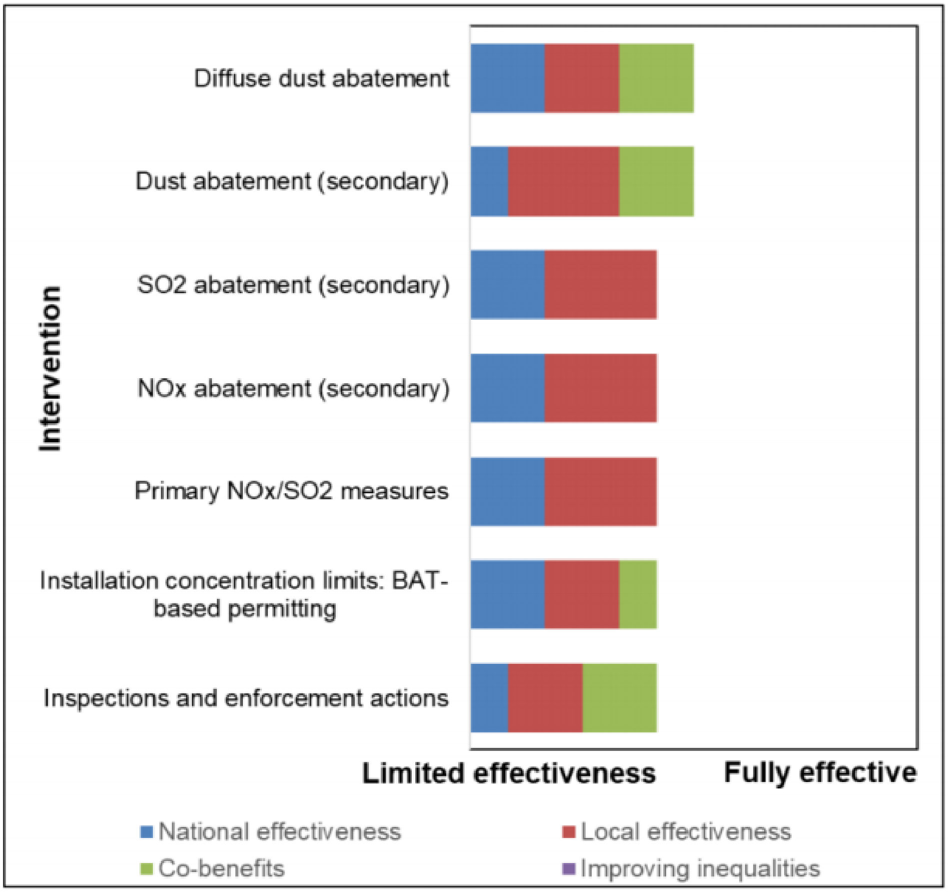

Figure 16 Industrial and regulatory Interventions - Evaluated public health impact, Source: Public Health England Review of Interventions to improve Air Quality

Intervention category	Description/Principles
Diffuse dust abatement	Measure to prevent and control diffuse dust emissions from industrial activities
Dust abatement (secondary)	Abatement measures to control dust emissions (combustion and process emissions) from industrial activities
SO2 abatement (secondary)	Primary measures to prevent formation of NOX, SO2 and PM from industrial activities
NOx abatement (secondary)	Abatement measure to control NOx emissions (secondary techniques) from industrial activities
Primary NOx/SO2 measures	Primary measures to remove sources of volatile organic compound VOC emissions from a rage of sectors applying surface treatment (eg cleaning, coating processes or printing)
Installation concentrations limits: Best available technique (BAT)-based permitting	Setting emission concentration limits which installations must comply with to receive a permit to operate
Inspections and enforcement actions	Measure to increase the number of inspection and enforcement actions

Table 6. Definitions of Industrial and regulatory Interventions - Evaluated public health impact, Source: Public Health England Review of Interventions to improve Air Quality

3.1.4. Agriculture

Much of the evidence regarding air quality improvements in agriculture looks at ways of reducing ammonia (NH3). Promising opportunities include:

- urease inhibitors and slow-release nitrogen (N) fertilisers
- slurry acidification
- low NH3 emission storage and spreading
- air filtration systems
- low protein feeding

In terms of the implementation of a combination of interventions, bio-filters and exhaust air scrubbers seem to have the greatest potential effectiveness on air quality (locally and at wider scale). If combined with livestock building design and strategic tree-planting, these interventions are thought to have high potential to benefit air quality [22].

Interventions assessed by Public Health England to have potential to deliver overall health benefits are shown in Figure 17. However, there is not a great deal of evidence evaluating the health impacts of these interventions, possibly because there is limited information on current levels of uptake of mitigation measures and public health outcomes.

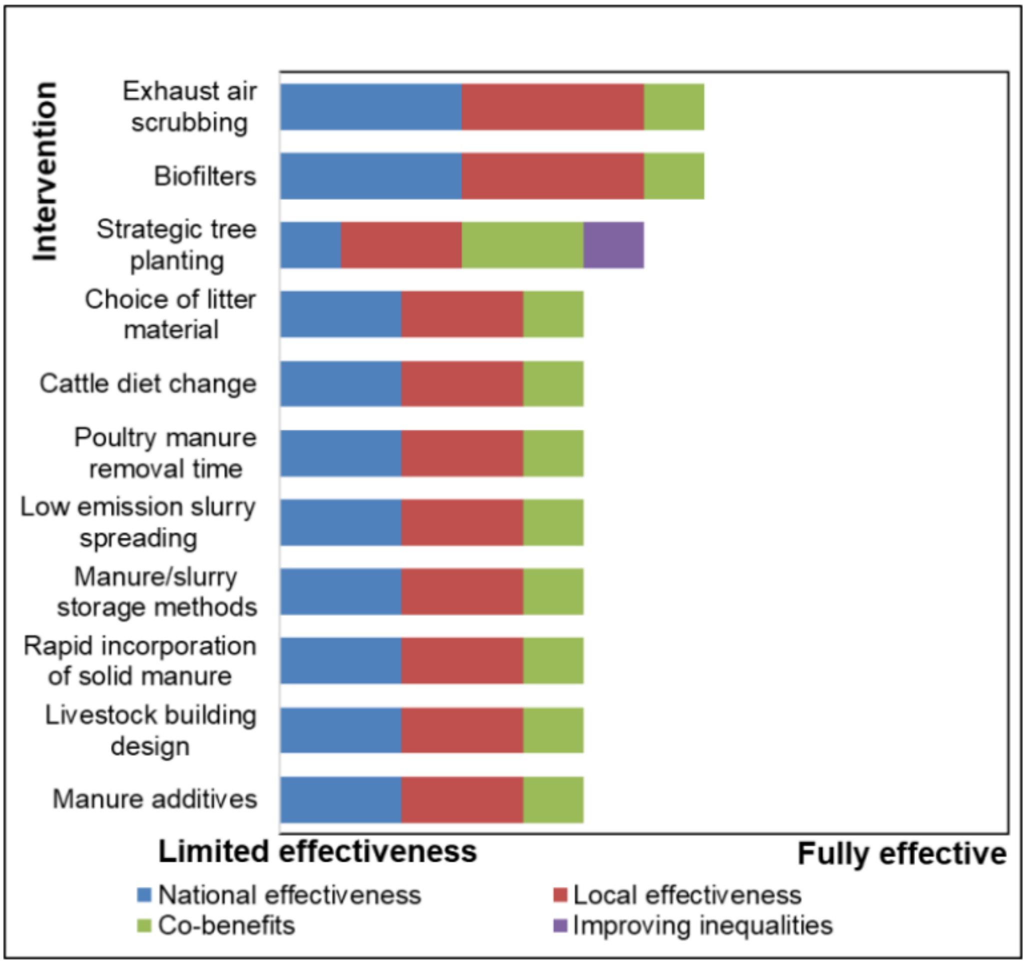

Figure 17: Agricultural interventions - Evaluated public health impact,

Source: PHE Review of Interventions to improve Air Quality

3.1.5. Behavioural Change

The highest potential to improve air quality and public health outcomes is associated with combining behavioural interventions with other policy or infrastructure-based interventions (for example, improving public transport or cycling infrastructure and using behavioural interventions to maximise use of these).

There is limited evidence to show effectiveness in reducing emissions from behavioural interventions alone, however lack of evidence should not be taken as evidence of ineffectiveness. For example, there is little evidence showing that behavioural interventions promoting alternative methods of transport have a direct impact on air pollution or health outcomes. However, they should not be discounted, as there is a wealth of evidence showing that removing vehicles from the road can reduce emissions. There is also strong evidence for the health benefits of physical activity associated with active travel [22].

Eco driver training and large-scale national events (such as the Global Action Plan National 'Clean Air Day') showed some evidence of potential to reduce emissions of air pollution. However, annual or one-off events can soon be forgotten, and evidence of their longer-term impact is limited. Following the event, people may return to their old behaviours.

Exposure-reduction programmes show potential benefits to vulnerable groups, especially in providing advice on how to reduce personal exposures to air pollutants. These interventions include educational programmes that can be targeted to specific groups [22].
.
There is strong evidence for the health benefits of physical activity, such as walking and cycling, however, raising awareness is not enough to affect change: it must be done in conjunction with other behavioural and non-behavioural interventions.

Behavioural interventions assessed by Public Health England to have potential to deliver overall health benefits are shown in Figure 18.

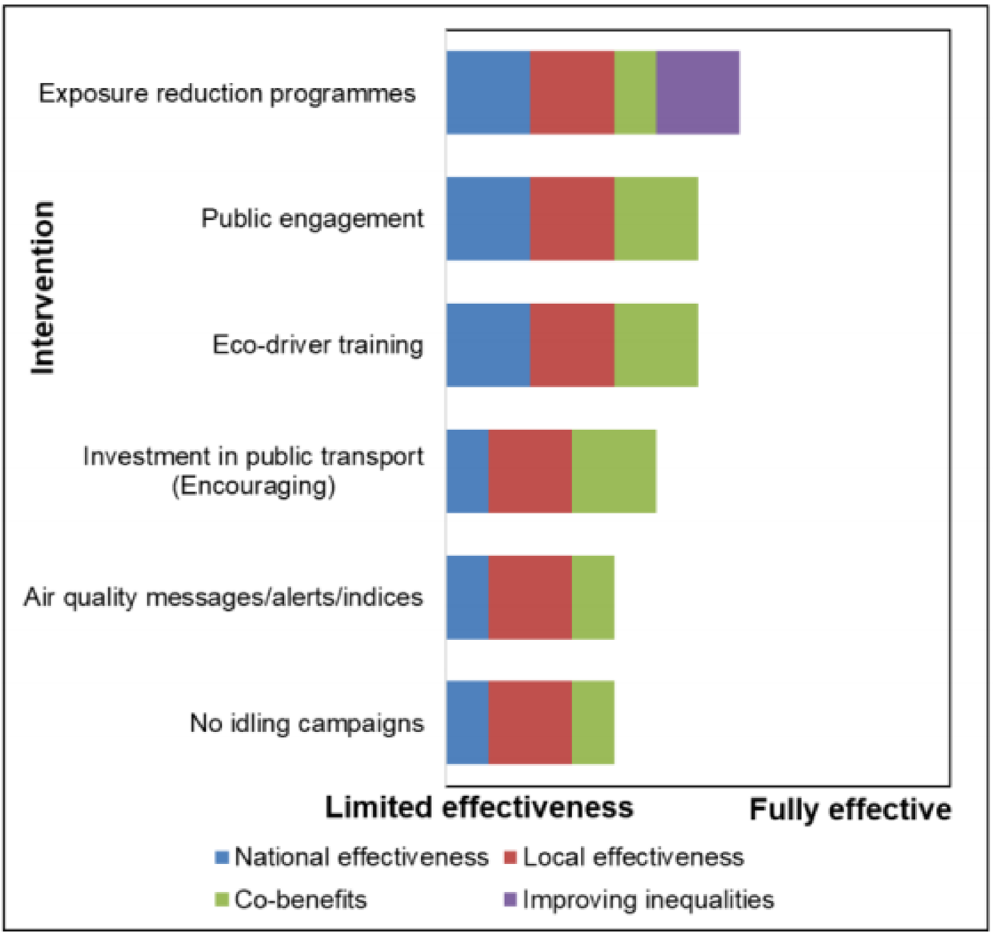

Figure 18 Behavioural Interventions: Evaluated public health impact, Source: PHE Review of Interventions to improve Air Quality

3.1.6. Indoor Air Quality

As well as exploring ways to reduce exposure to outdoor pollutants, it is vital to raise awareness of the importance of good air quality in people's homes and look at ways to achieve this.

The National Institute of Care and Excellence (NICE), in collaboration with Public Health England, issued NICE guidance on Indoor Air Quality (23) in January 2020. This provided evidence-based recommendations that could be taken to improve indoor air quality. The guidance recommends that local authorities should use inspections and home visits by health professionals, particularly to vulnerable individuals' homes, to identify poor indoor air quality and suggests that staff who visit people's homes should:

- know about sources of indoor air pollutants and their effects on health
- give advice on avoiding activities that increase pollutants (cookers, fires, cleaning products) and improving ventilation (this should include using background ventilation, extractor fans in kitchen and bathrooms and opening windows when possible)
- know who can provide help with repairs and necessary improvements
- give advice on requesting a housing assessment if poor indoor air quality is suspected

Private and social tenants should also be advised to contact their landlord (and their local authority if no action is taken) if:

- ventilation is inadequate
- repairs are needed to prevent water from entering the home
- improvements are needed to heating or insulation to prevent condensation

In addition to recommended action for local authorities, the guidance recommends the following actions for healthcare professionals:

- to ask about housing conditions if patients have repeated or worsening coughs or wheezing
- ensure that individuals with breathing or heart problems understand that indoor air pollutants can trigger or exacerbate conditions
- advise people allergic to dust mites to avoid second-hand mattresses, use allergen barriers (such as mattresses and pillow covers) and wash bedding regularly
- advise pregnant women and households with babies under 12 months on the increased risks from poor indoor air quality, and ask about housing conditions and request a housing assessment if concerned
- advise pregnant women and households with babies under 12 months to reduce household sprays and aerosols, open-fuel fires or candles and to avoid smoking/second-hand smoke

The NICE guidance also outlines recommendations for architects, designers, builders and developers about ensuring that materials used meet regulatory standards and that houses are designed and built with heating and ventilation systems carefully considered.

4. Summary & Recommendations

Air pollution can affect everyone, and air in all areas of the UK contains some proportion of human-made air pollutants. Exposure to air pollution has numerous health effects, which come about at every stage of life, from the first weeks in the womb all the way through to old age. The health effects of air pollution are complex, and range in severity of impact. In some cases, damage can be gradual and may not become apparent for many years.

The three main conditions associated with air pollution are respiratory conditions (such as asthma), cardiovascular disease (CVD), and cancers including lung cancer. Main pollutants of concern are NO2 and particulates

There is little evidence to suggest a threshold below which no adverse effects would be expected (2). Therefore, there are health benefits to be gained from improving air quality even below concentrations stipulated by EU and UK standards.

Air quality across most of Suffolk is reasonably good, however there are eleven Air Quality Management Areas (AQMA) across the county, with monitors that show ongoing breaches of the national air Quality Objectives (mainly Ipswich).

Since the first COVID-19 lockdown in March 2020, there have been significant changes to people's movements, lifestyles, knock-on effects on industries and undoubtably air quality. The full effect of these changes, both positive and negative, on air quality across Suffolk is yet to be understood. There are likely to be positive changes to some AQMA areas in the short term due to reduced traffic as a result of restricted movements, however the long-term work is still required to enable the lasting change.

There are numerous interventions that are shown to be associated with reductions in air pollutant levels and positive impacts on public health, however evidence clearly demonstrates that:

- Single, small scale actions are unlikely to lead to the significant reduction in air pollution needed to protect health
- Greatest improvements to air quality will be achieved by a clear collaborative strategy that integrates approaches across the different areas outlined in section 3 (transport, planning, industry, agriculture and behaviour change)
- Individuals and organisations across Suffolk will need to work together and ensure that priority areas are aligned
- Approaches that span the short, medium and long term are likely to have the best chances of improving air quality

The Suffolk Air Quality Steering Group, which includes representatives from the local districts as well as academic institutions, meets regularly to discuss all matters relating to air quality. This platform provides an excellent opportunity to better understand approaches and interventions taking place across Suffolk.

The declaration of a climate emergency by all Suffolk local authorities, and the development of a Climate Emergency Plan, provides an opportunity for further shared work focusing on emissions and their impact on air quality.

A number of schemes are already in place across Suffolk that promote active and green travel including *Plug in Suffolk*, *Active Travel Fund* and *Bikeability:* a scheme that trains over 3,000 children each year. Campaigns such as ‘Clean Air Day’ and anti-idling campaigns have also proven successful and there is scope to build on all of the above projects. It is important to map out what different sectors and organisations are currently doing, which would support partners to work together to achieve the best outcomes.

There are further opportunities to increase knowledge and confidence amongst professionals (transport, spatial planners), elected members and wider partners (NHS) with regards to air quality.

Key actions identified through the development of this profile include the need to:

1) Provide training and resource to increase the technical knowledge of officers such as transport, spatial planners, elected members and wider partners on impact of air quality on health and the actions which can be taken to mitigate.
2) Strengthen wider communication to the public on health impacts of air quality.
3) Undertake further research at local level on links between air quality and health in Suffolk.
4) Map and sharing current interventions and good practice.
5) Develop a County council strategy to describe the levers Suffolk County have to positively impact on AQ and consider how to optimise.

5. References

1. Environmental Audit, Committee. Air Quality- Fifth report of session 2009-2010 (Volume I). Strategy [Internet]. 2009;I. Available from: https://publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/229/229i.pdf

2. National Institute of Health and Care Excellence (NICE). Air pollution: outdoor air quality and health [Internet]. 2017. Available from: https://www.nice.org.uk/guidance/ng70/resources/air-pollution-outdoor-air-quality-and-health-pdf-1837627509445

3. Department for Environment Food and Rural Affairs, Department for Transport. Improving air quality: national plan for tackling nitrogen dioxide in our towns and cities - Defra - Citizen Space. 2017;(May). Available from: https://consult.defra.gov.uk/airquality/air-quality-plan-for-tackling-nitrogen-dioxide/

4. Committee on the Medical Effects of Air Pollutants. Review of the UK Air Quality Index. Vol. 66, Health Protection Agency. 2011

5. COMEAP. Associations of long-term average concentrations of nitrogen dioxide with mortality - A report by the Committee on the Medical Effects of Air Pollutants. 2018; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf

6. COMEAP. Quantification of Mortality and Hospital Admissions Associated with Ground-level Ozone. A report by the Committee on the Medical Effects of Air Pollutants. 2015. 116 p.

7. Public Health England. Health Matters [Internet]. Air Pollution. 2018 [cited 2021 Feb 1]. Available from: https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution

8. Royal College of Physicians. Report of a working party February 2016 [Internet]. 2016. Available from: https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution

9. Public Health England. Estimation of costs to the NHS and social care due to the health impacts of air pollution [Internet]. 2018 [cited 2021 Feb 1]. Available from: https://www.gov.uk/government/publications/air-pollution-a-tool-to-estimate-healthcare-costs

10. Department for Environment Food & Rural Affairs (DEFRA). Pollution Forecast [Internet]. 2021 [cited 2021 Feb 16]. Available from: https://uk-air.defra.gov.uk/forecasting/

11. Department for Environment Food & Rural Affairs (DEFRA). Defra Air Quality on Social Media [Internet]. [cited 2021 Feb 16]. Available from: https://twitter.com/DefraUKAir?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor

12. Department for Environment Food and Rural Affairs. What is the Daily Air Quality Index? [Internet]. UK AIR. [cited 2021 Feb 16]. Available from: https://uk-air.defra.gov.uk/air-pollution/daqi?view=more-info

13. DEFRA. OPen Fires and Wood-Burning Stoves: A Practical Guide. 2019; Available from: https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1901291307_Ready_to_Burn_Web.pdf

14. Birchby D, Cooke S, Stedman J, Hurley F, Hunt A. Valuing the Impacts of Air Quality on Productivity. Rep Dep Environ Food Rural Aff [Internet]. 2014;(3). Available from: https://uk-

air.defra.gov.uk/assets/documents/reports/cat19/1511251135_140610_Valuing_the_impacts_of_air_quality_on_productivity_Final_Report_3_0.pdf

15. Department for Environment Food & Rural Affairs (DEFRA). Clean Air Strategy [Internet]. 2019. Available from: https://www.gov.uk/government/publications/clean-air-strategy-2019

16. Department for Environment Food & Rural Affairs (DEFRA). UK and EU Air Quality Limits [Internet]. [cited 2021 Feb 4]. Available from: https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits

17. Ministry of Housing Communities and Local Government. The English Indices of Deprivation 2019: Research report. 2019;(September):1–86. Available from: https://www.gov.uk/government/publications/english-indices-of-deprivation-2019-technical-report%0Ahttps://www.gov.uk/government/publications/english-indices-of-deprivation-2019-technical-report%0Ahttps://assets.publishing.service.gov.uk/government/uploads

18. Department for Environment Food & Rural Affairs (DEFRA). UK-AIR: Information Resource [Internet]. [cited 2021 Feb 4]. Available from: http://uk-air.defra.gov.uk/

19. Department for Environment Food & Rural Affairs (DEFRA). National Atmospheric Emissions Inventory [Internet]. Available from: https://naei.beis.gov.uk/data/

20. Department for Environment Food & Rural Affairs (DEFRA). UK AIR: Air Quality Management Areas (AQMAs) [Internet]. [cited 2021 Feb 8]. Available from: https://uk-air.defra.gov.uk/aqma/

21. Public Health England. Public Health Outcomes Framework [Internet]. [cited 2021 Feb 4]. Available from: https://fingertips.phe.org.uk/profile/public-health-outcomes-framework

22. Public Health England. Review of interventions to improve outdoor air quality and public health. 2019

23. National Institute for Health and Care Excellence. Indoor Air Quality at home. 2020;ng149(January)

24. Department for Environment Food & Rural Affairs (DEFRA). UK Emission Mapping Methodology (defra.gov.uk) https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1910040848_Mapping_Methodology_for_NAEI_2017_v1.pdf

25. NHS Greener NHS campaign to tackle climate ‘health emergency. https://www.england.nhs.uk/greenernhs/2020/01/greener-nhs-campaign-to-tackle-climate-health-emergency/