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Executive summary

Introduction

Air pollution is the top environmental risk to human health. In the UK it is ranked as the fourth greatest threat to public health after cancer, heart disease and obesity, and is a contributory factor to heart disease and some types of cancer.

Human-made air pollution comes from a range of different sources including agriculture, industrial, commercial and domestic activities, and transport. Emissions from road traffic are one of the largest contributors to ambient air pollution in urban areas.

Long-term exposure to air pollution, at the levels experienced in many urban centres in the UK, including Nottingham, causes respiratory and cardiovascular disease and lung cancer. It has also has been linked to other cancers. In children, air pollution reduces lung development and function and can lead to the development of asthma.

Short-term exposure to elevated levels of air pollution leads to a worsening of symptoms for those with existing asthma, respiratory or cardiovascular diseases, and can trigger acute events such as asthma and heart attacks in vulnerable individuals.

In Nottingham in 2016, it is estimated that **181** adult deaths were brought forward due to the health impacts of **air pollution** (comprising PM_{10}, $PM_{2.5}$, NO_2 and other pollutant species).

The impact of air pollution on health is modifiable, and there are cost-effective, achievable local collective and personal actions that reduce personal exposure to, and emissions of, air pollution, and improve health and air quality. These include active travel (walking and cycling), travelling using public transport and ultra-low emission vehicles, and increased

energy efficiency (coupled with appropriate ventilation) in buildings and homes. These actions also produce benefits across local priorities, including increasing physical activity, achieving and maintaining healthy weight, reduction in hospital admissions due to excess cold, respiratory, cardiovascular and obesity problems, reduced CO_2 emissions (a key driver of climate change), and reduce the generation of secondary pollutants that also effect health, and have other adverse impacts on the natural environment.

Unmet needs and gaps

The national Public Health Outcomes Framework (PHOF) datasets show that in Nottingham in 2016 approximately **146** deaths (6.3%) of all adult mortality was attributable to long-term exposure to human-made particulate air pollution. It is estimated that in Nottingham in 2016 ambient concentrations of nitrogen dioxide (NO_2) contributed to **35** additional deaths, i.e. **181** adult deaths were attributable to the combination of $PM_{2.5}$, NO_2 and other air pollutants.

It was predicted that by the end of 2019 concentrations of NO_2 in Nottingham's air will be below the annual mean National Air Quality Objectives (NAQOs), and EU limit value. However, despite meeting the NAQO for PM_{10}, concentrations of particulate matter (PM_{10} and $PM_{2.5}$) currently exceed, and are likely to continue to exceed, the World Health Organization's guidelines. Furthermore, the WHO have advised there is no 'safe' concentration for particulate matter in ambient air.

There is increasing evidence that indoor air pollution significantly affects health, and contributes to the development of respiratory conditions that are then further exacerbated by ambient/outdoor air pollution and indoor air pollution e.g. asthma.

The government's Clean Air Strategy 2019 considers both outdoor and indoor air pollution and how reducing emissions, pollutant concentrations and exposure, both outside and inside buildings and homes, can protect and improve health.

The National Institute for Clinical Excellence is preparing guidance (for publication late 2019) for local authorities and health organisations on how to improve citizen health by reducing outdoor and indoor air pollution, and exposure to it.

Gaps include:

- Organisational and public awareness and understanding of the range of air pollutants, wide range of sources, and their effects on health.
- Comprehensive demographic/geographic air pollution-health impact information for Nottingham's citizens.
- Air quality monitoring data of sufficiently high temporal and spatial resolution to inform studies into local health impacts and distribution and thus the need for additional air quality monitoring to inform the studies.
- Cost-benefit analysis tools that holistically (and therefore more fully) identify and consider the fullest range of economic, environmental and health impacts of air pollution (including CO_2, knock-on effects of climate change and the predicted likely consequent environmental change impacts on health and infrastructure).
- Organisational application of approaches and mechanisms that most effectively achieve behavioural change. (Inform, promote, model, enable and reinforce choices and decisions that reduce emissions and exposure).

- Resources/funding to sustain a co-ordinated holistic behavioural change programmes and multi-media messages.

Recommendations for consideration by commissioners

- Continue to include in the Health and Wellbeing Strategy an action plan to raise awareness of the impacts of air pollution and the need to improve air quality, and a summary of the actions citizens and businesses can take to reduce emissions and personal exposure,
- Support the development and roll-out of a communication strategy and awareness raising events to provide key messages on air pollution (outdoor and indoor), emission and exposure reduction to the public and businesses (e.g. information in GP surgeries),
- Support the development and use of comprehensive cost-benefit analysis tools to better quantify the impact of air pollution and mitigation measures on health and healthcare costs in Nottingham and Nottinghamshire,
- Support the collection of air pollution/health impact geo-spatial data for Nottingham to inform local and national air pollution-health studies, and enable targeted action if appropriate.

JSNA: Air Quality and Health

What do we know?

1) Who is at risk and why?

Air pollution; both outdoor and indoor, affects us all. It damages human health across a lifetime, from before birth to older age, and is linked to cancer, asthma, stroke, heart disease, diabetes and dementia (1).

In the UK it is estimated between 28,000 to 36,000 deaths a year are attributable to exposure to outdoor air pollution, with more linked to exposure to indoor air pollution (2).

Long-term exposure to air pollution at the levels experienced in many towns and cities in the UK, including Nottingham, causes respiratory and cardiovascular disease and lung cancer. It has also has been linked to other cancers and dementia. In children, air pollution reduces lung development and function and can lead to the development of asthma (1, 2).

Short-term exposure to elevated levels of air pollution leads to a worsening of symptoms for those with existing asthma, respiratory or cardiovascular diseases, and can trigger acute events such as asthma and heart attacks in vulnerable individuals (1, 2).

Exposure to short term elevated levels of traffic generated air pollution occurs whilst travelling in vehicles and at the roadside/pavement (as a cyclist/pedestrian) (1, 2, 3).

'Air pollution episodes', caused by a combination of emissions and weather conditions, can lead to more widespread exposure to elevated pollution levels, often across a whole urban area or region (4).

For the definition, description and types of air pollution see Appendix 1.

2) Size of the issue locally

The Local Impact on Mortality

The national Public Health Outcomes Framework (PHOF) (5) Indicator 3.01 datasets show that in Nottingham City in 2016 6.3% of all adult mortality was attributable to long-term exposure to human-made particulate air pollution. When cross-referenced with National census data for 2016 (6) this equates to approximately **146** adult deaths.

Using COMEAPs 2018 report's conclusions and 2016 census data it was calculated that in Nottingham in 2016 **up to 181 (i.e. an 35 additional)** adult deaths were brought forward due to the health impacts of **air pollution** (comprising PM_{10}, $PM_{2.5}$, NO_2 and other pollutant species) (2).

3) Targets and performance

Health

The Public Health Outcomes Framework (PHOF) sets out a vision for public health to 'improve and protect the nation's health and improve the health of the poorest fastest' (5).

National and local Public Health bodies and partners have a duty to deliver this vision.

PHOF indicator 3.01i 'Fraction of mortality attributable to particulate air pollution' ($PM_{2.5}$) is the current indicator linking air pollution to health.[1] The lower the value (for a given geographic area/local authority, the fewer the number of adult deaths that are attributable to particulate air pollution (Figure 1).

Figure 1. PHOF: East Midland Authorities, including Nottingham City

Indicator	Period	England	East Midlands region	Derby	Derbyshire	Leicester	Leicestershire	Lincolnshire	Northamptonshire	Nottingham	Nottinghamshire	Rutland
3.01 - Fraction of mortality attributable to particulate air pollution	2016	5.3	5.7	6.4	5.2	6.4	5.9	5.2	5.5	6.3	5.7	5.4

Limitations in the health and air quality data prevent any further detailed analysis on the distribution of air pollution related health impacts (spatially or demographically). However, it is reported (7) that the most deprived 20 % of neighbourhoods in England have higher air pollution levels than the least deprived neighbourhoods. Those communities that are subject to the most pollution, generally emit the least pollution, and tend to be amongst the poorest in Britain.

[1] Note. At the time of publication (June 2019) the national PHOF does not have a specific indicator for NO_2.

Nottingham scores highly on the scale of multiple deprivation (ranked 6th in England in 2015) (8) and many of its most deprived areas include roads with higher levels of air pollution (Appendix 3).

Prioritising action on air quality delivers benefits across the agendas of local authorities and clinical commissioners (including contributing to the Public Health and NHS Outcome indicators listed in Appendix 4). This is because there are significant overlaps between the actions needed to improve air quality and those actions needed to improve use of green space, physical activity, obesity and cardio-respiratory health. Action to improve air quality can reasonably be expected to reduce premature mortality from cardiovascular and respiratory disease over time. Action to reduce vehicle emissions and improve air quality will also contribute to sustainability and help to address a key contributor to climate change. Climate change has been described as one of the most important public health issues of the 21st Century (9).

Air quality

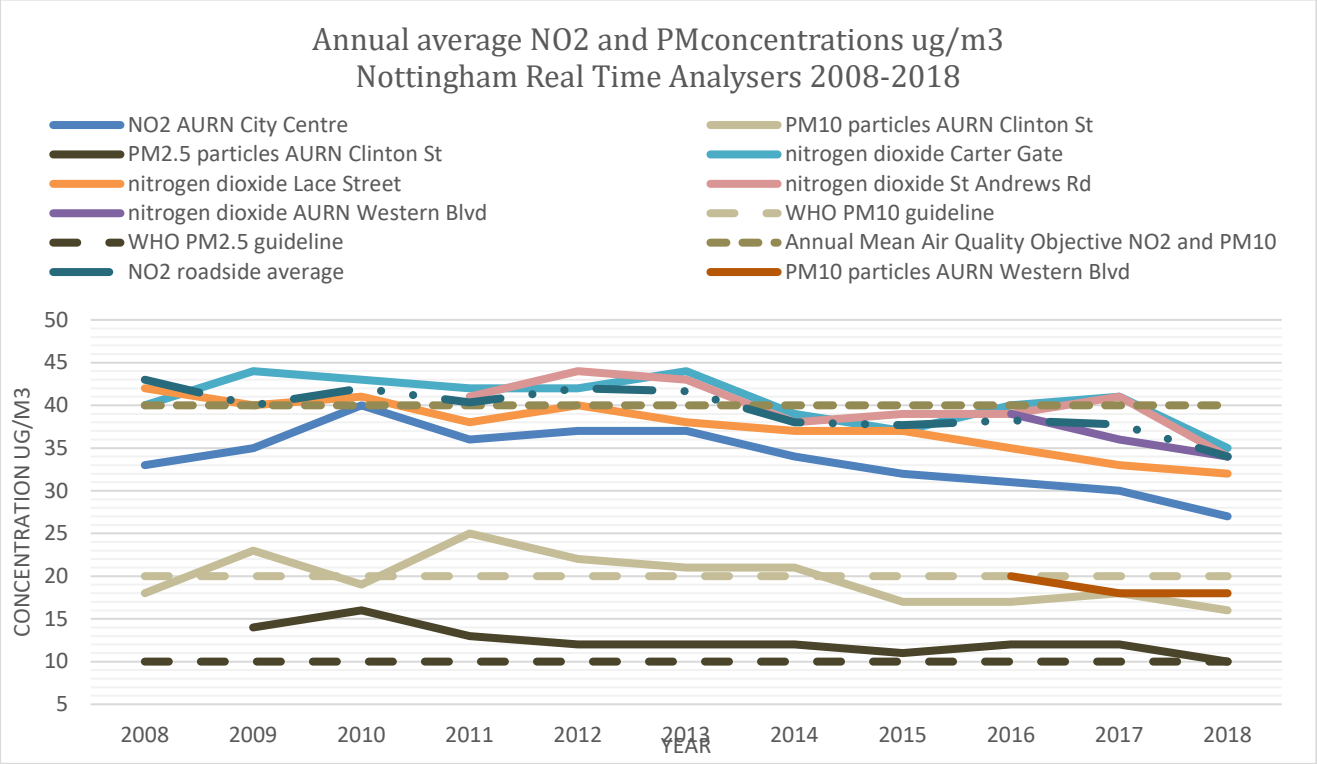
Local authorities have a statutory duty to assess outdoor air quality in their area and, where air quality does not meet the Air Quality Objectives, to declare Air Quality Management Areas and take action to improve air quality (10).

Nottingham City Council's regulatory activity and measures to protect, maintain and improve air quality are detailed in its Annual Status Report 2018 (11).

Following its 2018 review of air quality, including modelling conducted to evaluate the need for a Clean Air Zone, Nottingham City Council varied one of its AQMAs to cover the whole of its administrative area (Appendix 5).

The real time air quality monitoring data collated for Nottingham's Local Air Quality Management Annual Status Report 2019 indicates that in Nottingham in 2018 PM_{10} and NO_2 concentrations met the current National Air Quality Objectives (2015) and measured concentrations of $PM_{2.5}$ particles met the World Health Organization Guideline of 10ug/m^3 (Figure 2).

Figure 2.



4) Current activity, service provision and assets

No one individual, organisation or authority is ultimately responsible for air pollution and efficient and effective air quality management requires strong multidisciplinary co-operation between stakeholders. Nottingham City Council and Nottinghamshire's District and Borough Councils are working together, and with other partners, to reduce emissions and improve air quality.

Key areas of Council activity and action to reduce air pollution include:-

- regulatory activity (Environmental Permitting and Smoke Control Areas) (12, 13), urban planning (14),
- transport planning (15), including a local plan to improve air quality in Nottingham (as part of Clean Air Zone feasibility and implementation project ensure compliance with NO_2 limit value) (16),
- partnership working with the NHS, PHE, local Health and Wellbeing Board members and other public sector organisations etc. (17).

Key assets are:-

- 3x NO_2 and 2x DEFRA AURN air quality monitoring stations (providing real time air quality data) (18) and network of widely distributed NO_2 diffusion tubes (monthly data summarised in annual air quality reports) (19).
- Nottingham City Council's web based information covering:- air quality and health, active travel and ultra-low emission vehicle technologies (20).
- Nottingham(shire) Air Quality Strategy (21)

- Nottingham's Air Quality Improvement Plan (16)
- East Midlands Air Quality Network (PHE, Public Health, Environmental Health, Spatial and Transport Planning, SUSTRANS)
- Health and Wellbeing Board Air Quality group (Nottingham City Council, NHS, EMAS, NFRS, Notts Police, UoN, NTU)
- Public Health Steering Group (PHE, Public/Environmental Health)
- Portfolio Holders Air Quality Steering Group

5) Evidence of what works

Nottingham City Council has already introduced and implemented a range strategies, policies and measures that reduce emissions and exposure to air pollution including:-

- Active travel - walking and cycling
- Public transport - with low emission/zero emission at point of use vehicles
- Congestion charging (also known as the 'Workplace Parking Levy')
- Ultra-low emission vehicle infrastructure (across the greater Nottingham conurbation)
- Low emission Taxi strategy
- Anti-idling enforcement (2019) – see the ASR 2018 for further information (11)
- Low Emission Zones (2019) – see the CAZ additional measures Air Quality Action Plan (16)
- Behaviour Change Programme (22, 23).

6) What is on the horizon?

Technology

Advances in vehicle and heating/hot water system technology and increasing energy efficiency are expected to reduce emissions of CO_2 (24, 25), and therefore emissions of the co-pollutants NO_X and particles (26).

Legislation

The government published its Clean Air Strategy in January 2019 (27). It generated a significant response and the government has announced its intention to replace the Clean Air Act and its associated regulations, the Pollution Prevention and Control Act and its permitting regime, and the Environment Act /Local Air Quality Management process with comprehensive legislation in 2019, which will assure environmental protection and clean air.

Guidance

NICE published its guideline "Air pollution: outdoor air quality and health" (28) in June 2017, much of which had already been implemented in Nottingham. NICE is currently developing guidance on "Indoor air quality at home", for publication in September 2019 (29).

Behavioural Change

It is now recognised that appropriate and maintained behavioural change can have a more significant role and impact in emission and exposure reduction, and will therefore become a greater part of Nottingham's strategy and action plans to deliver improved health.

7) Local views

Each year Nottingham City Council typically receives over a hundred service requests, enquiries and complaints about air pollution (30).

Consultation undertaken during 2018 as part of the Clean Air Zone evaluation and feasibility project generated substantial local and regional citizen and business response, showing continuing concern about the effects of air pollution and a desire to improve air quality (31).

In May 2018 'Nottingham Citizens' approached Nottingham City Council requesting it (via the Portfolio Holder) to pledge to a range of measures to reduce emissions and improve air quality (32). Actions to deliver the pledges are in progress.

What does this tell us?

8) Unmet needs and service gaps

It is known that health impacts occur at pollutant concentrations below those the national Air Quality Objectives require local authorities to achieve, and Nottingham's citizens and business community remain concerned about air pollution.

Despite many years of local authority activity to regulate and reduce emissions, raise awareness of air pollution and promote behavioural change, air pollution levels are only falling slowly and further significant efforts are required if Nottingham is to remain below the UK's current Air Quality Objectives and World Health Organization guidelines.

Nottingham's air pollution monitoring is limited preventing detailed pollution concentration/health impact analysis and evaluation of measures and schemes to reduce emissions. If the spatial and temporal resolution of air pollution data were increased, it would facilitate or assist -

- the identification and evaluation of measures to reduce emissions, which would assist identifying effective schemes,
- the acquisition of location specific and time varying pollution concentration data,
- Local health studies into the health impacts of Nottingham's spatial/temporal variations in air pollution on Nottingham/conurbation residents and
- Acquisition, near real time reporting and forecasting of real time air pollution information that could assist citizens with travel choices

Nottinghamshire Air Quality Strategy

To maintain the current high profile of air pollution, raise awareness and promote the fullest range of measures to reduce emissions and exposure to air pollution an updated Nottinghamshire Air Quality Strategy has been prepared. It is due for publication during 2019.

Local initiatives

Nottingham has participated in three National Clean Air days, a number of events to promote Ultra Low Emission Vehicles, and has a long running, sustained campaign to encourage active travel and the use of public transport.

The effectiveness of these activities requires evaluation to determine what more is needed, and can practicably be done, to reduce air pollution and increase the uptake of public transport and active travel in Nottingham's 'travel to work' area.

9) Knowledge gaps

There are a wide range of interventions that have been suggested in the literature to tackle air pollution. However, developing evidence of effectiveness is complicated by difficulties in linking specific interventions to subsequent improvements in air quality, and by difficulties in generalising the findings of studies, due to the localised nature of air pollution hotspots.

Whilst a limited number of interventions are supported by guidance or evidence review, a number of innovative approaches are developing as individual case studies.

Periodic reviews of existing and emerging evidence base would help to establish the effectiveness, impact and cost-benefit of specific interventions, in order to prioritise these for local action.

10) Recommendations for consideration by commissioners

The key recommendation for commissioners is to recognise that air quality remains a significant public health issue and concern and that many of the actions needed to reduce emissions have health and climate change benefits.

Additional resources to promote awareness of the health impacts of air pollution and the health benefits of reducing emissions and exposure are likely to deliver air quality improvements and benefits in other PHOF indicators more quickly.

- Continue to include action to raise awareness of the impacts of air pollution and need to improve Air Quality within the Health and Wellbeing Strategy,
- Support the development and roll-out of a communication strategy and awareness raising events to provide key messages on air pollution (outdoor and indoor), emission and exposure reduction to the public and businesses,
- Support the development and use of comprehensive cost-benefit analysis tools to better quantify the impact of air pollution and mitigation measures on health and healthcare costs in Nottingham and Nottinghamshire,
- Support the collection of air pollution/health impact geo-spatial data for Nottingham to inform local and national air pollution-health studies, and enable targeted action if appropriate.

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Appendix 1

What is air pollution?

A World Health Organization definition of air pollution is ‘‘contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.’

Air pollution occurs outside and inside buildings and vehicles, and it enters and leaves them via ventilation systems, doors, windows and other gaps in the structure.

The composition and proportions of each component in air pollution varies with location and prevailing weather conditions. A full list of the most common air pollutants, their sources and their health impacts is available at https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution

Outdoor Air Pollution

Historically the main sources of human-made air pollution has been the combustion of carbon based fuels, particularly wood, coal and other fossil fuels. In addition to carbon dioxide (CO_2), coal and other fossil fuels emit sulphur dioxide (SO_2), particles/smoke (PM) and, due to combustion in air (comprising mainly nitrogen N_2 and oxygen O_2), nitrogen oxides (NO_X : a mixture of NO and NO_2).

Today, the air pollution in town and cities is mainly NO_2 from gas-fired boilers and, near roads, primarily NO_2 due to emissions from diesel and petrol engine motor vehicles, ultrafine particles from the combustion technology used in many diesel engines, and air-borne particles generated by tyre, road and brake wear. Emissions from distant sources, carried in the wind, also contribute to urban pollution concentrations.

In Nottingham, and most other UK cities, the main sources of urban NO_2 comprises emissions from transport, natural gas fired heating/hot water systems and boilers (industrial, commercial and domestic sources), and NO_2 from distant sources. Furthermore, in some locations in Nottingham (near busy roads), monitored concentrations of NO_2 exceed the annual mean Air Quality Objective/EU limit value of 40 ug/m^3.

In Nottingham, the largest local contributors to ambient concentrations of particulate matter (PM_{10}, $PM_{2.5}$, $PM_{0.1}$) are from road transport: diesel engine vehicles, tyre, brake, and road surface wear, and the burning of solid fuel such as coal-based ‘smokeless fuels’ and wood. However, air quality modelling indicates that the majority of Nottingham’s fine particulate air pollution ($PM_{2.5}$) comes from sources outside the City and comprises a proportion of secondary particles formed by chemical reactions between air pollutants such as ammonia, sulphur dioxide and nitrogen dioxide (Appendix 3a).

Indoor Air Pollution

Buildings and vehicles enclose space, and that space includes air. Indoor air pollution includes CO_2 and water vapour in exhaled breath, NO_2 and water vapour from cooking, and hydrocarbons and volatile organic compounds (VOCs) from air fresheners, and soft furnishings. Other biological sources in the home such as mites and moulds emit allergens and spores. Some of these chemicals and compounds not only affect comfort they also

adversely affect health and it is therefore important to ensure there are sufficient air-changes to prevent their build-up.

Generally, buildings and vehicles are not airtight, allowing air changes with the outside air, to occur. Outdoor air pollution thus contributes to indoor air pollution levels and vice versa; although shutting windows and vents (particularly when in a vehicle) slows the rate at which outdoor air pollution can enter, and indoor air pollution can leave, a building or vehicle.

In-vehicle Air Pollution

Whilst travelling in a vehicle the occupants breathe air drawn into the vehicle via the ventilation system and containing pollutants emitted from other vehicles. Studies show that drivers and passengers, particularly commuting in cars, receive the majority of their daily exposure to air pollution in this way, and higher concentrations than those measured in buses or at the roadside.

Appendix 2

Nottingham City NO_2 Air Quality Objective Monitoring (2013-2017)



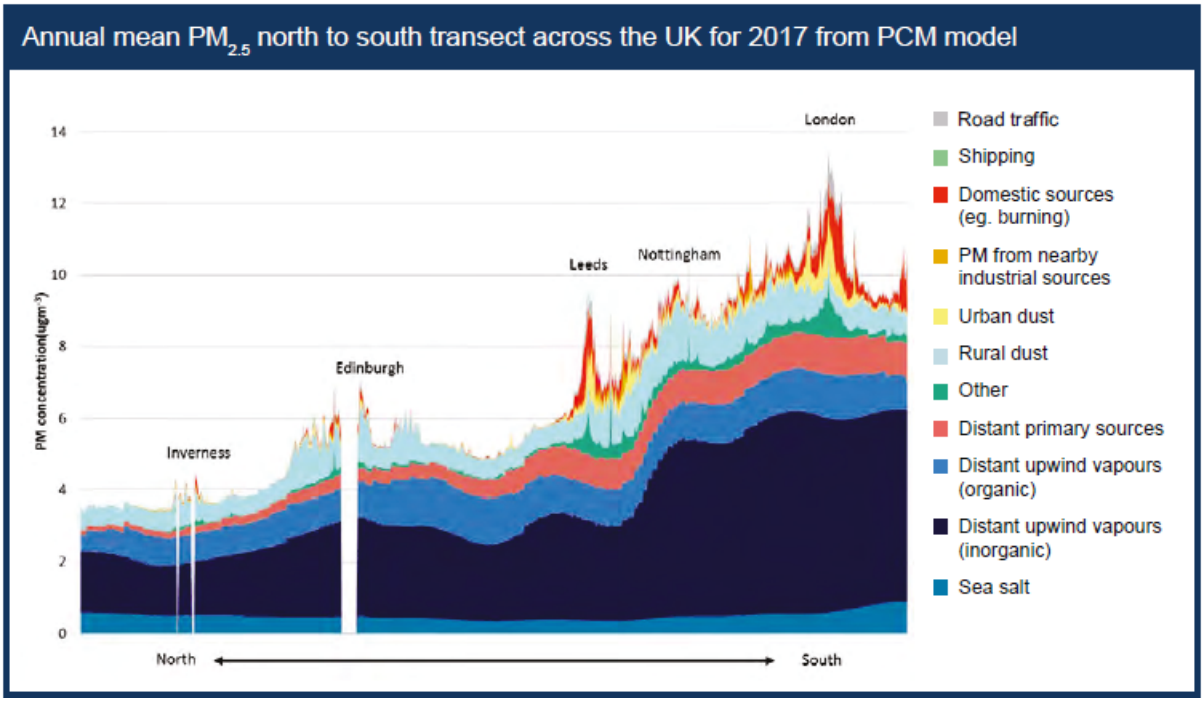
Air Quality Monitoring Sites: NO_2 Objective Adherence — **Air Quality Management Areas** (AQMAs)

- ('SA' & 'CG' real-time analysers) **NO_2 Annual Mean Air Quality Objective (AQO) exceeded in 2017**
- (Numbered) **Diffusion tube bias adjusted levels exceed AQO using either local (1.07) or national (0.89) bias adjustment factor**
- **Diffusion tube bias adjusted levels exceed AQO using local bias adjustment factor (1.07)**
- **Diffusion tube bias adjusted levels have not exceeded AQO (2013-2017) using either local or national bias adjustment factor**
- 'Non-sensitive' monitoring sites

Tubes 24, 25 & 26 co-located at St.Andrew's Road ('SA') are not shown on map.
Note that numbers on points relate to site IDs and not NO_2 levels.

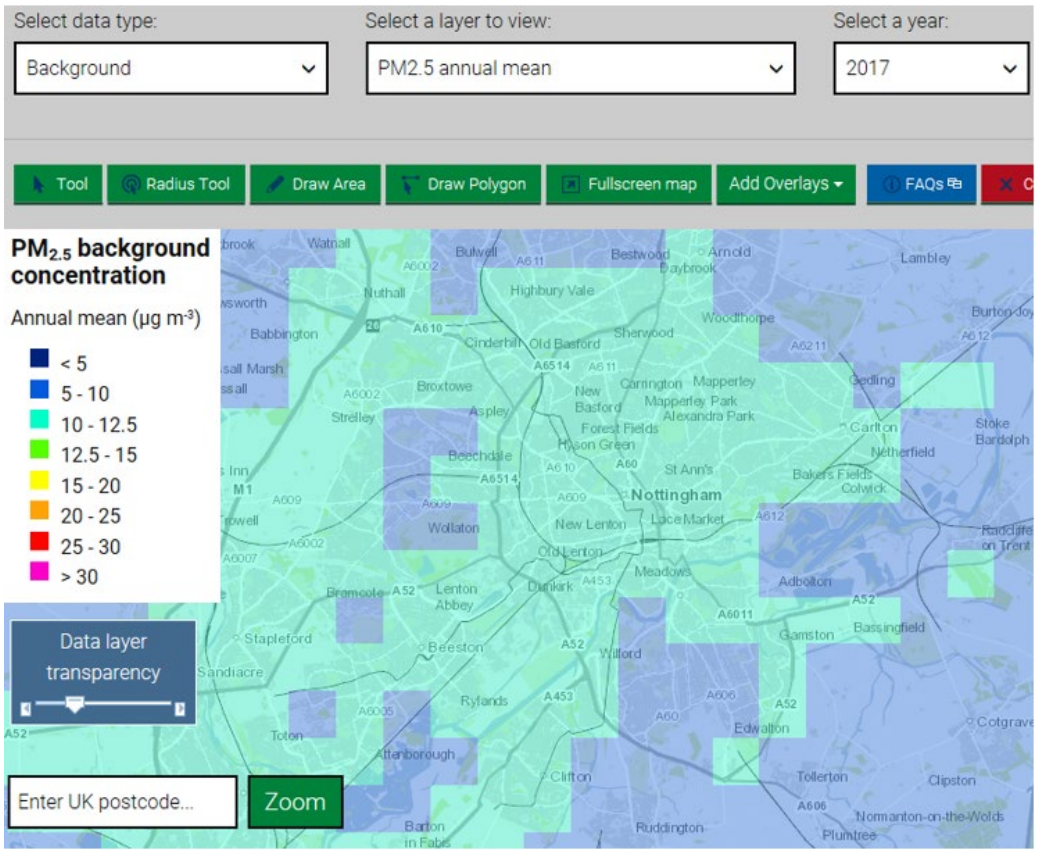
Nottingham City Council

Appendix 3a



From UK Clean Air Strategy 2019 DEFRA. https://www.gov.uk/government/publications/clean-air-strategy-2019

Appendix 3b – PM2.5 https://uk-air.defra.gov.uk/data/gis-mapping



Appendix 4

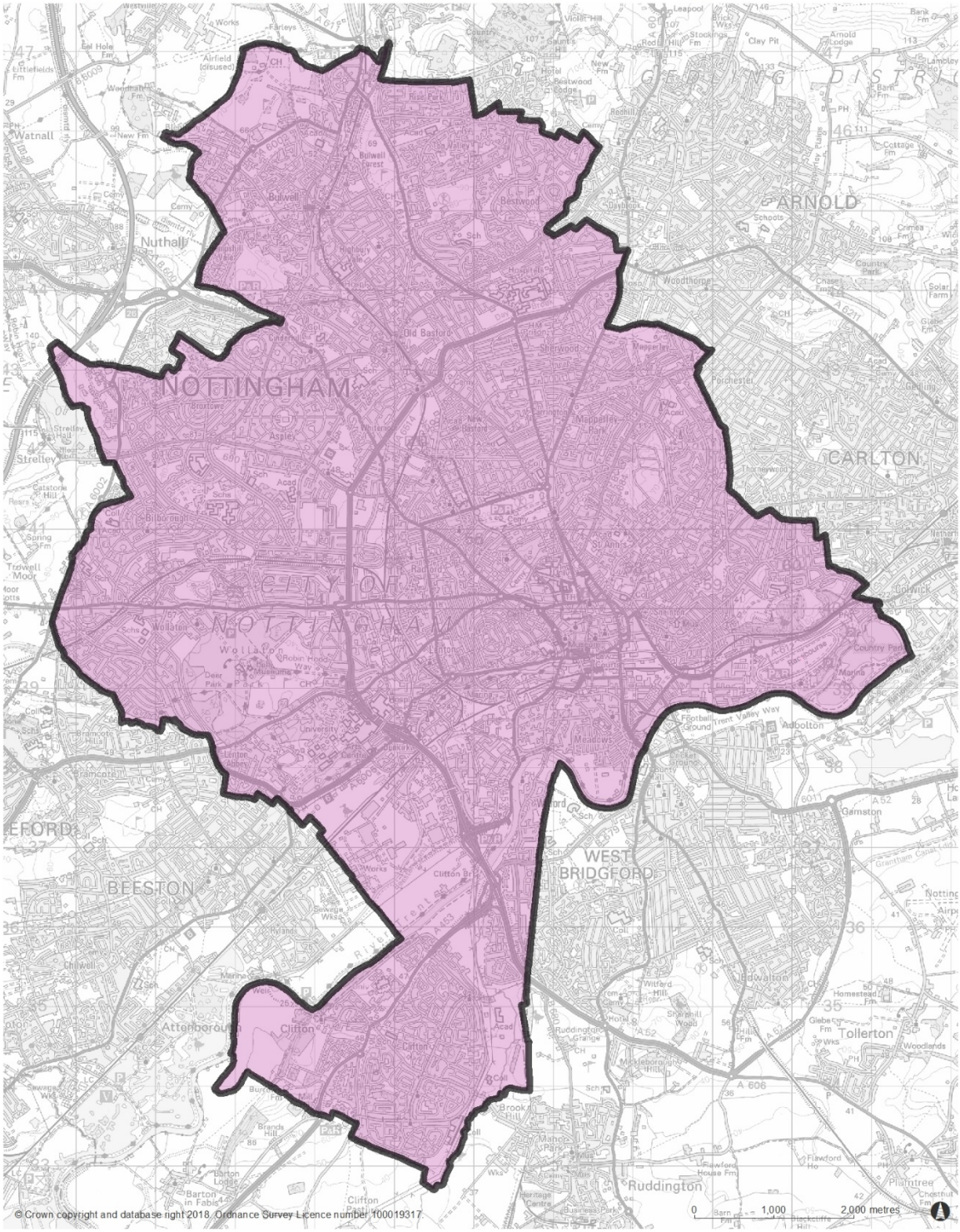
Indicators from the Public Health Outcomes Framework and NHS Outcomes Framework for which action on air quality could contribute towards health improvements

Indicator (Framework)	Description	Example of Actions
1.10 (PHOF)	Rate of people killed and seriously injured on the roads, all ages, per 100,000 resident population	Developing safer routes for walking to school, and creating road spaces which prioritise 'place' over cars by creating safe enjoyable local environments with 'walkability' will improve air quality and also reduce road accidents.
1.16 (PHOF)	Percentage of people using outdoor space for exercise/health reasons	A modal shift toward active travel would result in larger numbers of people using outdoor space for exercise, and improve air quality.
2.06i (PHOF)	Percentage of children aged 4-5 classified as overweight or obese	A modal shift toward active travel would contribute to reductions in obesity, and improve air quality
2.06ii(PHOF)	Percentage of children aged 10-11 classified as overweight or obese	A modal shift toward active travel would contribute to reductions in obesity, and improve air quality
2.12 (PHOF)	Percentage of adults classified as overweight or obese	A modal shift toward active travel would contribute to reductions in obesity, and improve air quality
2.13i (PHOF)	Percentage of adults achieving at least 150 minutes of physical activity per week in accordance with UK CMO recommended guidelines on physical activity	A modal shift toward active travel would contribute to increases in physical activity, and improve air quality
3.01 (PHOF)	Fraction of all-cause adult mortality attributable to long-term exposure to current levels of anthropogenic particulate air pollution	All actions to improve air quality and reduce exposure to air pollution would result in an improvement in mortality attributable to exposure to air pollution.
3.06 (PHOF)	Percentage of NHS organisations with a board approved sustainable development management plan	Commitment to actions on air quality can reasonably be incorporated into board approved sustainable development management plans.

4.04i (PHOF)	Age-standardised rate of mortality from all cardiovascular diseases (including heart disease and stroke) in persons less than 75 years of age per 100,000 population	A reduction in traffic emissions would lead to less long-term exposure to air pollution with an associated reduction in cardiovascular disease.
4.07i (PHOF)	Age-standardised rate of mortality from respiratory disease in persons less than 75 years per 100,000 population	A reduction in traffic emissions would lead to less long-term exposure to air pollution with an associated reduction in respiratory disease.
2.3i and 2.3ii (NHS OF)	Reducing time spent in hospital by people with long-term conditions i Unplanned hospitalisation for chronic ambulatory care sensitive conditions (adults) ii Unplanned hospitalisation for asthma, diabetes and epilepsy in under 19s	A reduction in traffic emissions, together with a reduction in exposure to air pollution for vulnerable groups would result in fewer acute episodes related to heart disease, asthma and respiratory disease, as well as reducing the long-term prevalence of these conditions.

Appendix 5

Nottingham Air Quality Management Area (nitrogen dioxide) 2019



Area of Nottingham City subject to the Nottingham No.2 Air Quality Management Order 2002 (Nitrogen Dioxide) Variation Order 2019

Nottingham City authority boundary

Nottingham City Council