Air Quality in the West Midlands: Options Paper

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1.0 Purpose of the paper

This paper[1] aims to give an overview of the sources, levels and impacts of air pollution across the West Midlands. It briefly reviews existing work that is taking place to address poor air quality, and provides an indicative summary of additional interventions that might be adopted. The timing of this paper is significant given the that the Environment Act has recently received Royal assent, this Act updates national legislation and governance around all aspects relating to the natural environment, including air quality. The Act requires the Secretary of State to set targets for particulates as well as outlining expectations on new ways of working to reduce emissions. The paper concludes with two options for progressing work on air quality across the West Midlands:

1. Retaining existing working arrangements on air quality, supported by the activity undertaken as part of Transport for West Midlands' action on regional transport (as well as other WMCA strategies relating to energy, net zero and the natural environment), with local authorities seeking ad hoc assistance from the combined authority in line with the Environment Act (2021) provisions.
2. Air quality is addressed through a more proactive collaborative working arrangement with local authorities developing air quality plans within a wider West Midlands Air Quality Framework which clarifies roles for different parties and identifies a number of shared working practices.

If the latter is identified as the preferred option, additional work will be undertaken to produce such a framework, identify resourcing implications and bring proposals back to the WMCA Board.

2.0 Context setting: existing regulation and policy

There are already a number of different regulatory and advisory limits on air pollutants, as well as suggested policy approaches and measures for tackling poor air quality. The principle of subsidiarity will play a role in deciding the appropriate measure for delivery at the right scale, whether that is community, local authority, region, national government or suggested international limits. This section outlines the different approaches and solutions already in existence or, anticipated following the Environment Act (2021).

2.1 Local Air Quality Management responsibilities

The constituent local authorities of the Combined Authority and WMCA have concurrent legal duties to monitor, manage and review air quality under the Environment Act 1995. WMCA gained these concurrent duties through the West Midlands Combined Authority (Functions and Amendments) Order 2017 which was agreed as part of the second devolution deal for the West Midlands. Before the Order, only the constituent authorities had these duties.

Part IV of the Environment Act (1995) sets out these Local Air Quality Management (LAQM) duties. The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. Annual Status Reports (ASRs) are then an annual requirement showing the strategies employed by local authorities to improve air quality and any progress that has been made. In the WMCA area, levels are such that all constituent authorities

[1] The paper uses some technical terms, which are elaborated in Appendix 1: Glossary.

are required to produce an AQAP apart from Solihull (but the local authority has set out its plans in its own air quality strategy).

The intent of conferring the concurrent duties on WMCA as part of the second devolution deal was to support WMCA if it decided to use its existing powers in relation to the creation of a cross-boundary Low Emission Zones and/or Clean Air Zones. In such a situation there would need to be mutual co-operation between WMCA and the constituent authorities before WMCA could discharge relevant functions. In practice, the constituent authorities manage air quality and a need for WMCA to discharge statutory air quality functions has not been identified hitherto, over and above existing WMCA/TfWM actions and measures to support local authorities to improve local air quality.

An important aspect of air quality regulation and actions has been the requirement to reduce nitrogen dioxide levels in accord with the *UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations* 2017 and its 2018 supplement. Birmingham City Council was identified as a 'First Wave' authority, mandated to implement a Clean Air Zone. Coventry City Council was identified as a 'Second Wave' authority, whilst Dudley MBC, Sandwell MBC, Solihull MBC and City of Wolverhampton were identified as 'Third Wave' authorities. All seven of these local authorities have taken actions to reduce annual exceedances of NO_2 at locations exceeding the national Air Quality Objective level of an annual average of 40 $\mu g\ m^{-3}$.

2.2 UK: Existing legal responsibilities

Current UK (national - devolved) air quality limits and objectives (for outdoor, ambient air) are set in UK and European Union (EU) legislation and directives as follows:

- Objectives and regulations for local air quality management are set out in UK air quality policy
- Mandatory limits on acceptable pollutant concentrations were set in an EU framework and have been transcribed into UK legislation. UK air quality targets have not yet been impacted by the UK leaving the EU.
- The Environment Act commits the government to establishing new targets for England, including at least one target for fine particles in air ($PM_{2.5}$).

In parallel, the World Health Organisation issues non-binding guideline levels of air pollutants for the protection of human health. These are effectively the lowest concentration at which there is clear evidence of a risk to health. The WHO guideline levels, previously dating to 2005, were updated in 2021, including interim targets intended to guide reduction. These guideline levels are exceeded in most urban areas in the UK.

In 2020, Southwark Coroner's Court formally recognised poor air quality as making a material contribution to the death of a young girl in London, with this formally recorded on her death certificate, the first such determination worldwide. Although the finding has no binding impact, instances such as this could increase pressure for achievement of legal targets, and wider awareness measures.

Table 1: Selected current Air Quality Objectives for England, and WHO 2005 and updated 2021 guideline levels

Pollutant	Averaging Time	**Air Quality Objectives** **(England – Current legally binding limits)**	WHO Guidelines 2005	**WHO Guidelines 2021**
Fine Particles, $PM_{2.5}$	Annual mean	**25**	10	**5**
Nitrogen Dioxide, NO_2	Annual mean	**40**	40	**10**
Ozone, O_3	Daily max 8h mean	**100**	100	**100**

See links for precise target definitions and other pollutant targets. This table is heavily simplified. Concentrations in μgm^{-3}

- The Clean Air Strategy (2019) set an ambition to achieve a 50% reduction in the number of people living in locations above the (then) WHO $PM_{2.5}$ guideline level of 10 ugm^{-3} by 2025.
- Current PM and NO_2 levels across the West Midlands are shown in Figure 2, below.

2.3 Future policy: the implications of the Environment Act

The Environment Act, 2021 sets out the government's framework for environmental legislation post-Brexit. This Bill was included in the Queen's Speech in May and received Royal Assent in November 2021.

The Act is expected to increase focus on $PM_{2.5}$ and, requires the Secretary of State to establish at least one long term (minimum 15 years) target in respect of air quality, and a target for $PM_{2.5}$ concentrations expressed as an annual mean. These targets would be legally binding and the Act says that they '*must be laid before Parliament on or before 31 October 2022'.* If the annual mean $PM_{2.5}$ target were to be set at the (previous) WHO guideline level (10 $\mu g\ m^{-3}$), DEFRA modelled average concentrations of $PM_{2.5}$ across 72 of the 192 wards within the WMCA would be in exceedance of this target (2019 data). Similar exceedances would be observed in other comparable urban areas in England. It is anticipated that there will also be targets set around NO_2.

In addition to the changes to targets for specific pollutants, the Environment Act also gives the Secretary of State the power to designate, following consultation, relevant public authorities as 'Air Quality Partners' who would also be required to co-operate with the development of action plans, and to take proportionate action to improve air quality where necessary. The onus will remain on local authorities to develop air quality action plans but they will be able to identify air quality partners to co-operate with them. More specifically:

"85A Duty of air quality partners to co-operate

(1) For the purposes of this Part, an "air quality partner" of a local authority means a person identified by that authority in accordance with section 82(5)(b) or (c).

(2) An air quality partner of a local authority must provide the authority with such assistance in connection with the carrying out of any of the authority's functions under this Part as the authority requests.

(3) An air quality partner may refuse a request under subsection (2) to the extent it considers the request unreasonable.

85B Role of air quality partners in relation to action plans

(1) Where a local authority in England intends to prepare an action plan it must notify each of its air quality partners that it intends to do so.

(2) Where an air quality partner of a local authority has been given a notification under subsection (1) it must, before the end of the relevant period, provide the authority with proposals for particular measures the partner will take to contribute to the achievement, and maintenance, of air quality standards and objectives in the area to which the plan relates.

(3) An air quality partner that provides proposals under subsection (2) must—

> *(a) in those proposals, specify a date for each particular measure by which it will be carried out, and*
>
> *(b) as far as is reasonably practicable, carry out those measures by those dates.*

(4) An action plan prepared by a local authority in England must set out any proposals provided to it by its air quality partners under subsection (2) (including the dates specified by those partners by virtue of subsection (3)(a)).

(5) The Secretary of State may direct an air quality partner to make further proposals under subsection (2) by a date specified in the direction where the Secretary of State considers the proposals made by the partner under that subsection are insufficient or otherwise inappropriate.

(6) A direction under subsection (5) may make provision about the extent to which the further proposals are to supplement or replace any other proposals made under subsection (2) by the air quality partner.

(7) An air quality partner must comply with any direction given to it under this section."

The Environment Act will also require Councils and other relevant public bodies to work closely together when developing air quality action plans. Specifically:

86B Role of combined authorities in relation to action plans

(1) Where a local authority in the area of a combined authority intends to prepare an action plan it must notify the combined authority.

(2) Where a combined authority has been given a notification under subsection (1) by a local authority, the combined authority must, before the end of the relevant period, provide the local authority with proposals for particular measures the combined authority will take to contribute to the achievement, and maintenance, of air quality standards and objectives in the area to which the plan relates.

(3) Where a combined authority provides proposals under subsection (2), the combined authority must—

> *(a) in those proposals, specify a date for each particular measure by which it will be carried out, and*
>
> *(b) as far as is reasonably practicable, carry out those measures by those dates.*

(4) An action plan prepared by a local authority in the area of a combined authority must set out any proposals provided to it under subsection (2) (including the dates specified by virtue of subsection (3)(a)).

(5) In this section "combined authority" has the meaning it has in Part 6 of the Local Democracy, Economic Development and Construction Act 2009 (see section 120 of that Act)."

2.4 The starting point: activity underway in the West Midlands

It is important to recognise that there is already significant work underway in relation to addressing poor air quality across the West Midlands. This has been led through local authorities, and programmes that are part of the regional Local Transport Plan, led by Transport for West Midlands.

2.4.1 Local authority air quality plans

Current air quality policy at a **local authority level** has tended to focus on transport interventions and is driven by the need to meet mandatory concentration limits for pollutants (see Appendix 2 for more detail). As a result, the plans described below prioritise actions related to reducing NOx rather than particulates. These include:

- ***Birmingham City Council Air Quality Action Plan*** (2021 – 2026) includes the implementation of the Clean Air Zone and other mitigation measures as well as exploring the impact of transport and demand reduction. There is also some work on controlling industrial and domestic emissions and behaviour change.
- ***Solihull MBC Clean Air Strategy*** (2019 – 2024) focuses on a range of different behaviour change and transport interventions, including schools' programmes, electrification of transport, provision of infrastructure for electric vehicles and modal shift. Solihull's plan is different from the other local authorities as the only constituent authority not mandated (by Defra) to produce an Air Quality Action Plan.
- ***Sandwell MBC Air Quality Action Plan*** (2020 -2025) focuses on a number of transport measures to improve air quality, as well as exploring the role of planning and behaviour change campaigns. It highlights the need for the local authority to lead by example.
- ***Coventry City Council Local Air Quality Plan*** (approved by government in 2020) is focused on transport and behaviour change around travel, including promoting EVs, decarbonising the public transport network, real-time air quality monitoring linked to dynamic traffic management, improvements to the road network to tackle congestion, construction of segregated cycle routes and initiatives supporting behaviour change and active travel.
- ***Walsall MBC's Air Quality Action Plan*** (2009) addresses the need to reduce vehicle emissions and traffic, as well as promoting public transport and active travel. It also looks to address both road and rail infrastructure.
- ***Dudley MBC Air Quality Plan*** (2011) includes the following approaches to tackling air quality: behaviour change, addressing school travel, improvement of public transport, leading by example with the council's fleet and building air quality into planning.
- ***Wolverhampton City Council's Air Quality Action Plan*** (2006) addresses reduction of emissions from transport, industry and commerce, improving public transport and active travel options as well as reducing emissions and traffic volumes, and infrastructure improvements.

Annual Status Reports (ASRs) provide updates from the local authorities on progress in improving local air quality.

2.4.2 Air quality work in the West Midlands

In 2019, a draft "*West Midlands Combined Authority Regional Air Quality Review and Action Plan"* was prepared by AECOM. This provides a useful reference point for air quality improvements across the West Midlands and was used to inform Transport for West Midlands' (TfWM) air quality work. TfWM regularly updates the WMCA Transport Delivery Committee Member Engagement Group (MEG) for Air Quality, Congestion and Environmental Impact on transport actions currently being undertaken to reduce emissions of NO_2 and other pollutants in the West Midlands. These are based on ten themes:

1. Greater use of public transport, cycling and walking, and home working
2. Cleaner vehicle engines
3. Greener streets

4. Improved air quality at junctions
5. Travel Demand management and smarter choices
6. Research and development to reduce fine particulates
7. Lower freight emissions
8. Co-ordinated funding bids
9. Improved monitoring and research
10. Sharing best practice for planning and transport

These actions have a positive impacts on NO_2 and transport related PM2.5 emission, but do not currently address the wider concerns related to particulates, for example from domestic and industrial combustion. TfWM is currently producing a new West Midlands Local Transport Plan which will have carbon reduction and improved air quality as key themes for West Midlands transport strategy.

2.4.3 Air quality and wider environment plans: co-benefits

In addition to this, the WMCA has now developed clear and ambitious plans to reduce regional carbon emissions and improve the natural environment. These include the region's first five year plan for Net Zero, and a Natural Environment Plan. A regional approach to air quality would sit alongside these plans, which are mostly complementary but may include a consideration of trade-offs in some circumstances:

- Air pollution and climate change are two separate, but closely linked, environmental problems, often sharing similar sources[2].
- **Greenhouse gases impact the global climate**. These compounds absorb and emit infrared energy from the Earth, warming the planet's surface. Carbon dioxide is the dominant anthropogenic greenhouse gas, and is not harmful to health at everyday levels.
- **Air pollution is impacted by local and regional emissions** of toxic gases and particles. These pollutants have a smaller impact on global climate than carbon dioxide, but directly impact human health.
- Most air pollutants only last a few hours or days in the atmosphere – so local actions reduce local concentrations, and improve local air quality and local health. The **clean air benefit is local to the region**.
- Actions to improve climate can lead to air quality co-benefits (e.g. electric vehicles; active transport) and in some cases tensions/conflicts (e.g. promotion of diesel rather than petrol vehicles).
- By integrating considerations of air quality and climate change, actions and public policies which offer maximum benefit to both health and climate can be prioritised and unexpected negative consequences can be mitigated or avoided.

The work being done by WMCA to reach Net Zero is likely to have significant air quality co-benefits.

2.5 Other regional examples

The Greater London Authority (GLA) and Greater Manchester Combined Authority (GMCA) have both undertaken significant work on air quality:

- Both the GLA and GMCA have prioritised high levels of monitoring, resourcing real-time data provision across the respective regions available to citizens. To tackle domestic air pollution,

[2] Royal Society: Effects of net-zero policies and climate change on air quality. Royal Society, London, 2021.

the GLA is encouraging the installation of cleaner low-carbon boilers and working to increase awareness of Smoke Control Zones to ensure only the cleanest appliances and fuels are used.

- The GLA has substantially expanded the Ultra-Low Emission Zones in place (eighteen times larger than the existing ULEZ) with stricter polluting compliance. GMCA is launching its GM-wide Clean Air Zone in May 2022 with £120m national government funding to support businesses to upgrade non-compliant vehicles. The zone covers all 10 of the local authorities, but will not charge private cars instead focusing on 'high-polluting, non-compliant HGVs, buses, taxis, private hire vehicles, light goods vehicles and minibuses'.
- To tackle air pollution on construction sites and with the movement of heavy goods, the GLA has introduced multiple consolidation centres and Non-Road Mobile Machinery Zone Enforcement, which ensures the use of the cleanest construction equipment.
- Both the GLA and GMCA are working on creating versions of Low Emission Neighbourhoods (LENs), which aim to improve infrastructure for walking, cycling and ultra-low emission vehicles at a local level, as well as innovative measures such as School Streets (a School Street is a road outside a school with restrictions on motor traffic at school drop off and pick up times). In Greater Manchester this wider plan is known as the BEE Network, which is receiving funding from national government's Active Travel Fund, the Transforming Cities Fund and with aspirations to receive further government investment for a total budget of £1.5bn.
- Additionally, both regions are investing heavily in electric vehicle incentives, with infrastructure, such as charging points, being installed rapidly through GLA/GMCA-led measures (in some cases implemented by the constituent local authorities), and financial incentives to invest in cleaner vehicles, including for taxi and private hire vehicles. Public transport is also receiving investment to become cleaner, with hydrogen bus trials in Greater London and bus retrofitting in Greater Manchester having been awarded £14.7m.

3.0 Emerging issues and trends

To understand where we need to prioritise interventions, as well as what those interventions might be, it is important to have a clear idea of what the data is telling us about regional air quality and who is impacted. This falls into three broad areas:

3.1 Health impacts of poor air quality

Exposure to poor air quality results in short- and long-term health impacts and is estimated to be responsible for up to 36,000 premature deaths each year across the UK[3]. In the West Midlands Nitrogen dioxide (NO_2) and particulate matter (PM) are the pollutants with the greatest impact on health. In the short term, exposure to NO_2 can lead to the irritation of airways, worsening the symptoms of those suffering from lung diseases. Epidemiological studies have shown long term NO_2 exposure to be associated with worsening of bronchitis symptoms, reduced lung function, and reduced lung development in children. NO_2 exposure has been associated with increased risk of all-cause mortality even at low exposure levels[4].

[3] Royal College of Physicians (RCP). Every breath we take: the lifelong impact of air pollution. Report of a working party. London: RCP, 2016

[4] COMEAP: Associations of long-term average concentrations of nitrogen dioxide with mortality. COMEAP, London, 2018. (https://www.gov.uk/government/publications/nitrogen-dioxide-effects-on-mortality)

Particles are classified by their diameter with PM_{10} indicating particles with a diameter of 10 µm or below (approx 1/5 the width of a human hair) and $PM_{2.5}$ a diameter of 2.5 µm or below. Smaller particles penetrate more deeply into the lungs and may enter the bloodstream, and are associated with greater negative health impacts. The health effects of short- and long-term exposure to fine particles ($PM_{2.5}$) are well documented, including respiratory and cardiovascular morbidity, and increased risk of mortality from cardiovascular and respiratory diseases, and lung cancer. There is emerging evidence of impacts on cognitive function.

The number of deaths attributable to $PM_{2.5}$ exposure in the West Midlands can be estimated using standard dose-response coefficients, applied to the proportion of deaths among those aged 30 or over in each of the seven metropolitan boroughs of the West Midlands Combined Authority area[5]. Using 2019 data, 1385 early deaths each year were attributable to long term $PM_{2.5}$ exposure across the West Midlands[6].

3.1.1 Impacts of Covid-19

The March 2020 Covid lockdowns led to a step change in many aspects of societal and economic activity across the West Midlands and more widely. Overall traffic levels in particular fell by over 60%, and road traffic emissions of nitrogen oxides correspondingly fell significantly, while ozone levels rose. After adjustment for weather effects, levels of NO_2 fell by up to 40% during the period to 15 June, compared to pre-lockdown norms[7]. However, levels of PM showed less response (and were impacted by long-range transport effects, driven by the weather). Similar changes were observed for other cities[8]. The air quality response to the Covid lockdowns demonstrated the response of NO_2 to changes in traffic – reflecting transport sector emissions as dominating NO_2 levels across the region – and also that for particulates, a wider range of emission sources, and advection of PM from elsewhere, are important.

A recent (Sept 21) review of published studies of the relationship between Covid and Air Quality[9] has found evidence of a link between long-term exposure to air pollution and increased risk of hospitalisation / worse health outcomes in people infected with COVID-19, and that long-term exposure to air pollution may increase risk of contracting the disease, if exposed to the virus.

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[5] PHE: Review of interventions to improve outdoor air quality and public health, Public Health England, London, 2019

[6] Hodgson J., Zhong J., Bartington S. and Bloss W.: Briefing Note: Updated World Health Organisation (WHO) Air Quality Guidelines & Implications for the West Midlands. WM-Air, Birmingham, 2021. (https://wm-air.org.uk/wp-content/uploads/2021/09/Updated-WHO-Guidelines-for-Air-Quality-2021-West-Midlands-briefing-note.pdf)

[7] Bloss W., Shi S., Rooney D., Cowell N. and Song C.: Air quality in the West Midlands: impacts of COVID-19 restrictions, March-May 2020. WM-Air, Birmingham, 2020 (https://wm-air.org.uk/wp-content/uploads/2020/06/UoB-Briefing-May2020-WM-Air-Quality-Bloss-v2.pdf)

[8] Shi Z., Song C., Liu B., Lu G., Xu J., Van Vu T., Elliot R.J.R., Li W., Bloss W.J. and Harrison R.M.: Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns. Science Advances, 7, 2021 (https://www.science.org/doi/full/10.1126/sciadv.abd6696)

[9] Walton H., Evangelopoulos D., Kasdagli M., Selley L., Dajnak D. and Katsouyanni K.: Investigating links between air pollution, COVID-19 and lower respiratory infectious diseases. Imperial College London, London, 2021– (https://www.imperial.ac.uk/media/imperial-college/medicine/sph/environmental-research-group/ReportfinalAPCOVID19_v10.pdf)

3.2 Economic and wider environmental impacts of poor air quality

Poor air quality affects economic development through a range of channels. The best understood of these is the pollution-health-economy channel through which poor air quality can result in a number of economic impacts[10 11]:

- Poor air quality leads to poor human health, which then leads to higher health expenditure.
- Poor air quality leads to deaths (reduced working population) / work absenteeism / reduced physiological and cognitive ability / reduced labour market performance - reduced productivity reducing GDP.
- Poor air quality negatively affects human capital accumulation (e.g., poorer academic performance) reducing individual productivity.

Additionally, poor air quality will negatively affect ecological systems and the quality of Natural Capital, which can be transferred into economic loss. Similarly, poor air quality leads to reduced agricultural yields and will therefore result in reduced GDP. Poor air quality has also been shown to negatively affect decision making. Studies have shown that the decision-making of investors, as well as financial performance (stock market / derivatives) is negatively affected by poor air quality.

Analysis by CBI Economics (2020), commissioned by the Clean Air Fund, showed that reducing NO_2 concentrations across the UK to meet the WHO 2005 guidelines (annual average less than 40 µg m^{-3}) would provide £1.6 billion a year benefit to the UK economy. The same study found that a 5µg m^{-3} reduction in NO_2 concentrations in Birmingham would result in 216,000 hours worked extra per annum and a £2.7 million benefit to Birmingham's economy each year.

3.3 Air pollution levels in the West Midlands

Real time air pollution monitoring is performed at a limited number of fixed points around the region by Local Authorities and through national DEFRA monitoring stations, operating accredited instruments which meet technical requirements for data quality. These fixed monitors can be supplemented by passive diffusion tubes, which give an average (typically 4-week) estimate of NO_2 levels, but require offline laboratory analysis. Fewer $PM_{2.5}$ measurements are available, in part, due to the cost of purchasing reference method monitors. Increasingly, "low cost" sensor networks are supplementing the established approaches in particular areas, but there is no national quality standard or coordinated approach to their use.

Given the limited measurement coverage, air quality levels can also be estimated using computer model simulations. Figure 2 shows model predictions for indicative annual average NO_2 and $PM_{2.5}$ concentrations across the region, based upon emissions data from the National Atmospheric Emission Inventory[12].

Predicted annual mean NO_2 levels range from 12 to over 60 µg m^{-3}, with the spatial pattern closely reflecting the road network. Predicted annual mean $PM_{2.5}$ levels range from 8 to nearly 20 µg m^{-3},

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[10] Dechezleprêtre A., Rivers N. and Stadler B.: The economic cost of air pollution: Evidence from Europe. OECD, Paris, France, 2019

[11] Zivin J.G. and Neidell M.: Air pollution's hidden impacts: Exposure can affect labor productivity and human capital. Science, 359 (6371), 39-40, 2018

[12] Zhong J., Hood C., Johnson K., Stocker J., Handley K., Wolstencroft M., Mazzeo A., Cai X. and Bloss W.J,: Using Task Farming to Optimise a Street-Scale Resolution Air Quality Model of the West Midlands (UK). MDPI, 12(8), 983, 2021.

with a more diffuse spatial pattern reflecting their wider range of sources and longer atmospheric residence time.

Annual mean NO_2 levels in localised areas exceed the current UK air quality objective (40 $\mu g\ m^{-3}$), and such areas are usually the subject of local authority Air Quality Management actions outlined above. Predicted annual mean $PM_{2.5}$ levels meet the current UK air quality objective (25 $\mu g\ m^{-3}$), but exceed the 10 $\mu g\ m^{-3}$ ambition set in the national Air Quality Strategy / 2005 WHO guideline in many areas. $PM_{2.5}$ levels are higher than the 2021 WHO air quality guideline level across the region.

- The highest annual average $PM_{2.5}$ concentrations in the West Midlands are modelled in central Birmingham, Coventry, Sandwell and Walsall.
- DEFRA provide air pollution estimates of pollution concentrations at 1km resolution. When averaged to ward level, these data show annual average $PM_{2.5}$ levels in 72 of the 192 wards within the West Midlands exceed 10 $\mu g\ m^{-3}$
- 1.2m people or *ca*. 40% of the West Midlands' population live in wards exceeding the 2005 WHO guideline level (10 $\mu g\ m^{-3}$).
- The least advantaged areas (highest IMD score) tend to have the worst air quality.

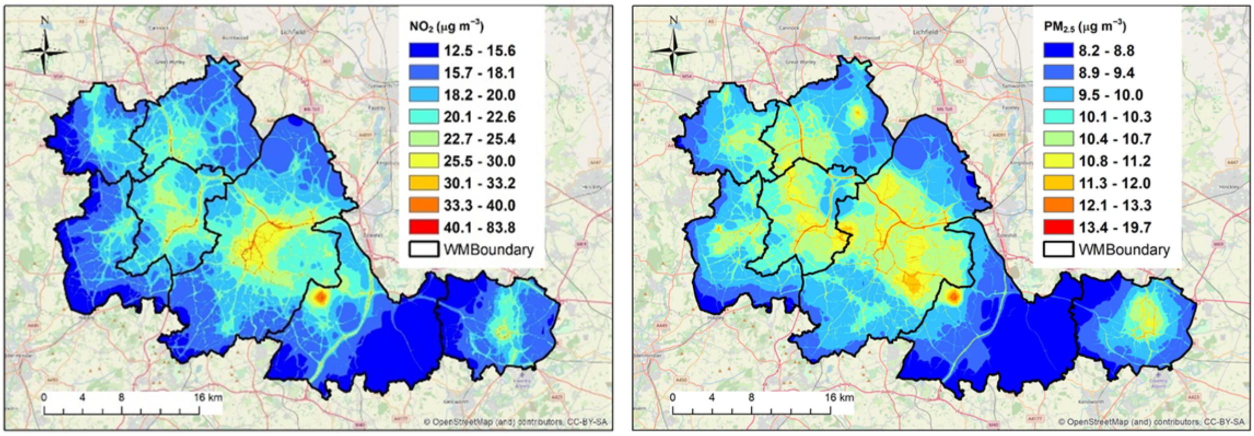


Figure 2: Predicted annual average concentrations of NO_2 (left) and $PM_{2.5}$ (right) in the West Midlands. Drawn from NAEI emission data & WM-Air modelling[13]

3.3.1 Trends in emissions with time

Emissions of nitrogen oxides and urban concentrations of NO_2 have fallen over the past decades, with the implementation of more stringent vehicle emissions standards (EURO classifications) and as newer vehicles penetrate the overall fleet. Electric vehicles (EVs) comprise a small fraction of the current fleet mileage, but their wider future adoption, encouraged through national phase-out measures, will further reduce tailpipe emissions of NO_2. Power plant emissions may remain, depending upon the electricity source. Vehicle emissions of PM arise from both the exhaust, and non-exhaust sources (notably brakes and tyres). The latter are significant – comprising the larger fraction of primary emitted particles for modern vehicles. Expected reductions in road transport nitrogen oxide emissions will increase the relative importance of and focus upon PM as the key air pollutant for health impacts in future.

[13]Zhong J., Hood C., Johnson K., Stocker J., Handley K., Wolstencroft M., Mazzeo A., Cai X. and Bloss W.J,: Using Task Farming to Optimise a Street-Scale Resolution Air Quality Model of the West Midlands (UK). MDPI, 12(8), 983, 2021.

3.3.2 Measuring Progress

Most national air quality objectives take the form of a pollutant threshold concentration, which should not be exceeded. This is conceptually straightforward, and best protect communities exposed to the worst air quality - which also tend to be otherwise disadvantaged - but neglects the clear science that no threshold for health effects has been identified. Population health gains from improvements in air quality below the legal threshold level are not captured (or incentivised).

An alternative metric considers *population exposure* – how many individuals are exposed to how much pollution. Reducing population exposure captures gains across the population, and is relevant when assessing chronic and long-term population health impacts. Population exposure can also be used to evidence progress over time – rather than just compliance (or not) with a fixed limit. Figure 3 below shows population weighted exposure (combining ward-level overall population and ward-level average concentrations) for $PM_{2.5}$ across the West Midlands.

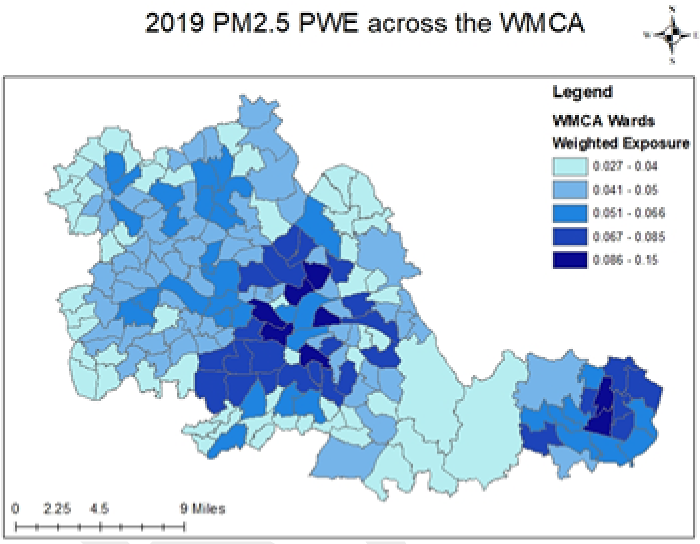


Figure 3: Population-weighted exposure to annual mean PM2.5 level

A combination of threshold and population exposure metrics may best combine measuring clean air progress across the population, with protection for the communities exposed to the poorest air quality. Adoption of such an approach would be leading, nationally, and position WMCA for the likely format of the targets required by the Environment Act. Such metrics will also allow actions to be prioritised for locations where exposure is greatest, to deliver the greatest health gain, and to reduce regional environmental health inequalities.

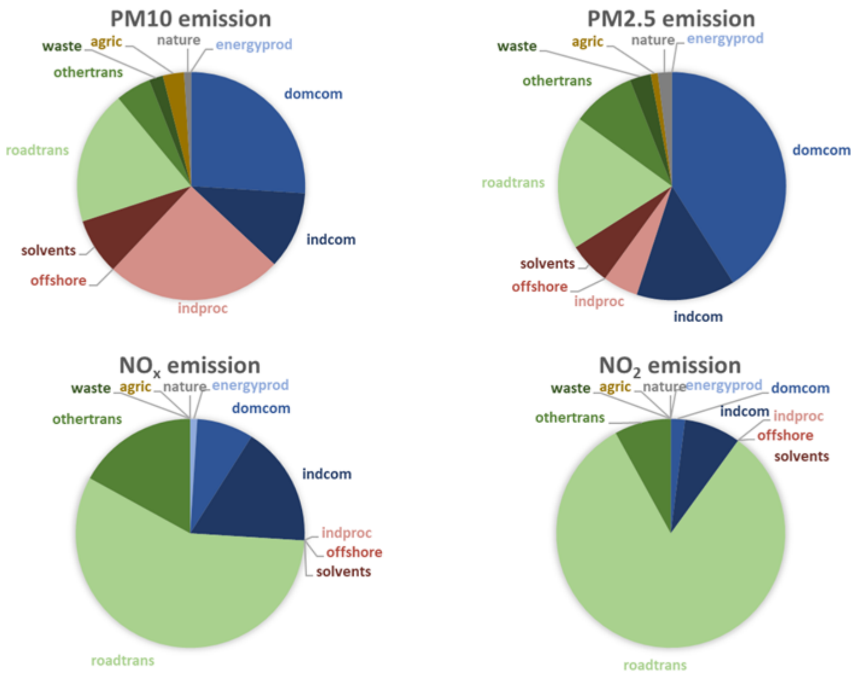
3.3.3 Sources of Air Pollutants in the West Midlands

Air pollution sources are categorised as primary – species directly emitted to the air, such as soot particles – and secondary – pollutants which are formed in the atmosphere, from the processing of primary emissions. The policy implication is that levels of primary pollutants typically respond in a straightforward way to control relevant emissions, while the response of secondary pollutants is more complex.

- Nitrogen dioxide is essentially a primary pollutant, emitted directly from or formed following high temperature combustion (notably, road transport).
- PM has both primary and secondary elements. Direct emission sources include biomass (wood) burning, combustion, resuspended dusts and mechanically generated particles; secondary sources include particle formation from the atmospheric processing of NO_2, SO_2 and VOC gases, and ammonia.

- Ozone gas is a secondary pollutant, formed in the air from the processing of VOCs and NO_x in the presence of sunlight
- The National Atmospheric Emissions Inventory (NAEI) collates direct emissions of pollutants from different economic sectors across the UK. NAEI-derived emissions for the West Midlands are shown below. These are the *primary* emission components – neglecting secondary PM sources. Some metropolitan regions (e.g. London and Manchester) maintain their own detailed emission inventories.

Figure 4: Direct emissions of pollutants by sector for the West Midlands



- NO_2 and NO_x emissions in the West Midlands are dominated by road transport (*roadtrans*). Within this, in typical urban UK environments, emissions are dominated by older diesel vehicles. Data on the split by vehicle type (e.g. car vs HGV vs bus) is available. WM-Air work is assessing the actual, real-world on-road variation in emission with vehicle type and operation.
- Primary PM emissions in the West Midlands have a much wider spread of sources – including commercial and domestic combustion (*domcom*), industrial production (*indproc*) and road transport (*roadtrans*). The largest single source of PM emissions though is commercial and domestic combustion.
- Secondary PM sources are in addition to those shown in Figure 4 above. These include components derived from NO_2 (from e.g. transport and power generation), from SO_2 (from e.g. power generation), from VOCs (from e.g. industrial, commercial and domestic emissions, and from the biosphere) and from NH_3 (e.g. agriculture)
- Air pollutants are dispersed and transported by the wind. Weather conditions can also affect their deposition and removal. Their rate of removal from the air – or lifetime – reflects how important transported pollution can be, relative to local emissions: levels of short-lived species will be dominated by local or regional emissions (e.g. NO_2); at the opposite extreme levels of very long lived species depend upon emissions globally (e.g. CO_2).

- PM, with a lifetime of a few days, bridges this divide: PM levels in the West Midlands reflect both local emissions, and transported pollution from elsewhere. See also case studies in sections 4.2 and 4.3, below.
- Pollutant emission is impacted by the weather. In cold periods increased domestic combustion and increased use of cars can increase emission of particulates and NO_2. High temperature and stagnant air in heatwaves can lead to increased ozone and particulate concentrations.

3.3.4 The growing significance of Particulate Matter

The importance of $PM_{2.5}$ relative to NO_2 for air quality will increase, as Net Zero policies, emission controls and the transition to electric vehicles lead to reductions in NO_x emissions.

Future emissions trends are projected through the National Atmospheric Emissions Inventory[14]. The emission trends anticipated in the 2019 Clean Air Strategy, without additional interventions, are shown below (as primary emissions relative to 2016 levels). Secondary formation mechanisms will modify the response of PM levels in air to these emission trends.

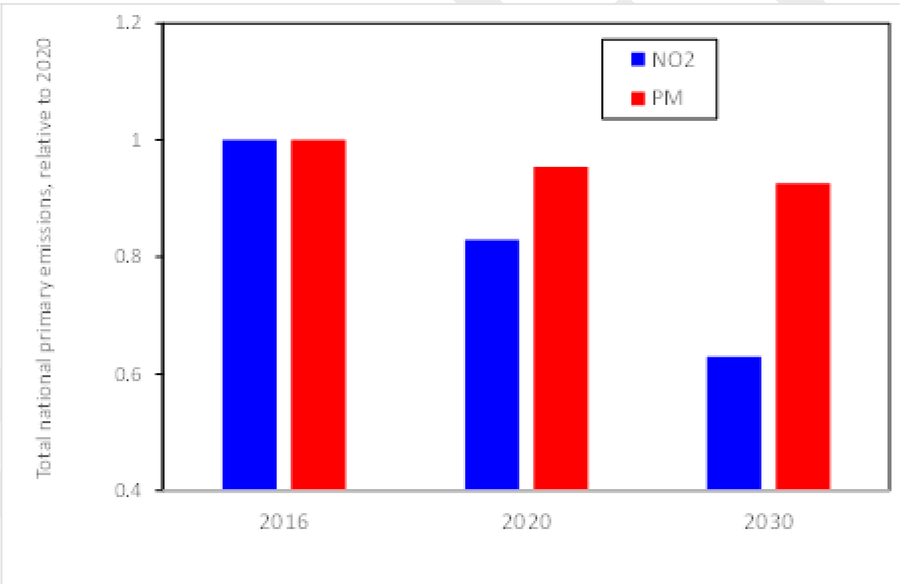


Figure 5: Direct (primary) national total emissions of NO_2 and $PM_{2.5}$ for 2016, and projections (without additional interventions) for 2020 and 2030, from the Clean Air Strategy (2019).

Delivery of Net Zero commitments – particularly relating to power generation, industry and transport – are likely to lead to additional significant reductions in national NO_x and PM emissions, although this is dependent on the non-fossil-fuel heat and power sources implemented.

The transition to electric vehicles will reduce tailpipe NO_x emissions (which dominate in the West Midlands), although on a national-scale emissions linked to the power generation requirement may remain.

[14] National Atmospheric Emissions Inventory, available at https://naei.beis.gov.uk/

In combination, together with strengthening evidence for the impact of even low concentrations of PM on health, an increased focus on PM is anticipated following the Environment Act – although the effects of NO_2 should not be neglected, as reflected in the tightened WHO guidelines (Table 1).

4.0 Implementation measures to improve air quality

Strategies to address poor air quality can be broadly categorised as "Reduce–Extend–Protect''.

- Reducing the emission of air pollutants is the most effective way to improve air quality (e.g., electric vehicles to reduce NO_2 emissions, eliminating combustion through decarbonisation of industry).
- Extending the distance between pollution source and human receptor gives time for air pollution to disperse, and can reduce exposure (e.g., redirecting traffic, moving walking routes away from main roads). This is usually the second most effective method of reducing exposure.
- Finally protecting vulnerable people by separating them from pollution in places where these vulnerable groups gather and wait, such as in front of hospitals, schools or at bus stops (e.g., green walls). For reducing exposure these "protect" interventions are generally less effective than those that reduce emissions or extend the distance between people and pollutant sources[15].

Options that could be delivered at a regional level, or combined with local authority activity, are outlined in brief below and are described in more detail in Appendix 3.

4.1 Transport

4.1.1 Road transport

Nationally road transport is the main source of NO_2 and also makes a significant contribution to primary emissions and secondary formation of $PM_{2.5}$. In the West Midlands, road transport accounts for ~80% of NO_2 emissions and ~20% of primary emissions of $PM_{2.5}$. NO_2 is produced during combustion in petrol and diesel vehicles, with per-vehicle emissions typically significantly higher from diesel than petrol vehicles. "Euro" standards are set type approval emissions standards which manufacturers must meet, and have set progressively lower emission limits for NO_2, particulates and other species from newer vehicles. Over the past decade, Euro standards have not delivered the anticipated improvements in air quality as the on-road emissions of some vehicles have been shown to be significantly higher than those in the standardised emissions test cycles then in force. This led to the diesel emissions scandal and revision of the test cycles, and demonstrates the importance of real world on-road emissions data.

Euro standards are typically used to identify compliant and non-compliant vehicles in clean air zones (CAZ). In the Birmingham CAZ, charges apply to vehicles that do not meet the minimum emissions standards – for example, Euro 6 for diesel cars and Euro 4 for petrol cars.
In addition to exhaust emissions, vehicles emit PM through abrasion of tyres and brakes, road surface wear, and resuspension of road dusts. In modern cars, these non-exhaust emissions of

[15] Hewitt C.N., Ashworth K. and MacKenzie A.R.: Using green infrastructure to improve urban air quality (GI4AQ). Ambio, 49, 62–73, 2020

particulates can exceed direct exhaust emissions[16]. Therefore, while the increasing proportion of electric vehicles (EVs) will in due course reduce tailpipe NO_2 emissions, this will have a smaller impact on PM emissions.

Interventions to reduce the air quality impact of road transport on health can focus on directly reducing emissions, or extending the distance between emission sources and resident populations, therefore reducing exposure. A broad range of interventions have been employed in the West Midlands to address NO_2 emissions. These have been delivered by TfWM and by Local Authorities through air quality action plans and other transport strategies, for example the Birmingham CAZ, new cycle routes, bus fleet upgrades, and school streets initiatives.

Interventions designed to reduce emissions from road transport fall into three broad groups: i. interventions designed to reduced demand for road transport (or more polluting forms of road transport); ii. Interventions designed to reduce emissions from existing vehicles; and, iii. Interventions designed to promote vehicles with low emissions.

Actions designed to reduce demand can be delivered at a local or regional level, and often involve improvement to public and active transport infrastructure. These measures could include:

- new tram and SPRINT Bus Rapid Transit routes;
- new suburban rail stations;
- core bus network improvements, including the All Electric Bus City, which will see Coventry's bus network operated by electric zero emission buses by the end of 2025;
- Very Light Rail (in Coventry), which will see a battery-powered lightweight tram providing mass transit within the city; and
- segregated cycle tracks and other initiatives to improve active travel (e.g. the WM Cycle Hire Scheme).

Increasing physical activity through active travel will deliver public health co-benefits alongside benefits to air quality. Behavioural change interventions at a local or regional level such as the promotion of home working and active travel aim to reduce road transport demand and therefore the emission of pollutants.

Traffic management schemes, such as signalised junction improvements, can be used to reduce emissions from existing vehicles. These actions limit congestion and therefore lead to reduced emissions from vehicles idling, braking and accelerating.

The uptake of low emission vehicles has the potential to deliver large reductions in emissions. Actions such as scrappage schemes and the introduction and expansion of clean air zones encourage a move to more modern, lower emitting vehicles. These have been employed at a local scale in Birmingham and Coventry, where people can trade in their old, polluting, car and in return receive credits worth up to £3k for public transport, bike share and car share, for example. The uptake of electric vehicles can be supported further through the expansion of EV charging infrastructure. Interventions can target private vehicles e.g., priority parking for low emission vehicles and public

[16] Harrison R.M., Allan J., Carruthers D., Heal M.R., Lewis A.C., Marner B., Murrells T. and Williams A.: Non-exhaust vehicle emissions of particulate matter and VOC from road traffic: A review. Atmospheric Environment, 262, 2021

information campaigns; business e.g., vehicle procurement best practise; and public transport e.g., electric buses.

Alongside interventions to reduce emission of pollutants, action can be taken to reduce population exposure. These interventions increase the distance between pollutant sources and people, allowing pollutants to disperse thereby reducing population exposure. These interventions can be employed at a local scale and include city centre lorry bans, freight consolidation centres and ensuring that newer buses are used on routes where the greatest pollution exposure occurs.

4.1.2 Rail and air transport

Emissions of NO_2 and $PM_{2.5}$ from rail and air travel make up a small proportion of total emissions at a national level but can be significant locally.

Emissions from the rail network are driven primarily by diesel trains but also are also produced by freight handling vehicles and road traffic at stations. Interventions to reduce emissions from the rail sector focus on electrification of the rail network and promotion of lower emissions from rolling stock. These interventions are primarily driven by national policy (the DfT’s Decarbonising Transport document sets targets in relation to phasing out diesel trains and for electrification of the rail network). Local authorities have less direct influence over rail travel but can support low-emission road transport links and cargo-handling and work with local operators towards other interventions[17]. There also may be scope to work with local operators to reduce exposure at enclosed stations through anti-idling and ventilation measures.

Emissions from airports can be grouped into 4 classes: i. aircraft emissions; ii. aircraft handling emissions; iii. infrastructure- or stationary-related sources; and iv. vehicle traffic sources[18]. There is limited scope to address aircraft emissions at a local level but action can be taken to reduce emissions from aircraft handling and vehicle traffic by supporting provision of EV infrastructure. Ensuring good public transport links and raising public awareness of these travel options may reduce traffic at airports and therefore vehicle emissions.

4.2 Industrial and agricultural emissions.

4.2.1 Industrial emissions

Emissions from industrial sources contribute significantly to regional NO_2 and $PM_{2.5}$ emissions. Industry is also a large source of volatile organic compounds (VOCs) which contribute to the formation of ozone the lower atmosphere. In the West Midlands the NAEI *Industrial Combustion* and *Industrial Production* sectors make up 8% of total NO_2 emissions and 19% of primary $PM_{2.5}$ emissions[19].

Interventions designed to reduce emissions from industrial sources can be broadly classed as “policy” (e.g. emissions ceilings and Eco-design and product standards) or “technology” (e.g. diffuse dust abatement) focused. Many of these interventions are controlled by national policy. Under Environmental Permitting Regulations (EPR 2016 & 2018) businesses must use best available

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[17] PHE: Review of interventions to improve outdoor air quality and public health, Public Health England, London, 2019

[18] ICAO: Airport Air Quality Manual. International Civil Aviation Organization, Montréal, 2015

[19] National Atmospheric Emissions Inventory (NAEI), 2019. Available at http://naei.beis.gov.uk/

techniques (BAT) to reduce their emissions. These techniques, and the emissions limits associated with the use of such techniques, are set out in best available technique reference documents[20]. The EU Withdrawal Act 2018 maintained the established environmental principles and ensured that existing EU environmental law continued to have effect in UK law, including the Industrial Emissions Directive (IED) and BAT Conclusion Implementing Decision made under it. The UK Government intends to put in place a process for determining the future of BAT for industrial emissions[21].

While most industrial interventions are dependent on national policy, allowing local flexibility to require stricter controls may help local authorities tackle emissions in problem areas. At a local scale Local Authorities can work with regulators and local operators towards site-specific interventions. For industry, technological interventions include dust abatement and primary and secondary control measures[22]. There may also be opportunity to consider operations of local facility clusters in combination. Actions underway to deliver industrial decarbonisation may lead to significantly reduced NO_x and $PM_{2.5}$ emissions, depending upon the alternative power solution implemented, as industrial combustion is a significant source of these species. However, emissions from biomass heat/power generation facilities have potential to worsen local air quality.

Alongside emissions reductions, there is frequently scope to reduce population exposure at a local level. For example, spatial planning could be used to ensure that new emission sources are placed away from vulnerable populations and interventions such as green infrastructure can be used to extend the distance between pollutant sources and residential populations, thereby increasing diffusion and reducing exposure.

4.2.2 Agricultural emissions

Ammonia (NH_3) is an air pollutant whose emissions leads to the formation of secondary particles through reaction with sulfuric and nitric acids. These particles are long lived in the atmosphere and can impact air quality long distances downwind of the emission source, contributing to PM levels. Agriculture is the dominant source of ammonia (NH_3) emissions in the UK, accounting for 88% of emissions in 2016[23] associated primarily with fertiliser and manure storage and application. Deposition of NH_3 can be a major source of pollution to sensitive ecosystems leading to nitrogen enrichment and acidification of soil and water sources. Recent analysis has shown that for mitigating $PM_{2.5}$ pollution controlling NH_3 emission may be more cost effective than further reductions to the emission of nitrogen oxides[24].

Interventions to reduce NH_3 emissions focus on changes to manure storage, application and fertilizer application changes. Changes to animal husbandry such as livestock housing (e.g. exhaust air scrubbing) and foodstuffs (e.g. changes to cattle diet) can also reduce emissions. These interventions can be driven by changes to national legislation or through local incentives leading to behaviour change.

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[20] DEFRA: Air Pollution in the UK 2020. Department for Environment, Food and Rural Affairs, London, 2021

[21] DEFRA, 2020, available at https://www.gov.uk/guidance/industrial-emissions-standards-and-best-available-techniques.

[22] PHE: Review of interventions to improve outdoor air quality and public health, Public Health England, London, 2019

[23] DEFRA: Clean Air Strategy 2019. Department for Environment, Food and Rural Affairs, London, 2019

[24] Gu B., Zhang L., Van Dingenen R., Vieno M., Van Grinsven H.J.M., Zhang X., Zhang S., Chen Y., Wang S., Ren C., Rao S., Holland M., Winiwarter W., Chen D., Xu J., Sutton M.A.: Abating ammonia is more cost-effective than nitrogen oxides for mitigating PM2.5 air pollution. Science, 374, 758–762, 2021.

Case study
WM-Air have modelled the impact of a hypothetical 30% reduction in NH_3 emissions from agriculture in the West Midlands (only - no change outside the region) for the month of July. NH_3 is primarily emitted from agricultural areas around the periphery of the region, and in the Meriden Gap. Due to the long lifetime of particulates in the atmosphere the impact of a 30% reduction of regional NH_3 emission on particulate concentrations is felt across and outside of the WMCA region, with reductions of ~3-10% in total $PM_{2.5}$ concentrations observed. The time taken for particle formation means that the greatest impact of the reduction in NH_3 emission within the West Midlands region is felt down wind of the region (Figure 6). For this specific measure, only a modest change in $PM_{2.5}$ within the region is achieved through within-region-only changes in emissions, and wider (national) coordination is needed.

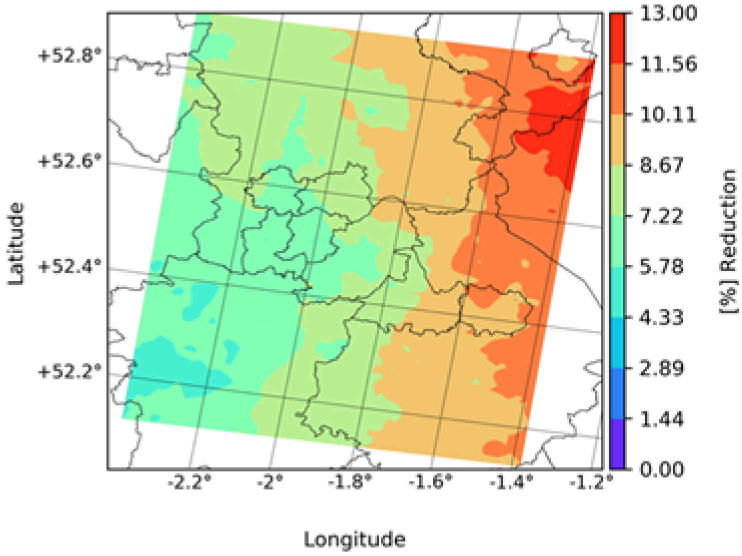

Figure 6: Effect of reduction in agricultural NH_3 emissions within the West Midlands region only, on $PM_{2.5}$ levels across the region. Within-region-only changes have a limited local impact for this emission source.

4.3 Domestic emissions

The National Atmospheric Emissions Inventory (NAEI) groups emissions from combustion in the Commercial, Industrial, Residential and Agriculture sectors collectively as "*domcom*". Of these sources, domestic combustion associated with residential premises makes the largest contribution to $PM_{2.5}$ emissions in urban areas. The UK Clean Air Strategy (2019) states that, based on NAEI data **38% of primary particulate emissions come from burning wood and coal in domestic open fires and solid fuel stoves**. In the West Midlands, the *domcom* sector contributes a small amount to total NO_2 emissions but is responsible for a large proportion of direct (41%) $PM_{2.5}$ emissions, primarily through domestic solid fuel combustion. Emissions are generally highest in population centres as these combustion sources are used primarily for home heating, but the impact on PM concentrations is felt across the region. Emissions from domestic combustion are highly seasonal with emissions highest in the winter months when domestic heating is most heavily used.

Interventions to reduce emissions from domestic and commercial combustion sources to date have focussed upon behaviour change actions to reduce the use of wood burners and encourage the use of less polluting fuels, and supplier actions: at a national level, restrictions on the sale of coal, wet wood and manufactured solid fuels for domestic use were introduced in May 2021 (there is no documented evidence of impact as yet). Smoke control areas are in place across much of the West Midlands. In these areas only authorised fuels can be burnt unless they are to be used in an exempt appliance e.g. burners or stoves. The Environment Act amended existing smoke control legislation (Clean Air Act, 1993) to make enforcement of smoke control area restrictions easier.

Energy efficiency retrofit and heating retrofit targets as part of the WM2041 Net Zero actions are likely to lead to a significant reduction in emissions from domestic combustion for properties adapted, through reduced heating demand and provision of alternative heating sources.

Case study

The impact of a hypothetical reduction of 85% of wood burning-related emissions within the West Midlands region (only) has been modelled by WM-Air for January. Reducing wood burning emissions has the greatest impact in winter when usage peaks. The simulations show that the reduction in $PM_{2.5}$ emission from wood burning leads to a 17 – 25% reduction in total $PM_{2.5}$ concentrations across much of the region (Figure 7). For this specific measure, a significant reduction in $PM_{2.5}$ within the region is achieved through within-region-only changes in emissions.

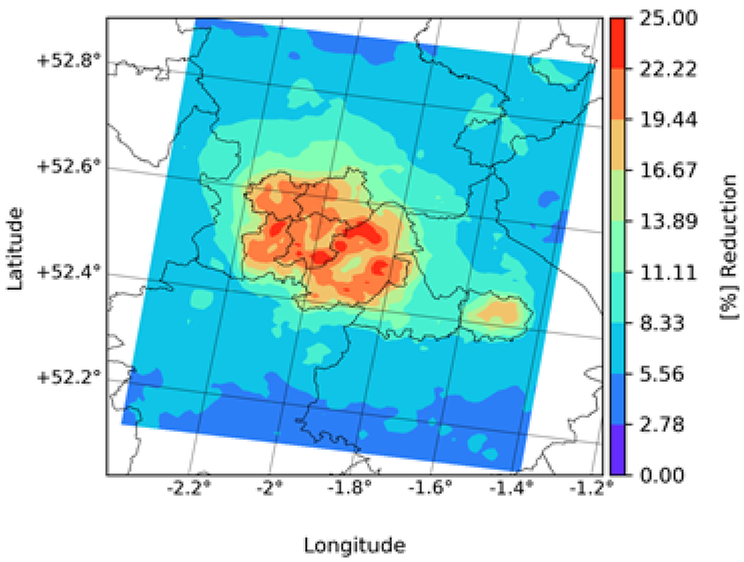

Figure 7: Effect of reduction in wood-burning emissions within the West Midlands region only, on $PM_{2.5}$ levels across the region. Within-region-only changes have a significant impact for this emission source.

4.4 Indoor Air Quality

The majority of the population typically spend most of their time indoors, at home, at places of work or study, or commuting. The air quality in these environments is therefore important as individuals have greater exposure to indoor air than to outdoor air. Air from outdoors enters buildings through, doors, windows and mechanical ventilation, and outdoor (ambient) air pollution is a key driver for indoor air quality – inflow of outside air may improve or worsen indoor air quality depending on the ambient pollution level and sources indoors. Other factors impacting indoor air quality include temperature and humidity. Humid environments can lead to the growth of microbes such as moulds which can then emit spores, cells, fragments and volatile organic compounds into indoor air[25].

Particulate matter, NO_2, ozone and VOCs are all emitted into the indoor environment. The principal sources of particulate matter in the indoor environment are cooking and combustion sources (e.g. smoking, wood burning stoves). Particles may also be formed in the atmosphere by the oxidation of VOCs in the air. NO_2 is produced directly through the combustion of fuels, for example by gas appliances. Ozone is produced by some electrical appliances and can cause increase hospital admissions and increase mortality[26].

Concentrations of VOCs are often higher indoors than outside. These compounds are emitted from a broad range of sources including furnishings, cleaning products and personal consumer products. The toxicity of these compounds varies by chemical species, with effects including irritation of the eyes and respiratory tract, allergies and asthma, central nervous system symptoms, liver and kidney damage, as well as cancer risks[27].

Other pollutants in indoor air can include radon, carbon monoxide (CO) and carbon dioxide (CO_2). In some areas radon gas emitted from the decay of small amounts of naturally occurring uranium in rocks and soils. The UK National Radon Action Plan sets out how radon exposure is assessed and managed in the UK[28]. Carbon monoxide is formed through incomplete combustion, and can lead to unconsciousness and death at very high levels[29]. In homes, CO issues are usually caused by incorrectly installed or poorly maintained gas heaters and cookers, which should be regularly serviced and CO alarms fitted. In poorly ventilated environments emission of carbon dioxide from respiration and combustion (e.g. gas cookers) can cause concentrations to become elevated. CO_2 is not usually considered a pollutant harmful to human health, but does provide a marker for ventilation – for example, in the management of viral infection risk.

National air quality guidelines focus on outdoor air quality where human exposure occurs, and there are no legal guidelines for domestic indoor air quality. In the workplace employers have a duty of care to their employees and permissible air pollution levels are covered by Health and Safety at Work legislation (Workplace Exposure Limits, which set permitted levels over 8 hour and 15 minutes periods which are typically significantly higher than the (ambient) air quality objectives listed in Table 1).

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[25] NICE: Indoor air quality at home, NICE, London, 2020. Available at https://www.nice.org.uk/guidance/ng149/resources/indoor-air-quality-at-home-pdf-66141788215237

[26] COMEAP : Quantification of mortality and hospital admissions associated with ground-level ozone. COMEAP, London, 2015 – (https://www.gov.uk/government/publications/comeap-quantification-of-mortality-and-hospital-admissions-associated-with-ground-level-ozone); IAQM: Indoor Air Quality Guidance: Assessment, Monitoring, Modelling and Mitigation. IQAM, London, 2021 – (https://iaqm.co.uk/wp-content/uploads/2013/02/iaqm_indoorairquality.pdf)

[27] PHE: Review of interventions to improve outdoor air quality and public health, Public Health England, London, 2019

[28] PHE: UK national radon action plan. PHE, London, 2018 – (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766090/UK_National_Radon_Action_Plan.pdf)

[29] IAQM: Indoor Air Quality Guidance: Assessment, Monitoring, Modelling and Mitigation. IQAM, London, 2021 (https://iaqm.co.uk/wp-content/uploads/2013/02/iaqm_indoorairquality.pdf)

Interventions designed to address indoor air quality follow the same hierarchy as those designed to address outdoor air pollution: 1. Reduce emission sources, 2. Extend the distance between sources and people, and 3. Protect vulnerable people. Interventions can be physical, or can be designed to change behaviour. Physical interventions include removing pollution sources – notably through home retrofit. Improving indoor air quality could be a significant co-benefit of heating / insulation retrofit programs designed to reduce carbon emissions. Care should be taken, however, to ensure adequate ventilation is in place. In areas where outdoor pollution is high, for example in properties situated by busy roads, increased ventilation may reduce indoor air quality. The impact of outdoor air quality should therefore be considered when installing ventilation systems. Behaviour change interventions focus on increasing awareness of indoor air quality and associated individual actions, for example how best to use ventilation, both mechanical and passive, and the installation of CO alarms.

4.5 Trans-boundary effects: longer-range pollutant transport

Air pollutants are dispersed and transported in the atmosphere, to an extent dependent upon their lifetime and the meteorology / weather. For species with short lifetimes, local emission controls are effective in reducing concentrations; for species with longer lifetimes, upwind sources (outside of the region) also need to be considered.

Local / regional emission controls are effective for nitrogen oxides, and for many primary components of PM (see section 3.3.3). However, some components of PM – particularly those formed through secondary processes - can be transported significant distances, meaning that sources outside the region impact air quality in the West Midlands, and controls must consider pollutant transport from outside of the region. Similarly, ozone formation occurs on a regional, national and international scale.

At a national level, trans-boundary sources are controlled through legislation regulating total national emissions of air pollutants (UK National Emission Ceilings Regulations 2018). This implements the EU 2016 National Emissions Ceiling Directive, which in turn reflects the international Gothenburg Protocol to the UNECE Convention on Long-range Transboundary Air Pollution. Note these set limits on *total national emissions* – in contrast to the local air pollutant *concentration limits* outlined in Section 2.2. On occasion, up to one third of background UK $PM_{2.5}$ concentrations – those away from local emission sources - originate from sources outside of the UK [30].

The total concentration of a pollutant depends on the sum of local sources (roads, industry etc.) and what has been transported to the region from upwind (transboundary) sources. The concentration remaining if local sources are removed is termed the "background concentration"[31]. DEFRA produces maps of background concentrations for use in air quality assessments. Background maps NO_2 and $PM_{2.5}$ concentrations are shown in Figure 8.

This background air quality modelling[32] shows the contrast between regional (transboundary) pollutant transport impacts for $PM_{2.5}$ and NO_2 (below). As NO_2 has a shorter atmospheric lifetime than $PM_{2.5}$, NO_2 background concentrations peak in urban areas where sources are strongest while $PM_{2.5}$ shows a broad regional background.

[30] DEFRA: Clean Air Strategy 2019. Department for Environment, Food and Rural Affairs, London, 2019
[31] DEFRA: Air Pollution in the UK 2020. Department for Environment, Food and Rural Affairs, London, 2021
[32] DEFRA: Air Pollution in the UK 2020. Department for Environment, Food and Rural Affairs, London, 2021

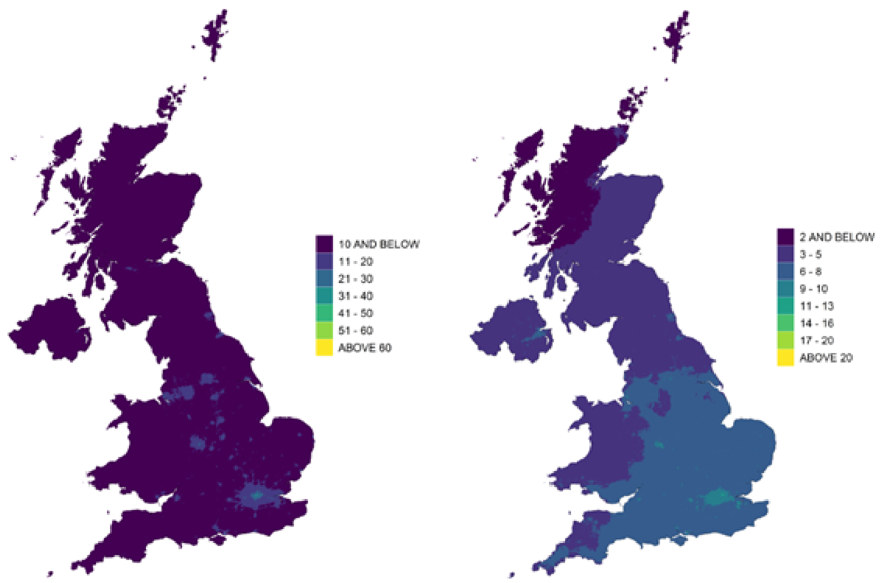

Figure 8. Modelled annual mean background NO_2 (left) and $PM_{2.5}$ (right) concentrations, 2020 ($\mu g\ m^{-3}$) [33] These maps show the concentration of a pollutant transported into an area without the impact of local sources.

The region cannot, therefore, control all aspects of its own air quality in isolation. It must work within national frameworks, recognise local, regional and imported components, and set objectives accordingly. Efforts to minimise transboundary pollution, therefore, depend upon collaboration with neighbouring authorities, national government, and European contexts.

4.6 Land use, planning and green infrastructure

Air quality in urban environments is strongly linked to urban form – the layout and shape of roads, buildings, green spaces and other elements of the landscape. These affect how readily emitted pollutants disperse, and how residents are exposed to (e.g. emissions from road transport). The spatial planning system has an important role in improving urban air quality - through assessment of the locations of future population areas, and of emissions sources, through development design to minimise exposure (below) and through provision of sustainable transport links[34].

Site allocation and the design of developments to minimise the need for travel (e.g., by ensuring that service providers such as schools and healthcare can be accessed easily from people's homes through active and public transport) can reduce the emission of pollutants. Consideration of the air quality at a potential site prior to approval can ensure that a development will not lead to increased exposure to poor air quality. Where appropriate mitigation measures can then be incorporated at an early stage of the design process. Good urban design can reduce exposure to poor air quality by separating people from pollution sources, and increasing "surface roughness" to promote mixing of

[33] DEFRA: Air Pollution in the UK 2020. Department for Environment, Food and Rural Affairs, London, 2021
[34] IAQM: Indoor Air Quality Guidance: Assessment, Monitoring, Modelling and Mitigation. Institute of Air Quality Management, London, 2021

air and dispersion of pollution[35]. Where vulnerable populations are present e.g., at schools and hospitals, design can mitigate air pollution exposure, for example locating school drop off/collection areas away from the roadside.

Green infrastructure – vegetation in urban areas – has only limited impact on air quality through direct removal of pollutants. Rather, it is a component of good urban design that can help to *reduce* emissions (encourage active travel), *extend* the distance between pollution sources and individuals (increase source receptor pathway physically and by effectively via promoting formation of eddies and dispersion) and *protect* vulnerable people (e.g. green barriers). Green infrastructure can also provide co-benefits such as improved biodiversity, reduced urban heat[36] and promote wider wellbeing and civic amenity. These could be considered early in the design stage to ensure that potential co-benefits are maximised.

Within the planning process, there is scope for best practice supplementary guidance, integrating examples in place in some areas already, to assess how are people on a development and the surrounding neighbourhood are exposed to air pollution, and to integrate mitigations within design from the outset. The air quality impacts and co-benefits arising from tree planting related to natural capital, biodiversity and net zero / carbon budgets could be optimised through clear provision of science-based guidance reflecting this aspect.

5.0 Interventions and options

Addressing air quality, particularly in light of the recent the Environment Act, requires a range of different approaches, which have been described above. Many of these have been, and will continue to be, the responsibility of local authorities in the region, particularly because of the current requirement for Air Quality Action Plans (in all the constituent authorities except Solihull). This report has evaluated potential interventions from a number of sources (below) but is not exhaustive:

- Public Heath England's *Improving outdoor air quality and health: review of interventions*. Most of the interventions identified are taken from this source.
- WM-Air: The University of Birmingham's WM-Air project has identified additional interventions through research and regional knowledge developed as part of this programme.
- Discussions with local authority air quality and transport officers, as well as colleagues in Transport for West Midlands.

5.1 Potential interventions

In total, there are 122 potential interventions identified through these sources (outlined in more detail in Appendix 3) that are relevant to the West Midlands context. Each intervention can be categorised as to its cost and impact, and also according to the spatial scale at which it might best be delivered. The interventions can be broadly split into:

[35] Ferranti, E.J.S., MacKenzie, A.R., Levine, J.G., Ashworth K., and Hewitt C.N. First Steps in Urban Air Quality. Second Edition. A Trees and Design Action Group (TDAG) Guidance Document. UK: London. Available at: http://epapers.bham.ac.uk/3069/

[36] Ferranti E.J.S., Futcher J., Salter K. and Hodgkinson S.P.B.: First Steps in Urban Heat for Built Environment Practitioners. Technical Report. Trees and Design Action Group 2021. Available at: http://epapers.bham.ac.uk/3452/

Technology/infrastructure solutions

a. **Vehicles and fuel**: there are 51 potential measures highlighted. Our analysis suggests that 6 of these currently lie within local authority responsibility, especially with regard to enforcement and licensing. Some of the measures identified would also need national delivery (e.g. national road pricing). There are 19 measures where there is potential for a joint local/regional approach, including information campaigns, developing infrastructure for electric vehicles and uptake of low/ zero carbon forms of transport. From a regional perspective, the new Local Transport Plan may provide the main route for alignment.
b. **Industry**: there are 21 measures identified, 7 of which require national action and 1 requires local delivery (on locating biomass heat generation). The remainder provide an opportunity for a collaborative approach across national, regional and local geographies. It is important to note that solutions in this area are challenging, but also an opportunity for innovation.
c. **Domestic emissions**: there are 5 measures identified, largely in relation to emissions around solid fuel burning. Some authorities have already included this as part of their work on air quality, but there may be potential for increased impact with regional coordination and messaging.
d. **Indoor air quality**: this remans a new area of work, but will be increasingly important to tackle alongside new build low/zero carbon homes and retrofit being delivered by local authorities and also through regional programmes. There are 4 measures identified.

Enabling solutions

e. **Spatial planning**: there are 13 actions related to planning, which mostly can only be delivered by local authorities given existing powers (there are some measures, for example tree planting, where other organisations can also play a role).
f. **Behaviour change**: there are 13 actions identified. These could be carried out independently by local authorities but might benefit from a collaborative approach across the region – for example having one message around burning solid fuels in a domestic setting rather than 7 separate campaigns.
g. **Data and innovation**: this is an important part of the programme – understanding how far existing interventions are going to improve air quality; the impact of new interventions and the co-benefits of interventions that address both carbon and air pollution will be important in guiding investment decisions. There are 6 interventions identified which have the potential to benefit from a collaborative approach.
h. **Policy and coordination**: there are 9 possible interventions, all of which could potentially benefit from a collective approach. The aim of collaborating in these areas is to benefit from a joined-up voice to national government and a consistent regional message around priorities and actions.

When considering the cost/impact of different interventions, the number of measures that will have a significant impact on health is much reduced. Furthermore, associated with a cost/impact analysis, further consideration needs to be made as to which spatial scale is best place to drive policy and activity, especially for those interventions where activity could be carried out both locally or regionally.

5.2 Options for consideration

At this stage, pending a more rigorous analysis of interventions, the Environment Act presents the West Midlands (and other combined authority areas) with two options:

Option 1: Retaining existing working arrangements on air quality

There is the potential to continue to deliver air quality action using the current working arrangements. In this scenario, local authorities will continue to lead on Air Quality Action Plans, which may need to be updated with new thresholds for particulates which the Environment Act requires the Secretary of State to set. The regional role would be delivered through work done as part of the Local Transport Plan, the Regional Energy Strategy, the Five Year Plan for Net Zero and the regional Natural Environment Plan, as is currently the case. The governance to deliver the joint approach would remain as it currently is, with the addition of new considerations around particulates as they relate to transport. The Environment Act allows local authorities to require certain actions of the combined authority as a designated 'air quality partner' on an ad hoc basis.

Option 2: A more collaborative approach to air quality

The Environment Act makes provision for local authorities to seek the support of other air quality partners, including the combined authority, to address their concerns, not least where pollutants move across local boundaries and collaborative interventions might be required. To support this, it might be advantageous to clarify respective roles and responsibilities, agree to a set of shared working practices, and identify those interventions where a regional approach can be collectively agreed. In simple terms, Local Air Quality Action Plans could be complemented by a regional West Midlands Air Quality Framework that would sit alongside the Local Transport Plan.

If combined authority partners demonstrated a preference for Option 2 and a more collaborative approach, then further work would need to be undertaken to develop a coherent regional air quality framework with a more detailed cost/benefit analysis of key interventions as applied at different spatial scales and further clarification of the respective roles of local, regional and national air quality partners. It is proposed that this work would be undertaken by a Shadow Regional Air Quality Advisory Group (convened by WMCA but with local authorities taking the lead), which would be in addition to existing governance arrangements around transport. This group would feed into TfWM governance but would also report to the WMCA Environment and Energy Board and would bring formal detailed proposals for a regional air quality framework and governance to a meeting of the WMCA Board in the next 12 months.

Appendix 1: Glossary

Ammonia (NH_3). A gas mainly emitted from agriculture; converted into a significant component of particulate matter in the atmosphere. Harmful to human health and ecosystems.

NO_X: nitrogen dioxide (NO_2) and nitric oxide (NO). Toxic gases mainly emitted by high-temperature combustion. Road traffic is the largest source in urban areas. Peak concentrations are driven by local emissions.

Ozone (O_3). A gas formed in the atmosphere, harmful to human health and vegetation , by reaction between NO_x and volatile organic compounds (VOCs). Concentrations can peak long distances down wind of original sources.

Particulate matter (PM). Classified by particle size or diameter (d): PM_{10} (d < 10 µm), $PM_{2.5}$ (d < 2.5 µm). Can be directly emitted (primary) or formed in the atmosphere (secondary). The most significant primary emission sources in urban areas are combustion and road transport.

Population weighted exposure (PWE). PWE is calculated by multiplying each ward's population by mean $PM_{2.5}$ concentration in that ward, then dividing by the total WMCA population.

$$PWE = \frac{\text{Ward PM2.5 x Ward Population}}{\text{WMCA Population}}$$

Sulfur dioxide (SO_2). A toxic gas emitted from combustion during power generation, industry and domestic heating, from burning of high-sulphur fuels.

Volatile organic compounds (VOCs). Gases emitted from both natural (vegetation) and human sources. Human sources include solvents, fugitive emissions, industrial processes and domestic cleaning and personal care products.

Appendix 2: A summary of local authority actions on air quality

Local Authority	**Document**	**Period Covered**	**Actions**
Birmingham City Council	Air Quality Action Plan	2021-2026	The plan covers a number of different elements related to air quality improvements, predominantly around transport. These include: 1. Implementing the Clean Air Zone 2. Supporting and implementing strategic transport improvements 3. Promoting behaviour change away from single occupancy private vehicle use 4. Promoting the use of alternatively fuelled vehicles 5. When locations are identified as having an exceedance of the air quality objectives, assess traffic management options relevant to the location. In addition to these specific measures there is also a commitment to the development of policies to support better air quality as well as to controlling industrial and domestic emissions.
Solihull Metropolitan Borough Council	Clean Air Strategy	2019-2024	This strategy is more wide-ranging than some of the other council plans on air quality as this is the only local authority in the West Midlands that does not have a requirement (from Defra) to produce an Air Quality Management Plan. The areas considered in the plan are: 1. Schools. Implementation of incentives and monitoring to drive behaviour change. This is through broader environmental schemes, such as the Greener Solihull Schools Award, as well as through specific programmes to encourage sustainable travel to and from school, e.g. ‘New roads’ and School Streets car exclusions. 2. Transport. This has a focus on active travel, developing infrastructure to charge electric vehicles, working with local business on travel plans and promoting electric taxis and buses. 3. Planning. Exploring how to use the planning system to drive positive change in relation to air quality through the local plan, as well as through supplementary planning guidance. 4. Environment. This includes the impact of air quality on the natural environment as well as potential nature-based solutions for addressing poor air quality. 5. Enabling actions. There are also a number of areas identified to develop behaviour change campaigns to improve air quality as well as exploring how the Clean Air Strategy can be used though council procurement.

Sandwell Metropolitan Borough Council	Air Quality Action Plan	2020-2025	The Air Quality Action Plan focuses on a number of transport measures to improve air quality, as well as exploring the role of planning and behaviour change campaigns. It includes: 1. Developing specific measures in consultation with communities to reduce NO2 concentrations at "hot spot" locations. 2. Promoting public transport, walking, cycling, car sharing and switching to low or zero emission vehicles. 3. Reviewing what impact the council has on air quality in its role of as a provider of public services and develop a plan to reduce emissions from its activities. This will include reducing emissions from council fleet and employee vehicles. 4. Supporting and encourage taxi and private hire vehicle operators and drivers in reducing emissions from vehicles. In addition, Sandwell is working in partnership with Birmingham City Council to minimise any negative impacts on Sandwell residents resulting from the implementation of the Clean Air Zone (CAZ).
Coventry City Council	Coventry Local Air Quality Plan	Submitted in 2020 - 2024	Coventry's Local Air Quality Action Plan is focused on transport and behaviour change around travel, including: • Promoting the use of electric vehicles • Real time monitoring of air quality linked to dynamic traffic management • Initiatives to promote changes in travel behaviour and reduce car use within the city • Highway improvements to ease congestion (focussed on Holyhead Rd/Spon End and Walsgrave Road) • Construction of new cycle routes In addition to the Air Quality Action Plan, Coventry also has a wider Air Quality Management Area for the city with its own associated action plan.
Walsall Metropolitan Borough Council	Air Quality Action Plan	2009	The headline measures from Walsall's Air Quality Action Plan cover the following areas: 1. Reducing vehicle emissions 2. Improving public transport to reduce traffic volumes 3. Rail infrastructure (light and heavy rail) 5. Road network improvement 6. Measures to reduce traffic 7. Working with industry and commerce to reduce emissions from these sources. 8. Promotion of alternative modes of transport

Dudley Metropolitan Borough Council	Air Quality Action Plan	2011	Dudley's plan includes the following approaches to tackling air quality: • Encouraging changes in travel behaviour through encouraging use of public transport and active travel. • Information and awareness raising on travel to and from school. • Leading by example, e.g. improving emissions from the Council's fleet of vehicles. • Reducing vehicle emissions, e.g. through reduction of idling and provision of EV charging infrastructure. • Improving public transport, e.g. through supporting low emission buses on existing routes. • Road network improvements • Ensuring that through the planning system development is future proofed against air quality issues. • Control emissions from domestic, commercial and industrial sources through the enforcement of pollution control legislation.
Wolverhampton City Council	Air Quality Action Plan	2006	The headlines from Wolverhampton's plan are as follows: 1. Reducing vehicle emissions 2. Improving public transport 3. Making road network improvements 4. Implementing measures to reduce traffic 5. Reducing emissions from industry / commerce 6. Promotion of alternative modes of transport

Appendix 3: Enabling actions for the region

The tables below indicate examples of the types of actions that could be taken to deliver improvements in the air quality across the West Midlands. The tables are based on the Public Health England report (*Improving outdoor air quality and health: review of interventions*); research by the University of Birmingham's WM-Air project and interviews/ research with local authority officers. They indicate potential impact, cost and spatial scale for delivery of different interventions to improve air quality. It should be noted that this summary is not exhaustive, has been completed at a very high level, and detailed review would need to be undertaken as part of any West Midlands Air Quality Framework, if approved by CA Board. The differences between the tables reflect the different nature of the interventions, with some centred on specific technologies (Tables 1-4) and others on enabling actions (Tables 5-8). The aim is to provide insight into the potential range of activities that could be developed regionally and locally to improve air quality, and where national initiatives are appropriate.

In addition, there has been a very high-level estimate on implementation cost and impact. In both cases, we have used a ranking of high, medium and low.
Cost: 'High' equates to million pound plus infrastructure projects; 'medium' to projects costing £10,000s – £100,000s; 'low' to £10,000s and below.

Impact reflects a categorical estimate of scale of benefit, in terms of reduction in human health impacts from air pollution, across the West Midlands. Behaviour change interventions are labelled "*" as impact depends upon scale and success of behaviour change.

Spatial scale reflects an approximate assessment of statutory remit. Table rows are colour-coded according to spatial scale for delivery.

Table 1: Vehicles and Fuel

Intervention group	Specific potential intervention	Cost	Impact	Spatial scale for delivery
Reduce demand for more polluting forms of road transport	Promote freight modal shift	M	*	National/regional/local
	Final mile delivery	M	M	Local only
Reduce demand for more polluting forms of road transport	Lorry road user charging	M	L	National
	Subsidising public transport	M	M	Regional/local
	Provision of school buses	M	L	Regional/local
	Designating new & priority bus measures	M	M	Regional/local
	Promote walking and cycling	L	*	Regional/local

	Promote car sharing	L	*	Regional/local
	Workplace charging levies	L	M-H	Regional/local
	High occupancy vehicle lanes	M	L	Regional/local
	National road pricing	?	M-H	National
	Local congestion charge	M	M-H	Local only
	Promote tele-working/video conferencing	L	*	National/regional/local
	Promotion of home working	L	*	National/regional/local
	Vehicle licencing and fuel duty	?	H	National
	New tram schemes/ very light rail	H	M	Regional/local
	Travel planning	L	L	Regional/local
Reduce emissions from existing road vehicles	Out of hours freight delivery	L	L	Local only
	Lorry overtaking bans	?	L	National
	Promote abatement retrofit	?	*	Local/regional/national
	Promote eco driving	?	*	Regional/Local
	Annual vehicle emissions tests	?	L-M	National
	Roadside vehicle emissions tests	?	L	National
	Active traffic light management	M	L	Regional/Local
	Intelligent speed adaptation	?	L	National/regional/local
	Improved anti-idling enforcement	M	L-M	Local only
	Traffic flow smoothing	?	M	Regional/Local
	Discourage use of high emitting vehicles	?	M-H	National/regional/local
Promote road vehicles with low emissions	Scrappage schemes	?	M	National/regional/local
	Fleet recognition schemes to promote LEV	?	L	National/regional/local
	Reduced vehicle excise duty	?	M	National
	Introduction of low emission zones	M	M	Regional/Local
	Priority parking for low emission vehicles	M	L	Local only
	Pollution car labelling scheme	L	L	National/regional/local
	Fiscal incentives for low emission vehicles	M-H	L-M	National/regional/local
	Development of EV charging infrastructure	H	H	National/regional/local

	Development of more local sustainable energy generation capacity and associated battery storage	M-H	M	National/regional/local
	Promote biofuels	M	*	National
	Promote the development of new electric vehicles	H	M	National/regional/local
	Public information campaign	L	*	National/regional/local
	Vehicle procurement best practice	L	L	Regional/Local
	Low emissions bus fleet	H	H	Regional/Local
Displace pollutant emissions from road vehicles outside hot spots and populated areas	Lorry ban in urban centres	?	L	Local only
	Freight consolidation centres	H	L	Regional/Local
	Newer buses used for most polluted routes	H	M	Regional/Local
Operational interventions at airports and alternative fuels	Electrifying ground support equipment	H	L	Regional/Local
	Lower emission road vehicles	?	M	Regional/Local
Electrification of rail network & promotion of lower emissions from rolling stock	Electrification of rail network	H	M	National
	Promote the uptake of bi-mode trains	H	L-M	National
	Abatement retrofit	H	M	National
Rail freight	Transition to low emission vehicles for freight handling	?	L	National/regional/local

Table 2: Industry and other

Intervention group	Specific potential intervention	Cost	Impact	Spatial scale for delivery
Policy interventions	Ambient air pollution concentration limits	L	M-H	National
	National emissions ceilings	L	L-M	National
	Installation absolute emission caps	L	M	National
	Installation emission concentration limits: BAT-based permitting	L	M	National
	Installation emission concentration limits: Cost Benefit Analysis (CBA) based-permitting	L	L	National
	Eco-design and product standards	L	L	National
	Major infrastructure (e.g., eliminate coal power stations)	L-H	M	National/regional/local
	Inspections and enforcement actions	L	M	National/regional/local
	Monetary incentives	L-H	L-H	National/regional/local
	Monetary penalties	L-H	L-H	National/regional/local
	Trading schemes	L	L-H	National
	Air quality innovation zones to sit alongside industrial decarbonisation programmes	L	M	Regional/Local
Technologies	Dust abatement	L-H	M	National/regional/local
	NOx abatement	L-H	H	National/regional/local
	SO2 abatement	L-H	H	National/regional/local
	VOC abatement	L-H	H	National/regional/local
	Discourage investment in biomass fuelled heat/power	L-M	L-M	National/regional/local
	Consideration of AQ health impacts for heat/power generation from biomass	L	M	Local only
Policy interventions	Dust abatement in construction	L-H	M	Regional/Local
	Industrial off-road mobile machinery emission controls	L	M	National/regional/local
	Industrial stationary machinery emission controls	L	M	National/regional/local

Table 3: Domestic combustion

Specific intervention	Cost	Impact	Spatial scale for delivery
Actions around wood (especially wet wood)	L-M	H	Regional/Local
Actions around other solid fuels	L-M	H	Regional/Local
Restrictions on domestic use of solid fuels	L	H	Regional/Local
Right fuel for domestic combustion information campaign	L	M	Regional/Local
Supporting the transition from gas central heating	M-H	M	Regional/local

Table 4: Indoor air quality

Intervention group	Specific potential intervention	Cost	Impact	Spatial scale for delivery
Public engagement	Raise awareness of indoor air quality issues with homeowners	L	*	National/regional/local
Behavioural interventions	Promote good practice with heating and drying	?	*	National/regional/local
Policy interventions	Support landlords and homeowners in accessing grants to retrofit	M	M	National/regional/local
	Engage with estate and letting agents to increase market awareness	L-M	L-M	National/regional/local

Table 5: Spatial Planning

Intervention group	Specific potential intervention	Cost	Impact	Spatial scale for delivery
Pollutant removal	Green infrastructure - urban vegetation	L-M	L	Regional/Local
	Pollution reducing surfaces - titanium dioxide	?	L	Local
Pollutant dispersal	Tree planting	M	L	Regional/Local
Active travel	Encouraging walking and cycling	L	M	National/regional/local
	Construction of new cycle and pathways	M	M	Local
Motorised transport	Road pricing / congestion charge	L-M	M-H	National/Regional/Local
	Driving restriction	?	M-H	Regional/Local
	Low emission zones	H	M-H	Regional/Local
	Traffic calming and speed limitations	?	L	Local
	Traffic displacement through road alterations	?	L	Local
	Co-implementation of various measures (e.g., restrictions based on license plates and meeting Euro emission standards)	?	M	Regional/Local
Planning policy	Providing guidance/best practise to minimise AQ exposure	L	M	Regional/Local
	Land use planning (e.g., allocating developments in locations that minimise the need to travel)	M	H	Local

Table 6: Behaviour change

Specific potential intervention	Cost	Impact	Spatial scale for delivery
Cycle and walking pathways (encouraging uptake)	L	*	Regional/Local
Promote public transport use	L	*	Regional/Local
Public engagement (e.g. through citizens' panel)	M	*	National/regional/local
Investment in public transport (encouraging uptake)	L	*	National/regional/local
Eco-driver training	M	*	Regional/Local
No idling campaigns	L	*	Regional/Local
Exposure reduction programmes	?	*	Regional/Local
Ecotravel coordination programmes	?	*	Regional/Local
Clean Air Day	L	*	National/regional/local
Air quality messages/alerts/indices	L	*	Regional/Local
An Air Quality Portal - information resource in the form of a coordinated public-facing website, incorporating new sensor information	L	*	Regional/Local
Provision of low cost AQ sensors for e.g. schools, voluntary organisations	M	*	Regional/Local
Tram and light rail promotion	L	*	Regional/Local

Table 7: Data and monitoring

Specific potential intervention	Cost	Impact	Spatial scale/ role
Datastore to quantify impact of air quality measures	L	M	Regional/Local
Understanding real-world emissions to underpin policy, e.g. identifying largest emitters across actual WM fleet (all vehicles).	L-M	M-H	Regional/Local
Understand relative importance of within-region emissions and transported air pollution for WMCA air quality	L	M	Regional/Local
To achieve economies of scale through regional coordination of measurement and particularly sensor networks (building on regional leadership using 5G).	L-M	M	Regional/Local
Metrics for improving air quality, to capture co-benefits from net zero actions and for policy to reduce regional health inequalities	L	M-H	Regional/Local
Data to enable assessment of "exposure reduction" and prioritisation of measures to reduce environmental health inequalities.	L	M-H	Regional/Local

Table 8: Coordination and policy

These are policy interventions that are not covered as part of specific areas of activity (e.g. transport and industry).

Intervention group	Specific potential intervention	Cost	Impact	Spatial scale/ role
Coordination	Coordinate regional approaches to government on policy and resources to tackle air quality challenges (DEFRA, HMT and key partners, e.g., Environment Agency, National Highways)	L	H	Regional/Local
	Coordinated approach to funding bids, e.g. the DEFRA Air Quality Grant Fund	L	M	Regional/Local
	Coordination of approaches to solid fuel combustion (domestic, industry), including guidance for retailers, wholesalers.	L	M	Regional/Local
	Develop guidelines for best practice for procurement that will support air quality improvements (e.g. use of Non-Road Mobile Machinery)	L	M	Regional/Local
Policy	Making information and resources on the scientific background of air quality available to elected members and officers	L	L	Regional/local
	Working though the Natural Environment Plan to identify best uses of green infrastructure for air quality	L	M	Regional/Local
	Integrate AQ considerations (evaluated as population health benefit) into other WMCA policy where relevant.	L	H	Regional/Local
	Scope for a “Net Health Gain” principle.	L	H	Regional/local
	Planning guidance for air quality	L	H	National/regional/local