School Streets

Reducing children's exposure to toxic air pollution and road danger

January 2021

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Glossary of key air pollution terms

Carbon dioxide (CO_2)
a greenhouse gas emitted from the burning of fossil fuels which is one of the main causes of global warming.

Greenhouse gases (CO_{2e})
a range of different gases which cause global warming. Generally expressed as CO_2 equivalent on the basis of their global-warming potential.

Nitrogen dioxide (NO_2)
One of the oxides of nitrogen formed in combustion processes. At high concentrations NO_2 is an irritant to the airways.

Nitrogen Oxides (NO_x)
Compounds formed when nitrogen and oxygen combine. NOx, which comprises nitric oxide (NO) and nitrogen dioxide (NO_2), is emitted from combustion processes. Road transport, particularly diesel, is one of the main sources.

Particulate Matter (PM)
Small airborne particles which can be both natural and man-made and cause a range of health effects.

$PM_{2.5}$
Particles (roughly less than 2.5 micrometres (µm) in diameter) which are small enough to be inhaled very deep into the lung. One µm is one millionth of a metre. Road transport, particularly from non-exhaust sources, is a significant source.

Executive Summary

High levels of air pollution in urban areas throughout the UK have a devastating impact on children's health which can be severe, long term and even deadly. The UK has a legal requirement to meet air quality limits as soon as possible. Yet achieving legal compliance is insufficient to protect children's health and we need to reduce air pollution throughout all areas as much as possible.

School Streets, where traffic is restricted on roads outside schools at pick-up and drop-off times during term-times, make it safer and easier for children to walk, scoot and cycle to school. This report focuses on School Streets as a practical and achievable measure to reduce children's exposure to toxic air pollution. School Streets also encourage active travel, which brings multiple other benefits including reducing traffic and air pollution over a wider area, reducing road danger, and increasing physical activity. Evidence shows that School Streets do not simply displace traffic but reduce it overall.

We have assessed the current status and future potential for School Streets in four cities: London, Birmingham, Leeds and Bristol, and estimated the possible impact if School Streets were rolled out comprehensively in those cities. We have estimated:

- There are currently around 430 schemes implemented in the four cities, with nearly 400 in London, and a further 50 planned in London.
- Primary schools are four times more likely to have School Streets implemented than secondary schools.
- There is substantial potential in all four cities for School Streets and this is likely to be the same in other towns and cities. Around half of schools already have school streets or else are judged likely to be feasible for School Streets (based on criteria such as whether they are on a main road). This proportion rises to around two-thirds if one includes schools that might be feasible for School Streets if implemented alongside bus gates and/or area-wide measures. A comprehensive roll-out of School Streets in the four cities would reduce exposure to air pollution and road danger for 1.25 million primary and secondary students.

- Across the four cities almost 10% of schools were 'main road' schools (i.e. the road nearest the school was an A or B road). It is not generally feasible to turn a main road into a school street, although we did judge that one could introduce a School Street for 17-24% of main road schools by closing an adjacent side street. Nevertheless, wider measures are required to deal with air pollution on main roads.
- If all feasible schools in the four cities had School Streets implemented this would reduce peak hour car trips in those cities by up to 32 million per year and reduce car mileage by over 71 million km per year. This is, however, less than 1% of the total number of peak hour car trips per year in the four cities.

This report finds that School Streets can effectively reduce air pollution and road danger outside the school gate. This is the time and place in which our most vulnerable road users are most concentrated, so it makes sense to prioritise urgent interventions to curb motor traffic here. However, on their own they can have only limited wider impact. Protecting children and the wider population from Britain's air quality crisis requires other measures which can reduce air pollution and traffic generally and not just on streets outside schools. Urgent action is needed to implement more ambitious measures such as low traffic neighbourhoods and Clean Air Zones which have immediate impacts on air quality and traffic across neighbourhoods and city-wide.

Ultimately, it is also clear that we need to implement a pay-per-mile Eco Levy on driving to reduce traffic and air pollution on all roads. Everyone wants to live on safe streets with clean air. This is particularly important for children, who are especially vulnerable to the impacts of pollution. We have the measures to transform transport to create healthier cities, we now need to make sure our local authorities, with the support of central government, deliver them.

Introduction

High levels of air pollution in urban areas throughout the UK have a devastating impact on children's health. Three out of four areas of the UK still have illegal levels of harmful nitrogen dioxide (NO_2)[1] and many areas have high levels of deadly fine particulate matter levels ($PM_{2.5}$), for which there is no safe threshold.

The consequences for children's health can be severe, long term and even fatal. Air pollution has a life-long impact starting from the first few weeks in the womb[2]. Children are particularly impacted by air pollution because they breathe faster and are more physically active[3], have narrower airways, and their brains and lungs are still developing[4]. Levels of air pollution that would cause only slight irritation in an adult can result in potentially significant obstruction in the airways of a young child[5]. Children with asthma are particularly affected: one in eleven UK children receive treatment for asthma, one of the highest childhood asthma rates in the world[6]. Living near busy roads could be responsible for some 15-30% of all new cases of asthma in children[7].

As well as causing breathing difficulties, air pollution is also detrimental to children's' ability to concentrate[8] and short-term memory essential for completing tasks[9]. And the

[1] For the purposes of reporting compliance with EU air quality Directives the UK is divided into 43 national air quality reporting zones. According to Client Earth's analysis, in 2019 33 (77%) out of the 43 zones had illegal levels of NO_2. Client Earth (2020) New data shows 75% of UK 'zones' illegally polluted – don't pause action now, say lawyers. Press Release 08/10/20.
[2] Royal College of Physicians (2016) Every breath we take: the lifelong impact of air pollution. Report of a working party. London.
[3] Bateson T F and Schwartz J(2007) Children's Response to Air Pollutants, Journal of Toxicology and Environmental Health, Part A, 71:3, 238-243, DOI: 10.1080/15287390701598234
[4] UNICEF (2016) Clear the Air for Children
[5] Mott L (1997) Our children at risk. The 5 worst environmental threats to their health. Report for National Resources Defence Council.
[6] Asthma UK (2017) UK asthma death rates among worst in Europe. Press Release undated.
[7] Aphekom (undated) Summary report of the Aphekom project 2008-2011. Project co-funded by the European Commission's Programme on Community Action in the Field of Public Health.
[8] Sunyer J et al (2017) Traffic-related Air Pollution and Attention in Primary School Children, Epidemiology, Vol 28, Issue 2, pp 181-189 doi: 10.1097/EDE.0000000000000603 x
[9] van Tongeren M and Munford L (2020) Protecting our children's memory – how can we tackle the scourge of poor air quality in and around our schools? Blog, University of Manchester.

impacts of air pollution can be lifelong: children who live in the most polluted areas are four times more likely to have reduced lung function as adults[10]. Children living in more deprived areas, tend to be exposed to more pollution, magnifying existing inequalities[11,12]. Not surprisingly the majority of parents of primary school age children are concerned about the effects of air pollution on their child's health[13]. Yet over a third of trips to and from primary school in England's towns and cities are made by car or van[14]. Every extra car on the road at rush hour makes walking and cycling to school more dangerous, unhealthy and unpleasant for everyone, in a self-reinforcing cycle[15]. Breaking this cycle is an urgent imperative.

The UK has a legal requirement to meet air quality limits as soon as possible[16]. Yet achieving legal compliance is insufficient to protect children's health and we need to reduce air pollution where they live, play, or go to school. This requires reducing emissions from road transport, particularly diesel vehicles, which are the single biggest source of air pollution.

School Streets, where traffic is restricted on roads outside schools at pick-up and drop-off times during term-times, make it safer and easier for children to walk, scoot and cycle to school. This reduces children's exposure to air pollution on part of their journey to school and from cars with idling engines outside the school gates. Government funding[17] and associated guidance[18] which specifically encourages School Streets, make it possible for more children across England to benefit from this initiative.

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[10] Royal College of Physicians (2016) Every breath we take: the lifelong impact of air pollution. Report of a working party. London.
[11] Aether (2017) Updated Analysis of Air Pollution Exposure in London. Report for Greater London Authority
[12] Goodman A, Wilkinson P, Stafford M, Tonne C. (2011) Characterising socio-economic inequalities in exposure to air pollution: a comparison of socio-economic markers and scales of measurement. Health Place, Vol 17, Issue 3, pp. 767-74. doi: 10.1016/j.healthplace.2011.02.002. Epub 2011 Feb 19. PMID: 21398166.
[13] Living Streets (undated) Fear of air pollution preventing a generation from walking to school. Blog.
[14] Department for Transport (2020), National Travel Survey 2019, Table NTS0615, Usual mode of travel to school1 by age group: England, from 1995/97.
[15] Department for Transport (2020), National Travel Survey 2019, Table NTSQ03013c, Barriers and encouragements around walking to school, 2018+, England.
[16] The UK has been required to comply with EU air quality Directives since 2010. ClientEarth has won three court cases against the UK Government over the country's illegal and harmful levels of air pollution. As a result, the government has directed over 60 English councils to identify local solutions to reduce pollution to within the legal limit in the shortest possible time. Client Earth (2020) New data shows 75% of UK 'zones' illegally polluted – don't pause action now, say lawyers. Press Release 08/10/20.
[17] Department for Transport (2020) Active travel fund: local transport authority allocations
[18] Department for Transport (2020) Traffic Management Act 2004: network management in response to COVID-19. Statutory Guidance, updated 13/11/20.

This report focuses on School Streets as a practical and achievable first measure that can reduce children's exposure to toxic air pollution and that has multiple other benefits. School Streets can also be beneficial during the Covid-19 pandemic to assist with social distancing. We assess the current status and future potential for School Streets in four cities: London, Birmingham, Leeds and Bristol, and estimate the possible impact on traffic and pollution if School Streets were rolled out across all suitable schools in the cities.

School Streets are a small but significant step towards protecting children's health on their journey to school. But they are not sufficient on their own. We need to make urban air safe for children to breathe wherever they are, not just in the last few hundred metres of their journey to school. And that means we need to go further, faster, in cutting traffic and toxic pollution. In section 6, we highlight three key policy measures that would complement School Streets.

In the Netherlands in the early 1970s a powerful campaign 'Stop the Child Murder' was launched in response to a record number of children killed on the roads by motor vehicles. Campaigners agreed that reducing road danger at source was the best way to tackle the rise in road deaths. This brought mass support for change, with many marches involving parents and children, leading to support for policies promoting people-friendly streets. Thirty years later, children in the UK are still facing life-threatening dangers from road traffic and air pollution. The onus should not be on parents. Protecting children and public health should be at the core of national and local transport policies and the way we design our towns and cities.

Why School Streets?

Parents wait to collect their children in the School Street outside Elm Wood Primary School, Lambeth, London.
Source: Anna Goodman.

School Streets are restrictions on traffic at school opening and closing times to improve road safety and air quality and increase the number of children travelling actively to school. Traffic restrictions are enforced using access signs, temporary bollards, and in some cases automatic number plate recognition (ANPR) cameras (now also to be allowed outside London).[19] Generally, there are exemptions for residents and blue badge holders.

School Streets are described by the Mayor of London as a measure that can "help create a safer, more pleasant environment for children travelling to school, by removing air quality and road safety problems associated with through traffic and drop-off activity on the street/s outside the school."[20]

[19] The Government has promised to bring into effect part 6 of the Traffic Management Act 2004 which would enable local authorities outside London to use cameras to enforce School Streets. Response to Parliamentary Question by Grant Schapps to Lloyd Russell-Mayer, 2 July 2020.
[20] Mayor of London (2018) Toolkit of Measures to Improve Air Quality at Schools

School Streets are needed because:

1. Children are exposed to high levels of air pollution and traffic danger on the school run.

- Children are exposed to particularly high levels of air pollution during the school run - including those who are driven to school - as pollution inside a car can be far higher than outside[21]. Pollution intensifies around schools at drop off time, so that children are exposed to levels of NO_2 five times higher when travelling to school in the morning than while at school[22].
- Children are most likely to be killed or seriously injured in road collisions during the hours of the school run. On average in the UK 16 children and young people under 25 are killed or seriously injured as pedestrians every week between 8am to 9am and 3pm to 7pm[23]. The impacts for pedestrians are higher on minor roads[24].

> "Every child should be safe on their journey to school, but those living in urban areas face a double threat – from the toxic emissions pumped out by vehicles they pass, and from road traffic injury."
>
> **Sheila Watson, FIA Foundation Deputy Director**[25]

School Streets reduce this danger, and provide space for social distancing during the Covid-19 pandemic:

- School Streets reduce children's exposure to pollution around the school, particularly at the school gates where children and younger siblings congregate[26]. They can

[21] King D (2017) Smoking in cars is banned. But children still inhale toxic fumes in backseats. Article for The Guardian, 12/06/17.
[22] Varaden D, Leidland E and Barratt B (2019) The Breathe London Wearables Study. Engaging primary school children to monitor air pollution in London. Report by King's College London Environmental Research Group for the Greater London Authority.
[23] Public Health England (2018) Reducing unintentional injuries on the roads among children and young people under 25 years
[24] Aldred R (2019) Motor traffic on urban minor and major roads: impacts on pedestrian and cyclist injuries. Municipal Engineer, Vol 172, Issue 1, pp. 3-9
[25] FIA Foundation (2020) School streets air quality testing launched in London. Blog, 22/09/20.
[26] Evidence from six School Streets in Edinburgh suggests there was a reduction in NOx emissions after implementation Edinburgh City Council (2016) School Streets pilot project evaluation. Transport and Environment Committee report, 30/08/16. A new air quality testing programme in London will compare the impact of School

also reduce road traffic danger, with a majority of parents agreeing that streets with vehicle restrictions feel safer[27]. This creates a virtuous circle as more parents feel able to let their children walk, scoot and cycle to school.

- School Streets facilitate social distancing during the Covid-19 pandemic. This is particularly important where pavement widths are narrow: in London, 17% of schools have average pavement width <2m on the road nearest the school[28].

2. The school run creates a lot of traffic so shifting this amplifies the benefits to children and brings wider benefits to the area in traffic and air quality

- Nationally, 39% of primary school children in urban areas, and 25% of secondary school children use a car as their usual main mode of travel to school (or 24% primary and 15% secondary school children in London)[29]. This generates 22% of car trips and 9% of car mileage in urban areas of England during peak school run hours[30]. For comparison, commuting trips generate 34% of car mileage during this period. 50% of these school run trips made by car are under 2 miles.

School Streets help reduce traffic across a wide area around schools and do not simply displace traffic to neighbouring streets:

Streets at 18 primary schools with results from schools with roads which remain open to motor traffic (FIA Foundation (2020) School streets air quality testing launched in London. Blog, 22/09/20). Funded by the FIA Foundation, a British road safety charity, results should be available in March 2021.

[27] Davis A (2020) School Street Closures and Traffic Displacement: A Literature Review and semi-structured interviews. Report by Traffic Research Institute, Edinburgh Napier University

[28] Calculated by the report authors using footpath width data from Palominos and Smith (2020; https://doi.org/10.5281/zenodo.3783806). Average pavement width <2m defined as streets where the total pavement width on both sides was <4m. The road nearest to the school was identified based on the school centroid – this will not always be the road where the school gate is.

[29] Calculated by the report authors using data from the National Travel Survey 2015-2019. Analyses were restricted to people living in urban areas of England. The proportion of children driven to school every day is based on those who report that the car is their usual, main mode of travel to school. If one looks specifically at the areas covering our city regions, the figures are 44% primary and 31% secondary school children driven to school in urban areas in the South West; 42% primary and 25% secondary school children in Metropolitan areas in the West Midlands; 41% primary and 28% secondary school children in Metropolitan areas in Yorkshire/Humberside; and 24% primary and 15% secondary school children in London.

[30] Calculated by the report authors using data from the National Travel Survey 2015-2019. Analyses were restricted to people living in urban areas of England. Peak school run hours were defined as trips on weekdays starting between 07:30 and 09:14, or between 14:30 and 16:29. School run trips were defined as trip starting during this time period, with car driver as the main mode, and with 'escort education' as the journey purpose.

- In almost all cases of School Streets monitored in a comprehensive evidence review, the total number of cars around the school and neighbouring streets reduced[31]. Existing schemes in Camden reduced traffic across the whole area by 7-8%, and not just outside the school[32]. In other words, School Streets do not just displace traffic, but reduce it overall. This will include traffic reductions on main roads in the vicinity of the school.
- Reducing cars at peak hours can lead to a dramatic reduction in pollution from all vehicle types[33]. It can sometimes require a relatively small change in the number of cars to make the difference between free-flowing traffic and congestion; although ideally School Streets would be part of a package of wider traffic restraint measures (see Section 6).

3. The benefits of School Streets are further amplified by shifting school travel to active modes

- In a recent evidence review, active travel levels increased at all School Streets schools reported on by local authorities[34]. This reduces traffic and pollution across the urban area, while bringing children the multiple physical and mental health benefits that come with increased physical activity[35].
- Physical activity additionally helps with learning[36]. According to Sustrans, "teachers find that pupils who cycle, walk or scoot arrive at school more relaxed, alert and ready to start the day than those who travel by car"[37].

[31] Davis A (2020) School Street Closures and Traffic Displacement: A Literature Review and semi-structured interviews. Report by Traffic Research Institute, Edinburgh Napier University. Further quantitative evidence on traffic displacement and road safety is being collected and evaluated at two schools in Birmingham as part of a study for the Road Safety Trust, results of which will be available end 2021.
[32] Camden Borough Council. Healthy School Streets webpage.
[33] Begg D and Haigh C (2017) Tackling pollution and congestion. Why congestion must be reduced if air quality is to improve. Report for Greener Journeys, 15/06/17.
[34] Davis A (2020) School Street Closures and Traffic Displacement: A Literature Review and semi-structured interviews. Report by Traffic Research Institute, Edinburgh Napier University
[35] Janssen I, LeBlanc A G (2010) Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7, 40. https://doi.org/10.1186/1479-5868-7-40
[36] Donnelly J E, Hillman C H, Castelli D, et al. (2016) Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. Med Sci Sports Exerc. 2016;48(6):1197-1222. doi:10.1249/MSS.0000000000000901
[37] Bennett C (2019) Why is travelling actively to school important? Sustrans blog, 25/02/19. t

Current status

A growing movement – but wide variety between local authorities

Although School Streets are growing in popularity, numbers are still quite limited across the UK. To understand how School Streets are currently distributed, we have looked at how many schools in four cities (London, Birmingham, Leeds and Bristol) currently have a School Street.

As shown in Figure 1, the number of School Streets implemented in London increased slowly across 2017 and 2018, then accelerated in 2019, before showing a huge leap in Autumn 2020. As of 10th November 2020, London had implemented 402 School Streets (66 permanently and 336 on a trial basis), with a further 50 planned[38]. These implemented and planned School Streets together covered 14.7% of all schools in the capital, and 14.5% of all pupils[39]. Many of the Autumn 2020 School Streets were implemented on a trial basis using Covid-19 emergency funding. The pandemic has therefore accelerated what was already a growing movement.

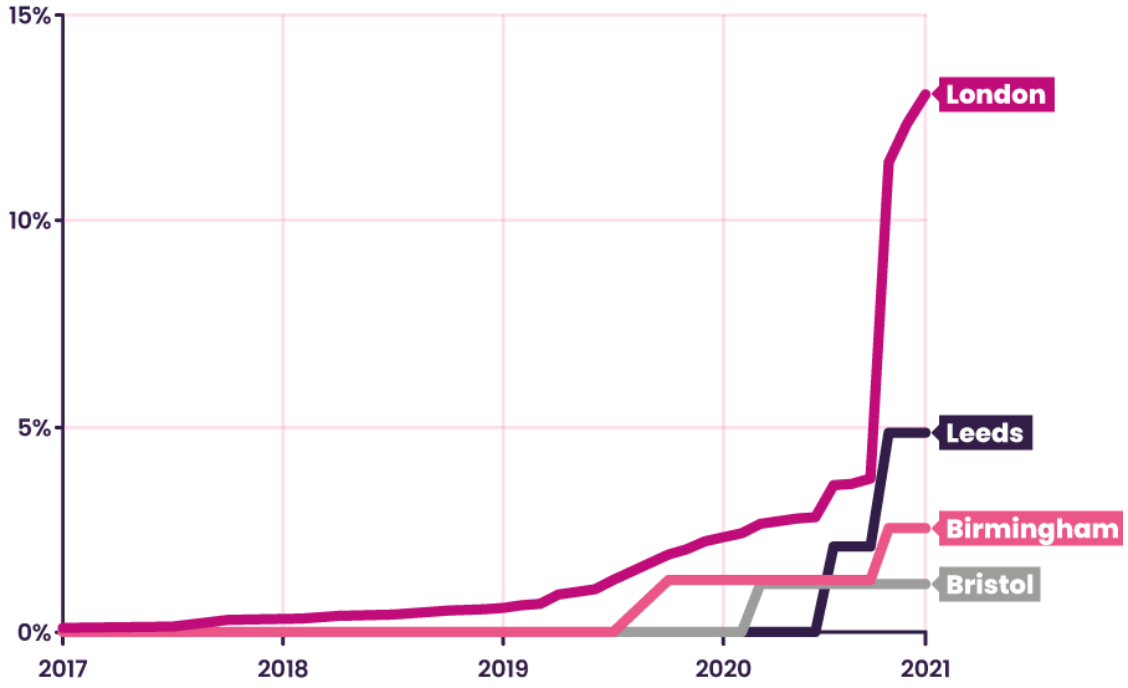
School Streets have also recently appeared for the first time in Birmingham, Bristol and Leeds. Birmingham introduced 6 in 2019 and 6 more in 2020, covering 2.5% of schools and 2.5% of pupils. Bristol introduced 2 in 2020, covering 1.2% of schools and 1.0% of pupils. Leeds introduced 14 in 2020, covering 4.8% of schools and 4.1% of pupils. All these schemes are currently operating on a trial basis, although Birmingham is in the process of making 5 of its School Streets permanent.

[38] There is no comprehensive register of School Streets. Schools with a School Street were therefore identified by Mums for Lungs, by combining announcements on local authority webpages, information held by Transport for London, direct contact with local authority officers and direct contact with parents. We have tried to be as thorough as possible, but it is possible we have missed some schools or sometimes misclassified their status (e.g. trial versus permanent).

[39] In calculating these percentages, we used as the denominator all educational establishments for school age children, as listed in Edubase. We excluded children centres; universities or educational establishments where the maximum age is over 20; 'other' educational establishments (e.g. secure units or learning support centres); or virtual organisations (e.g. a sixth form consortium). We also excluded very small establishments containing under 20 pupils, these being unusual establishments such as schools inside hospitals for children with long-term illnesses. In the 1% of schools missing information on the number of pupils, we imputed the average for that city and phase of education.

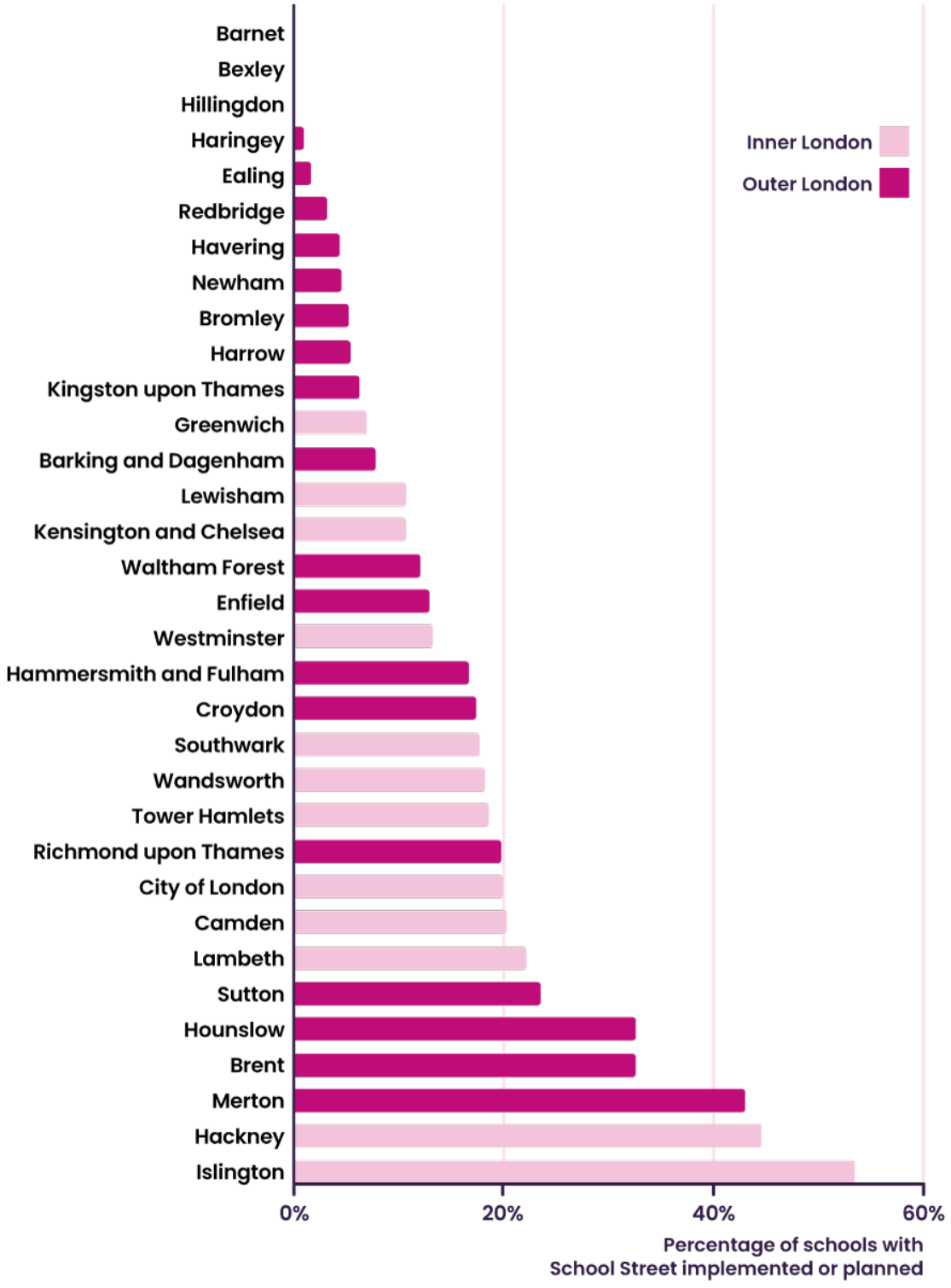
In all four cities, therefore, there has never been a better time to push for a School Street.

Figure 1: Proportion of schools with a School Street implemented (permanently or as a trial) in each city since 2017.



Although London as a whole has a far higher proportion of School Streets than the other four cities, there is considerable variation among its local authorities. As shown in Figure 2, the proportion of schools with a School Street ranges from 0% in Barnet and Bexley to 53% in Islington.

Figure 2: Current % of schools with an implemented or planned School Street by local authority.



Note that some of these local authorities, including Barnet and Bexley, have implemented other emergency measures around schools such as widening pavements to facilitate social distancing.

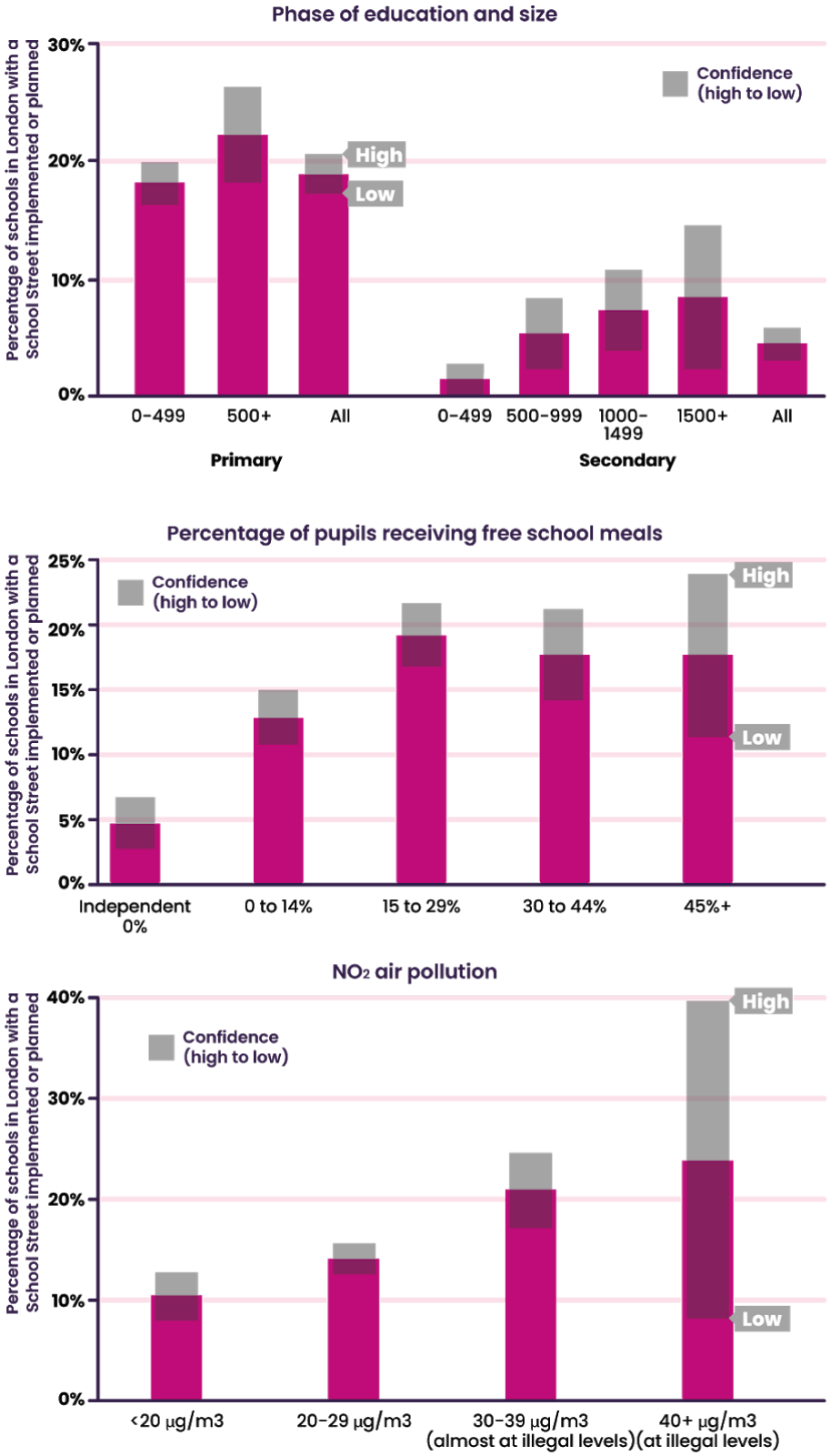
Which schools currently have School Streets?

We illustrate our key findings for London in Figure 3, with full details of our analyses presented in Appendix 1. Across London as a whole we find that:

- Primary schools are around four times more likely to have a School Street than secondary schools or 'all-though' schools that cover both primary and secondary phases.
- Amongst secondary and all-through schools, larger schools are progressively more likely to get School Streets than smaller schools.
- Independent schools were much less likely to have School Streets than state-funded schools (5% versus 16%). Amongst state-funded schools, London-wide there was a trend towards a higher proportion of School Streets in schools with a more deprived student body (as defined by percent receiving free school meals). No association with deprivation was observed, however, within local authorities (see Appendix 1). The London-wide effect therefore seemed to stem from local authorities with higher deprivation levels implementing more School Streets (e.g. many being implemented in relatively deprived Hackney), rather than from local authorities systematically targeting their most deprived schools.
- Schools in areas with higher levels of NO_2 air pollution are more likely to have a School Street than those without, but no association was observed within local authorities (Appendix 1). The London-wide effect therefore again seemed to stem from local authorities with higher pollution levels implementing more School Streets rather than from local authorities systematically targeting their most polluted schools. This suggests that London local authorities could do more to prioritise schools with the most polluted air.

In Birmingham, Bristol and Leeds, all of the School Streets currently implemented are in primary schools. Beyond this, the number of School Streets implemented is too small for robust analyses of other characteristics.

Figure 3: Proportion of schools in London with a School Street implemented or planned, by school type.



Future potential

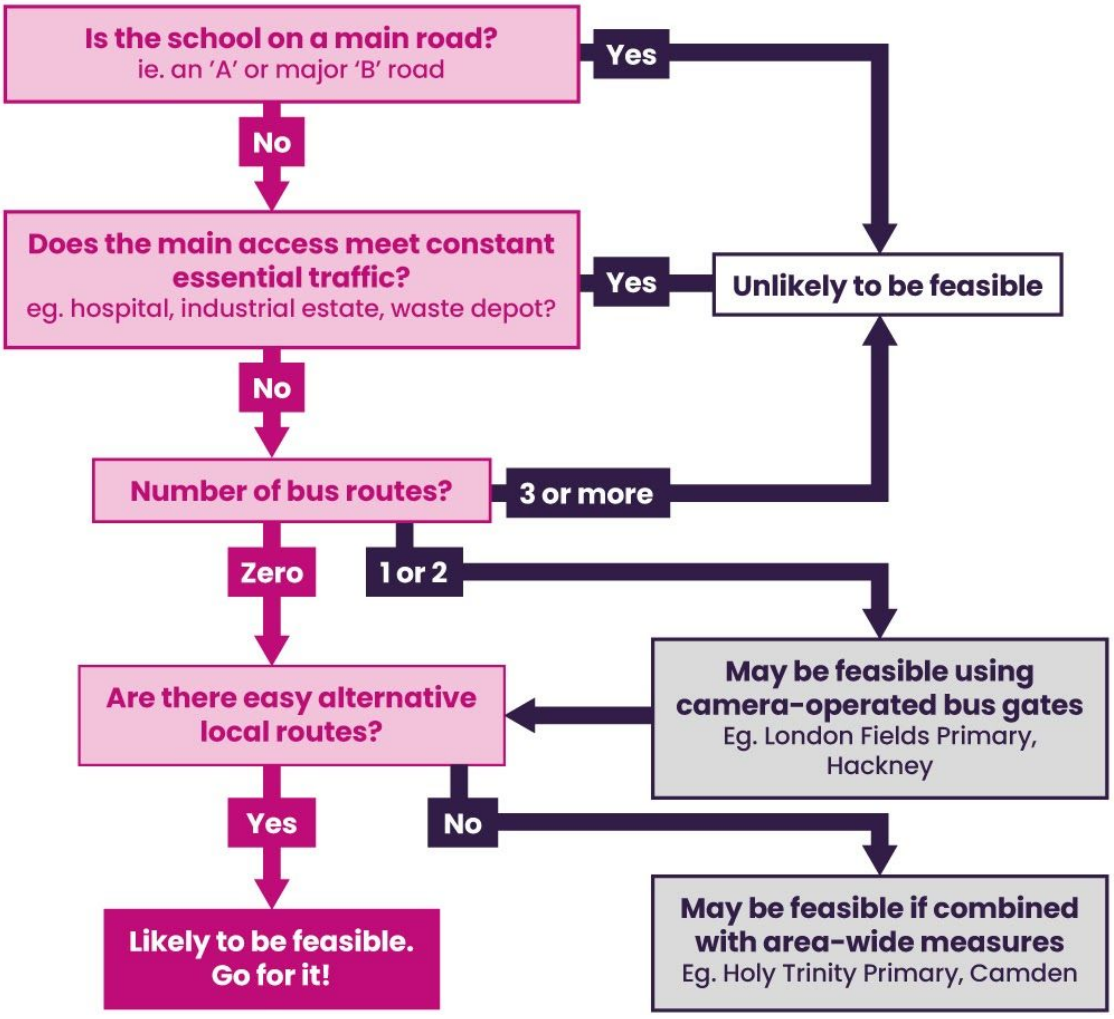
Where are School Streets possible?

As the last section shows, despite the clear benefit of introducing School Streets currently only a handful of schools in Birmingham, Bristol and Leeds are being piloted. Even in London, 85% of schools do not have a School Street. In this section we assess the scope for expansion of School Streets.

Figure 4 presents a flowchart we have created to assist children, parents, school staff, local authority officers and councillors to make a judgement as to whether a School Street is feasible in a certain location[40]. Figure 4 guided us in estimating the proportion of potential schools where a School Street could be provided across our cities. Briefly, for all 4020 schools in the cities, we did geographical lookups of relevant characteristics such as distance to the nearest A or B road. We then took a random sample of 134 schools and manually looked them up on Google maps to make a judgement as to School Street feasibility. This ultimately allowed us to estimate the approximate total number of schools in each city where a School Street was 'unlikely to be feasible, 'may be feasible, or 'likely to be feasible. For further details of our methods, see Appendix 2.

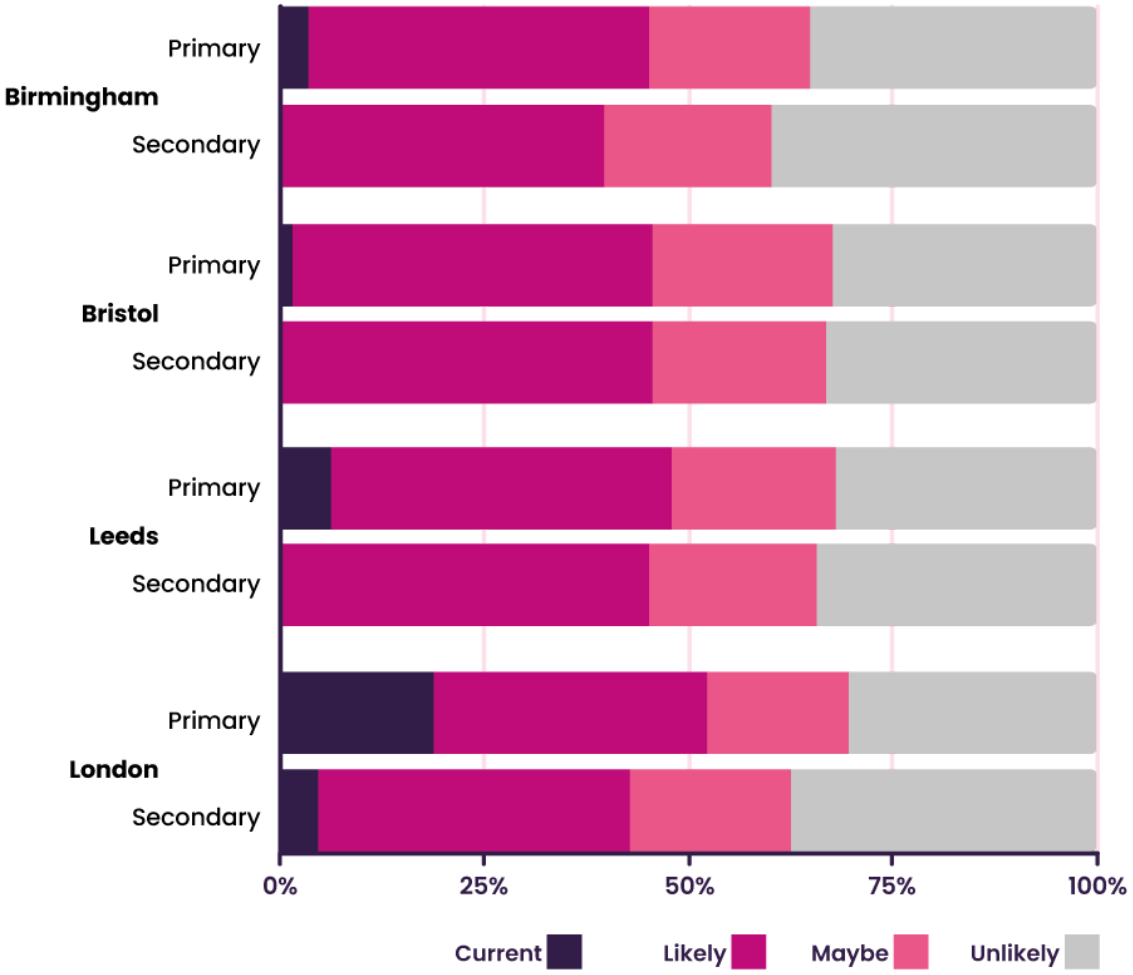
[40] We are grateful to input from School Street council officers from Camden and Hounslow local authorities in finalising this flowchart.

Figure 4: Conceptual flow chart providing an indication of School Street feasibility.



As illustrated in Figure 5, we found substantial potential for School Streets. In all four cities, around half of schools were either already School Streets or were judged likely to be feasible for School Streets. This proportion rose to around two-thirds if one additionally counted schools that might be feasible for School Streets if the implementation involved bus gates and/or area-wide measures. This high potential is also seen across other characteristics, for example in schools where background NO_2 was high as well as schools where it was low (see Appendix 2).

Figure 5: School Street potential, by school phase and city.



What about schools on main roads?

Across the four cities, almost 10% of schools were 'main road' schools, defined as having the road nearest the school being an A or B road. We found that School Streets were implemented or likely feasible for 17% of these main road schools in Birmingham and Leeds, 19% in Bristol, and 24% in London (Appendix 2). These School Streets involved, for example, closing an adjacent side street. It is, however, important to recognise that a School Street is unlikely to transform air pollution levels for the pupils of these main road schools – with wider measures instead being required (see Section 6).

Possible impact

Using the estimates of potential for School Streets in the four cities, combined with evidence from existing schemes on the likely reduction in car modal share, we have quantified the possible impact of School Streets in terms of reductions in car trips, car mileage, and emissions of air pollutants and greenhouse gases. We have used conservative assumptions to estimate minimum impacts as well as more ambitious assumptions to estimate what may be possible with a more ambitious roll-out combined with effective enforcement and supporting measures. In our 'conservative' scenario, we assumed School Streets are implemented everywhere that they are 'likely' to be feasible, and we assumed a reduction in the proportion of children driven to school of 3 percentage points. In our 'ambitious' scenario, we assumed School Streets are implemented everywhere that they are 'likely' to be feasible or 'may be feasible', and we assumed a reduction in the proportion of children driven to school of 6 percentage points. The detailed assumptions are shown in Appendix 3.

Figures 6 and 7 show that if all feasible schools in London, Birmingham, Leeds and Bristol had School Streets implemented this would reduce peak hour car trips in those cities in total by between 11 and 32 million trips a year, and car km by between 25 million and 71 million km a year. While large in absolute terms, this still represents a tiny percentage (<1%) of overall traffic mileage at peak times in the four cities.

Figure 6: Potential reductions in car trips per year in four cities with conservative and ambitious assumptions about the implementation of School Streets.

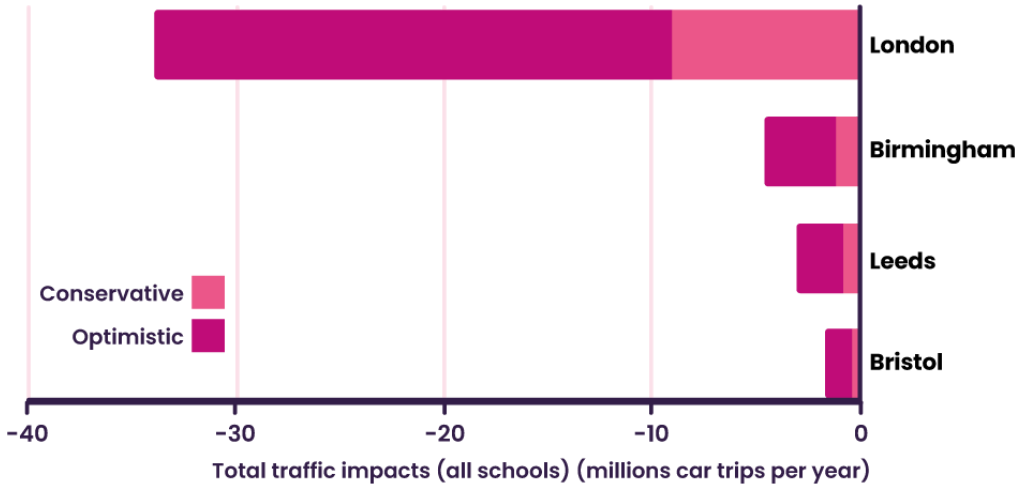
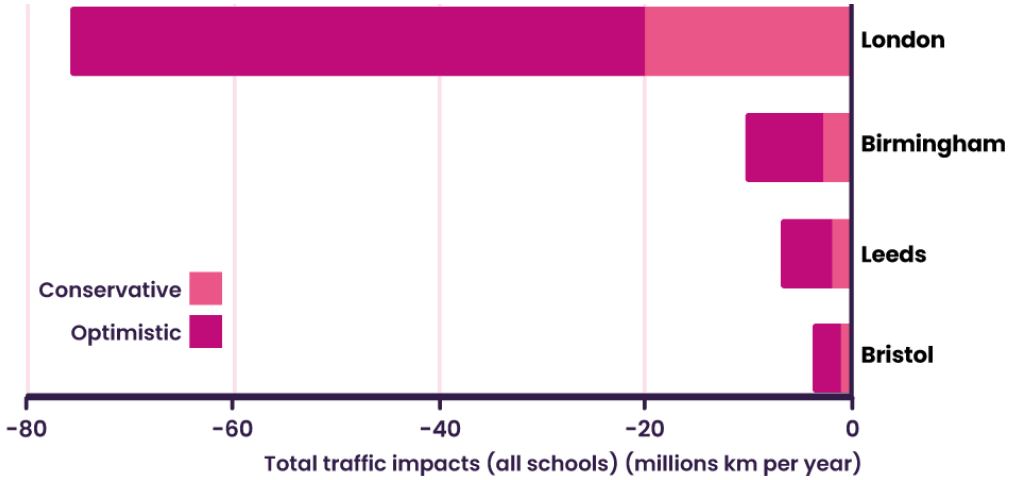


Figure 7: Potential reductions in car mileage per year in four cities with conservative and ambitious assumptions about the implementation of School Streets.



This in turn, based on average car emissions, will reduce emissions of air pollutants (NOx) by around 23,000 to 64,000 kg a year, and reduce emissions of greenhouse gases (CO_{2e}) by around 4,000 to 12,000 tonnes per year.

However even the 'ambitious' scenario does not tell the whole story. It doesn't include the synergistic effects of a city-wide network of School Streets on other road users such as local residents and commuters. It doesn't include the improved safety benefits of removing traffic from residential roads. It also doesn't include the impacts of wider measures discussed below, which can amplify the benefits of School Streets across neighbourhoods and the whole urban area. As we discuss below, the impacts of School Streets in areas with

more extensive road closures may be three times those shown here.

Area-wide measures to reduce air pollution

School Streets can reduce air pollution around a school area and are particularly helpful in reducing children's exposure to pollution on their journey to school. However, their impact in isolation is still limited – removing less than 1% of total traffic miles during peak hours and targeting only one of the many places where children are every day exposed to toxic air pollution levels.

We urgently need other measures which can reduce pollution and traffic across a whole local authority area and not just in a few streets. These wider measures can be grouped into four broad categories: Avoid, Shift, Separate and Improve[41]. Some measures, including School Streets, appear in more than one category and provide other benefits for road safety compared to measures that simply improve emissions.

Avoid	Shift	Separate	Improve
(i.e. less travel)	(i.e. more travel by walking, cycling and public transport)	(i.e. increase distance between people and vehicles)	(i.e. reduce emissions from vehicles)
e.g. Homeworking, consolidate deliveries	e.g. Road user charging, better and cheaper public transport, better walking and cycling routes, low traffic neighbourhoods, School Streets	e.g. Protected cycle/walk routes, low traffic neighbourhoods, School Streets	e.g. Clean air zones, encourage uptake of electric vehicles, diesel scrappage schemes, low emission/electric buses

[41] Adapted from the decarbonising transport categories developed by CREDS, University of Leeds: Marsden G et al (2020) Decarbonising transport. Getting carbon ambition right. Report for the Local Government Association.

Below we summarise three key measures that can amplify the benefits of a School Street, and have a significant impact on air pollution and traffic in towns and cities across the UK: Clean Air Zones (CAZ); a pay-per-mile Eco Levy on driving; and low traffic neighbourhoods (LTNs). Further details can be found in the Appendices.

Clean Air Zones (CAZs)

What are they?

Areas where vehicle models with the worst tailpipe emissions are banned or charged for entering. Minimum emission standards are set for different types of vehicles, with local authorities choosing what vehicles are covered (e.g. trucks, buses, coaches and taxis, or all vehicles). To be most effective, CAZs should cover the whole urban area, including major roads, and all types of vehicle, including the most polluting cars and vans.

Impact on traffic and air pollution

- An immediate and significant reduction in NO_2 air pollution within the zone, with a particularly large effect on roadside emissions[42].
- Less impact on $PM_{2.5}$ particulates, since vehicles with low tailpipe emissions still produce these small particles through tyre and brake wear.
- Can have a positive impact on air pollution at or beyond the CAZ boundary.
- May reduce traffic overall, though this is not the primary aim.

Where is it happening?

- London introduced an Ultra Low Emission Zone (ULEZ) in April 2019 which will be expanded in October 2021. The most polluting cars are charged £12.50 to enter the zone and larger polluting vehicles are charged £100.
- Bath and Birmingham are planning to introduce CAZs in 2021.
- Bristol is consulting on potential CAZ plans as this report goes to press.
- In October 2020 Leeds announced that it no longer needs a CAZ due to businesses switching to cleaner vehicles in preparation for the CAZ introduction,

[42] Mayor of London (2020) Central London Ultra Low Emission Zone – Ten Month Report. April 2020

meaning NO_2 pollution levels in Leeds currently fall below the legal limit (although 15% of schools exceed World Health Organisation air quality guidelines for $PM_{2.5}$). Further government support and funding is needed to help local authorities implement measures to reduce air pollution that go beyond mere legal compliance.

Pay-per-mile Eco Levy (a form of road user charging)

Source: Transport for London.

What is it?

A charge designed to reduce all road traffic. Daily charges to enter city centres are already used to cut congestion in London, Stockholm and elsewhere. A pay-per-mile Eco Levy would be different, with the price linked to distance driven as well as vehicle size and emissions. The charge could also be varied by time of day and area (e.g. higher charges at peak hours and lower charges in areas with less well-developed public transport). This would mean that people making short journeys in small low-emission cars in places without good public transport would not pay very much, but people driving a lot in large, polluting cars in places with good public transport would pay more. The Treasury has reportedly considered a national pay-per-mile scheme as a way to offset the expected drop in fuel duty from petrol and diesel cars as they are replaced by electric cars[43]. A road charging scheme for London based on distance, vehicle emissions and

[43] Swinford S (2020) Charges for using roads to fill £40bn black hole. Article in The Times, 16 November 2020.

availability of public transport has also been proposed by Centre for Cities[44].

Impacts on traffic and air pollution

- In London traffic fell by over one fifth after four years of the congestion charge, while air pollution fell by 12% in the first year.
- A distance-based charge linked to vehicle emission standards would be even more effective at reducing air pollution.

Where is it happening?

- A congestion charge is used to cut congestion in London, Singapore, Stockholm and Gothenburg.
- Many European countries have distance-based truck charges.

[44] Barrett S et al (2019) Green Light: Next Generation Road User Charging for a Healthier, more Liveable London. Report for Centre for London, April 2019.

The table below shows the benefits of the various road and vehicle charging schemes in terms of air quality, congestion and carbon emissions. It also shows which schemes are within local authority powers and whether the revenue generated is available for investment locally. It shows that the pay-per-mile Eco Levy provides the maximum benefits across all of the criteria shown.

Table 1: Road and vehicle charges and their benefits for local authorities.

Key:

✚ Large benefit ✚ Intermediate benefit ✖ No benefit

Road charges	Improve air quality	Reduce congestion	Reduce carbon	Within LA powers	Revenue goes to LA
Pay-per-mile Eco Levy	✚	✚	✚	✚	✚
Pay-per-mile national road pricing	✚	✚	✚	✖	✖
Congestion charge eg London Congestion Charge	✚	✚	✚	✚	✚
Clean Air Zone (charging) eg London ULEZ	✚	✚	✚	✚	✚
Workplace Parking Levy eg Nottingham's WPL	✚	✚	✚	✚	✚
Vehicle charges	**Improve air quality**	**Reduce congestion**	**Reduce carbon**	**Within LA powers**	**Revenue goes to LA**
Fuel duty	✚	✚	✚	✖	✖
Vehicle Excise Duty	✚	✖	✚	✖	✖

Low traffic neighbourhoods (LTNs)

Orford Rd, Waltham Forest before and after LTN.

Source: Paul Gasson.

What are they?

Groups of residential streets bordered by main roads, where "through" motor vehicle traffic is discouraged using 'modal filters'. These filters, such as planters, bollards or street furniture, prevent motorised through-traffic but allow people to pass through on foot or by bike. Residents can still drive onto their street or receive deliveries, but "rat running" from one main road to the next is harder or impossible.

What is the impact on traffic and air pollution?

- In Waltham Forest (see images above) traffic levels fell by over half (56%) inside the residential area and there were 10,000 fewer car journeys per day across the wider area.[45] This overall reduction happens because drivers adjust routes or choose other ways to travel.
- Evidence that people inside the LTN drive less and walk and cycle more as a result[46].

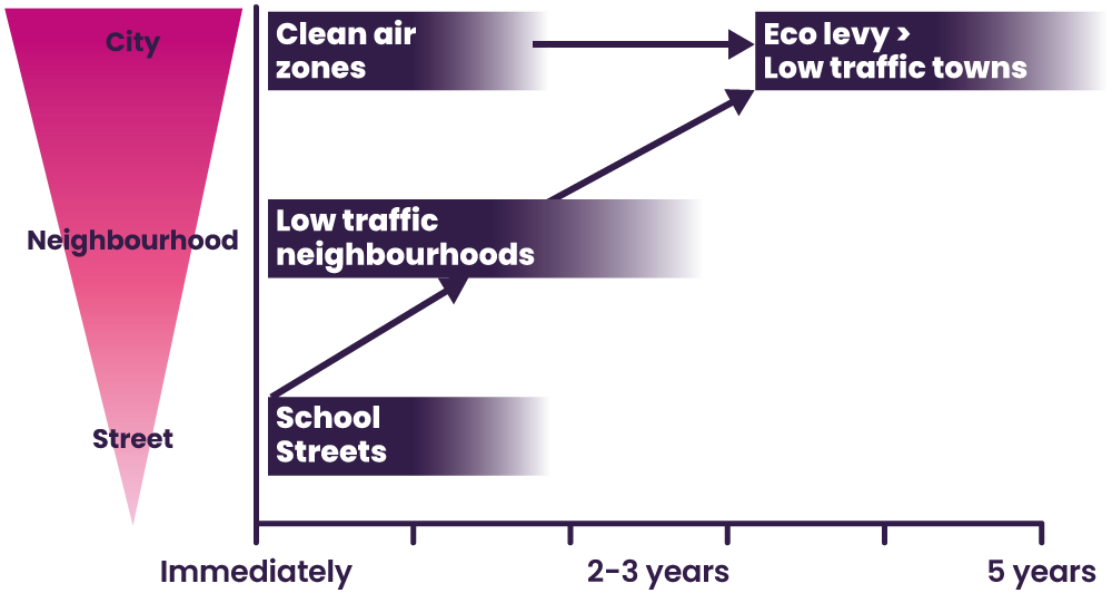
Where are they happening?

- Common in Dutch cities
- Dozens of schemes in London[47], including Waltham Forest (see image above)
- Introduced or being trialled in many other cities including Newcastle and Birmingham.

[45] Waltham Forest Borough Council (undated) Comparison of vehicle numbers before and after the scheme and during the trial.
[46] Aldred R and Goodman A (2020) Low Traffic Neighbourhoods, Car Use, and Active Travel: Evidence from the People and Places Survey of Outer London Active Travel Interventions. Findings, September. https://doi.org/10.32866/001c.17128.
[47] Aldred R (2020) Mapping London's new LTNs http://rachelaldred.org/research/mapping-londons-new-ltns/

These three measures apply at different geographical scales and can be implemented over different time scales. Figure 8 illustrates that immediately (over the next couple of years) local authorities should roll-out School Streets, LTNs and CAZs, together with a package of other 'avoid, shift, separate, improve' measures funded by the revenue from a charging CAZ. The greatest impact on reducing emissions from road transport and improving health will come from a package of policy measures[48].

Figure 8: Illustration of how our three key measures fit with School Streets.



Combining these broader measures with School Streets can make the latter much more effective. For example, a school in Enfield which was designated a School Street, and then became part of a much wider LTN, saw the proportion of children travelling to school by car reduce by 18 percentage points in one year[49]. If there was a comprehensive roll-out of School Streets and LTNs in the four cities, this level of car reduction could magnify by a factor of three the impacts estimated in Section 5 for our 'ambitious' scenario (which assumed a 6 percentage point reduction in car use).

Other supporting measures to reinforce the benefits of School Streets include controlled parking zones and behavioural change measures such as Modeshift STARS, cycle training, expanded cycle and scooter parking, improved crossings on

[48] Public Health England (2019) Review of interventions to improve outdoor air quality and public health. March 2019.
[49] Fox Lane LTN (2020) Environmental initiatives having a remarkable impact on school travel: car use halved and replaced by active travel over the last year at St.Monica's. Tweet, 06/11/20.

main roads and promoting safe routes to school. There also needs to be additional funding for School Streets as well as an urgent change to the rules to allow local authorities outside London use ANPR cameras to enforce School Streets.[50]

A CAZ is primarily a short-term action to speed up the replacement of more polluting vehicles with cleaner models and achieve rapid legal compliance with NO_2 limits. However, it does not tackle $PM_{2.5}$ pollution from brakes and tyres, and it does not reduce unacceptable traffic levels on main roads where people live, work and shop. It also doesn't reduce dangerous climate-heating carbon dioxide emissions. A pay-per-mile Eco Levy on driving could achieve a permanent, long-term reduction in traffic and air pollution, and the money raised from an Eco Levy could be invested in excellent and affordable (or even free) public transport. So far, no local authority has done this, but it is a necessary and logical step that local authorities should be looking at now, with a view to implementing it in the next 3-5 years across all of their urban area.

While measures to give more space to pedestrians and cyclists or to constrain driving can generate opposition from some people, there is actually very strong public support for action to tackle air pollution from cars. Four out of five (81%) residents in London, Birmingham, Manchester, Leeds and Glasgow are in favour of measures to reduce car emissions[51]. Reallocating road space to create more room for pedestrians as one of the measures to control air pollution is supported by 76% of respondents; additional cycle lanes are supported by 63% and Zero Emission Zones that ban non-electric cars from cities are supported by 71%. It is clear that most people want safer, cleaner streets.

By taking the first small practical step of arguing for School Streets, children and parents can encourage local councils to take the bigger leap of acting to reduce traffic and pollution on all roads where children (and adults) live, study and shop. In turn this needs to be supported by adequate funding from government.

[50] Although the government has agreed to introduce secondary legislation to give councils outside London the necessary powers for enforcement, this may not occur until summer 2021. Browne D (2020) 'Spring 2021' timeline for councils to moving traffic enforcement powers. Article in Highways Magazine, 7 October 2020. Local authorities outside London also have no dedicated funding for School Streets implementation, unlike London School Streets which were funded by Transport for London.

[51] Transport & Environment (2020) 4 in 5 city residents want cars to give way to bikes, buses and walking to tackle urban air pollution. Press Release, 11/06/20.

Resources for parents

Various resources for parents including air pollution maps, toolkits and campaign guides can be found in Appendix 7. Mums for Lungs have found that using resources like flyers, posters and campaign guides has been really helpful to mitigate any early worries from residents, parents or teachers about the scheme. Communication with all of the community is key to making School Streets a success.

For example, Mums for Lungs **campaigning guide** recommends:

- Mobilise parents to create a working group. Talk to your PTA and ask them to help raise awareness of the scheme amongst other parents, and to allay any concerns. Understand any opposition and try to find solutions for the issues raised – knowing your community and bringing them on board with you will help make the scheme a success.
- Talk to your headteacher and governors. Ask your headteacher to approach the council about the scheme.
- Contact local residents – explain how they might benefit from a School Street, for example, because there will be less traffic in the road at peak times.
- Contact your local councillors and the relevant portfolio holder/cabinet member for Environment/Transport/Clean Air in your borough, stating your support for a School Street.

Parents in Leeds, York, Birmingham, Bristol, Bath and London can also ask Possible's car free community campaign team for help. Possible's local campaigners' contact details can also be found in Appendix 7.

Conclusions

It is unacceptable that so many children in the UK are still exposed to levels of air pollution that have life-long impacts on their health and development and can be deadly. The majority of parents are concerned about the impacts on their children's health but may not be aware that they can make a difference.

School Streets are a small but achievable measure that parents can lobby for that can help reduce air pollution and traffic danger on the school run. There is evidence that this brings benefits to schools and the wider area in terms of traffic and air quality. The benefits are further amplified by shifting school travel to active modes providing significant health benefits for children.

Schools Streets are a growing movement, accelerated by the Covid-19 pandemic. First implemented in the UK only five years ago, the number of schemes has rocketed in the last two years with many cities introducing them on a trial basis. But there is considerable room for growth. Even in London, where there are nearly 400 schemes, many local authorities have few or no schemes. There has never been a better time to push for a School Street.

Our analysis of the distribution of School Streets in four cities has found that local authorities with higher deprivation levels and higher levels of air pollution have implemented more School Streets. While those authorities should be applauded, there are many hundreds of thousands of children still exposed to air pollution and traffic danger on a daily basis. Every child should be able to walk, scoot or cycle to school safely and breathe clean air.

For the first time this study has analysed the potential for School Streets. We found that there is a large opportunity to provide many more School Streets. In all four cities examined, a School Street is likely to be feasible for around half of schools (44-50%) and may be feasible for up to two-thirds of schools (64-68%). These findings from four cities are likely to be representative of the potential in other towns and cities. This shows the massive potential for improvement in the journey to school, which needs to be supported by adequate government funding

We have estimated that if all feasible schools in the four cities had School Streets implemented this would reduce car trips in those cities by over 32 million per year and reduce car

mileage by over 71 million km per year. This is an important change but is still less than 1% of total road traffic in these cities.

School Streets are a positive, practical measure that can help reduce children's exposure to air pollution, especially at the school gate. They can be rolled out rapidly and the barriers to doing so are low. But if implemented on their own, their impact will be limited. We need other measures to reduce air pollution and traffic across the whole urban area and not just on individual streets. Low Traffic Neighbourhoods and Clean Air Zones can improve air quality across a wider area. LTNs can also amplify the benefits of School Streets by a factor of three. A town- or city-wide pay-per-mile Eco Levy on driving could cut traffic, and all forms of traffic pollution including dangerous particles from tyres and brakes, while also raising significant sums to provide excellent, affordable (or free) public transport. It would be especially beneficial for people who live, work, study and shop on main roads.

Children are particularly vulnerable to the impacts of air pollution and deserve safe, healthy and pleasant journeys to school. Everyone wants to live on safe streets with clean air. We have the measures to achieve this, we now need to make sure our government funds and our local authorities deliver them.

Appendix 1: Statistical modelling as to which schools are getting School Streets

Table 1 presents analyses describing which schools are most likely to get a School Street across London. It examines four characteristics: phase of education; size of school; proportion of students in the school receiving free school meals (as a measure of deprivation of the student body); and the level of NO_2 air pollution in the school's vicinity.[52] Note that the reference value for the rate ratios is '1', i.e. any value above 1 indicates that category is more likely to have a school street.

In London, primary schools are around four times more likely to have a School Street than secondary schools or 'all-though' schools that cover both primary and secondary phases. Specifically, 19% of London primary schools have a School Street implemented or planned, compared to 5% of secondary schools and 5% of all-through schools (Table 1). This effect remains large after adjustment.

There was also evidence that, adjusting for phase of education, larger schools are progressively more likely to get school streets than smaller schools (Adjusted models in Table 1). This effect was only evident after adjusting for phase of education, because primary schools tend to be smaller than secondary schools.

Incidentally, there is an offsetting effect around school size such that a) primary schools are more likely to get a School Street than secondary schools (and primary schools are typically smaller, so each School Street benefits fewer pupils) but also b) adjusting for phase of education, larger schools are more likely to get a School Street than smaller schools (which benefits more pupils). These effects roughly balance out, which is why the proportion of schools in London with a School Street is very similar to the proportion of pupils at a school with a School Street.

Independent schools were much less likely to have School Streets than state-funded schools (5% versus 16%). Within

[52] The data on phase of education, number of pupils and % free school meals come from Edubase, the official register of schools in England, as downloaded October 2020 (https://get-information-schools.service.gov.uk/Downloads). The data on air pollution was extracted by taking the easting and northing of each school, and looking up the level of NO_2 and of $PM_{2.5}$ in the 1km grid square containing that school (https://uk-air.defra.gov.uk/data/pcm-data). We focused on NO_2 as it is the pollutant most closely associated with traffic.

state-funded schools, the overall trend across London was for a higher proportion of School Streets in schools with a more deprived student body (Adjusted model 1, Table 1). This effect was no longer clear, however, after adjusting for local authority (Adjusted model 2, Table 1). This effect therefore seemed to stem from differences between local authorities in rates of implementing School Streets (e.g. many being implemented in relatively deprived Hackney and Islington) rather than from local authorities targeting their most deprived schools.

Finally, there was evidence that schools in more polluted areas were progressively more likely to have a School Street. However, this effect was no longer evident after adjusting for local authority. As with school deprivation, therefore, the London-wide seemed to reflect which local authorities were implementing School Streets rather than local authorities targeting their most polluted schools. These findings on air pollution were very similar when instead looking at associations with background levels of $PM_{2.5}$, or when alternatively combining both NO_2 and $PM_{2.5}$ through standardising values of each, then taking the average, and then dividing into quartiles across London.

Table 1: Predictors of which schools have school street in London.

		No. schools	% with a school street	Adjusted model 1 ≈ 'Adjusted effect across London' (rate ratio, 95% confidence interval)	Adjusted model 2 ≈ Adjusted effect within local authorities (rate ratio, 95% confidence interval)
	All schools	3083	15%	-	-
Phase of education	Primary	2,167	19%	1***	1***
	Secondary	662	5%	0.12 (0.07, 0.19)	0.08 (0.05, 0.13)
	All through	254	5%	0.19 (0.10, 0.36)	0.16 (0.08, 0.32)
School size	0-499 pupils	2,141	15%	1**	1***
	500-999 pupils	612	16%	1.43 (1.10, 1.87)	1.96 (1.44, 2.66)
	1000-1499 pupils	247	8%	2.37 (1.29, 4.36)	3.33 (1.70, 6.50)
	1500+ pupils	83	8%	3.34 (1.35, 8.25)	6.68 (2.47, 18.05)
School deprivation	Independent (0% FSM)	448	5%	1***	1***
	0-14% FSM	980	13%	0.40 (0.24, 0.65)	0.22 (0.13, 0.38)
	15-29% FSM	1,056	19%	1.62 (1.26, 2.08)	1.61 (1.20, 2.15)
	30-44% FSM	456	18%	1.45 (1.04, 2.00)	0.77 (0.52, 1.13)
	45%+ FSM	143	17%	2.48 (1.46, 4.20)	1.28 (0.70, 2.33)
Mean annual NO_2	<20 µg/m^3	606	11%	1***	1
	20-29 µg/m^3	1,980	14%	1.33 (0.99, 1.79)	0.78 (0.50, 1.23)
	30-39 µg/m^3	468	21%	2.39 (1.65, 3.45)	1.09 (0.60, 1.97)
	40+ µg/m^3	29	24%	3.67 (1.39, 9.71)	1.24 (0.37, 4.15)

*p<0.05, **p<0.01, ***p<0.001 for heterogeneity. FSM=free school meals. Adjusted model 1 adjusts for all the variables shown in table. Adjusted model 2 additionally adjusts for local authority. Regression models fit using Poisson regression with robust standard errors. In adjusting for local authority, we combined Barnet with Harrow, and Bexley with Bromley, as Barnet and Bexley had zero school streets.

Appendix 2: Identifying school street feasibility - detailed methods and further results

Step 1

For all 4020 schools in the four cities, we did geographical lookups of the following characteristics:

- Nearest road type ('A', 'B', 'Minor', or 'Local and smaller').
- Crow-flies distance to the nearest A or B road.
- Number of bus stops within 100m.
- Number of other transport features within 100m judged plausibly to be relevant to school street feasibility. A list of these features is in Table 2.
- Number of sites within 100m judged plausibly to involve constant essential traffic (e.g. hospitals and industrial estates). A list of these sites is in Table 3.

Table 2: Types of transport features judged plausibly relevant to the feasibility of a school street, as taken from the Points Of Interest database. NB Bus stops were considered separately.

Aeronautical Features
Airports and Landing Strips
Bus and Coach Stations, Depots and Companies
Ferries and Ferry Terminals
Hail and Ride Zones
Helipads
London Underground Entrances
Moorings and Unloading Facilities
Parking
Petrol and Fuel Stations
Railway Stations, Junctions and Halts
Rivers and Canal Organisations and Infrastructure
Taxi Ranks
Tram, Metro and Light Railway Stations and Stops
Underground Network Stations
Motorway Service Stations

Table 3: Types of site judged plausibly to involve constant essential traffic, as taken from the Points Of Interest database [53]

Description	PointX Class
Accident and Emergency Hospitals	5280780
Ambulance and Medical Transportation Services	5290356
Building and Component Suppliers	2030779
Business Parks and Industrial Estates	7410531
Cemeteries and Crematoria	6340454
Clearance and Salvage Dealers	2120199
Clinics and Health Centres	5280365
Coal Mining	7380500
Construction Plant	2030047
Container and Storage	2150221
Courier, Delivery and Messenger	2150222
Courts, Court Services and Tribunals	6330409
Distribution and Haulage	2150223
Doctors Surgeries	5280369
Driving and Motorcycle Schools	5320390
Driving Test Centres	6330411
Fire Brigade Stations	6330414
Fuel Distributors and Suppliers	9480766
Hospices	5280370
Hospitals	5280371
Import and Export Services	2150225
Metalworkers Including Blacksmiths	2030044
Motorsport Venues	4240297
New Vehicles	9490695
Oil and Gas Extraction, Refinery and Product Manufacture	7380501
Ore Mining	7380502
Peat Extraction	7380503
Racecourses and Greyhound Tracks	4240298
Rag Merchants	2120198
Recycling Centres	6340462
Recycling, Reclamation and Disposal	2120196
Refuse Disposal Facilities	6340440
Road Construction Services	2030059
Sand, Gravel and Clay Extraction and Merchants	7380504
Scrap Metal Dealers and Breakers Yards	2120200
Second-hand Vehicles	9490696
Sports Grounds, Stadia and Pitches	4240302
Stone Quarrying and Preparation	7380506
Taxi Services	2150230
Unspecified Works or Factories	7410542
Vehicle Repair, Testing and Servicing	2130212
Veterinarians and Animal Hospitals	5260322
Walk-In Centre	5280812
Wastepaper Merchants	2120202
Waste Storage, Processing and Disposal	6340441

[53] https://www.ordnancesurvey.co.uk/business-government/products/points-of-interest

Step 2

We use the above geographic characteristics to stratify schools into a three-level 'School Street difficulty score'. The development of this score was partly guided by existing data on which schools in London currently have School Streets. The formula for this difficulty score was:

- Each school starts with 0 points
- +2 points if nearest road is NOT 'Local or smaller' (max +2 points)
- +1 point for any A or B road within 100m (max +1 point)
- +1 point for number of bus stops within 100m, capped at 3 points (max +3 points)
- +1 point for any other transport feature within 100m that may be relevant to school street feasibility (max +1 point)
- +1 point for any site within 100m that may involve constant essential traffic (max +1 point)

Then categorised as low difficulty score (0 points), mid difficulty score (1-2 points), high difficulty score (3-8 points).

Step 3

We took a random sample of 12 schools with each of the three difficulty scores from each of the four cities, i.e. 12*3*4=144 in total. Of these 10 were already School Streets. We manually looked the remaining 134 up on Google maps to make a judgement as to School Street feasibility (categories 'unlikely to be possible, 'may be possible', or 'likely to be possible').[54] Table 4 shows the resulting distribution of school street feasibility category according to difficulty score. Note that these analyses combine the four cities together, because we found no evidence of a difference between the cities in the extent to which each difficulty score predicted feasibility category (p=0.92 in a test for interaction).

[54] Manual lookups done by Anna Goodman and Asa Thomas, discussing difficult cases together. Interrater reliability in a random sample of 30 schools: 26/30 perfect agreement or marked as cases for discussion, 3/30 disagreed by one level, 1/30 disagreed by two levels.

Table 4: Distribution of School Street feasibility, by feasibility score

		% of schools in each feasibility category (from manual lookups on Google maps, excluding ones already a school street)		
		Likely feasible	May be feasible	Unlikely feasible
Difficulty score (from geographic characteristics)	Low	64%	20%	16%
	Mid	38%	29%	33%
	High	17%	13%	70%

Step 4

We took the total number of schools with each difficulty score, and multiplied that by the above probabilities to estimate the proportion of schools in each feasibility category. We then summed across the different difficulty score to estimate the total proportion of all schools in each feasibility category. We did this both for the cities as a whole, and for the cities stratified by pollution status and main road proximity, under an assumption that the matrix in Table 1 is valid across school characteristics. Results of doing this are shown in Table 5.

Table 5: Distribution of School Street feasibility, by school characteristics.

			No. schools	School Street feasibility category (row %)			
				Already a School Street	Likely feasible	May be feasible	Unlikely feasible
Birmingham	All schools		476	3%	41%	20%	36%
	Phase of education	Primary	342	4%	42%	20%	35%
		Secondary	109	0%	39%	21%	40%
		All through	25	0%	42%	20%	38%
	Mean annual NO_2	<20 µg/m³	262	3%	43%	20%	34%
		20-29 µg/m³	206	1%	39%	20%	39%
		30-39 µg/m³	8	0%	22%	17%	61%
		40+ µg/m³	0	-	-	-	-
	Main road	No	430	3%	44%	21%	33%
		Yes	46	0%	17%	13%	70%
Bristol	All schools		172	1%	44%	22%	33%
	Phase of education	Primary	124	2%	44%	22%	32%
		Secondary	28	0%	45%	21%	34%
		All through	20	0%	47%	21%	32%
	Mean annual NO_2	<20 µg/m³	150	1%	45%	22%	32%
		20-29 µg/m³	22	0%	38%	21%	40%
		30-39 µg/m³	0	-	-	-	-
		40+ µg/m³	0	-	-	-	-
	Main road	No	158	1%	47%	22%	30%
		Yes	14	0%	19%	14%	67%
Leeds	All schools		289	5%	42%	20%	32%
	Phase of education	Primary	227	6%	42%	20%	32%
		Secondary	44	0%	44%	20%	37%
		All through	18	0%	49%	23%	29%
	Mean annual NO_2	<20 µg/m³	252	4%	43%	20%	33%
		20-29 µg/m³	36	11%	40%	20%	29%
		30-39 µg/m³	1	0%	-	-	-
		40+ µg/m³	0	-	-	-	-
	Main road	No	278	5%	43%	21%	31%
		Yes	11	0%	17%	13%	70%
London	All schools		3,083	15%	35%	18%	33%
	Phase of education	Primary	2,167	19%	33%	17%	31%
		Secondary	662	5%	39%	20%	37%
		All through	254	5%	37%	20%	38%
	Mean annual NO_2	<20 µg/m³	606	11%	41%	19%	30%
		20-29 µg/m³	1,980	14%	35%	18%	33%
		30-39 µg/m³	468	21%	27%	16%	36%
		40+ µg/m³	29	24%	21%	16%	39%
	Main road	No	2,760	15%	37%	19%	29%
		Yes	323	8%	16%	12%	64%

Main road defined as schools where the nearest road was A or B.

Appendix 3: Estimating the impacts of School Streets

We estimated the potential impacts of School Streets on car trips, car mileage, NOx emissions and CO_{2e} emissions in the four cities, using 'conservative' and 'ambitious' scenarios. For the 'conservative' scenario we assumed a percentage point reduction in car travel to school of 3 percentage points and a percentage of schools amenable to School Streets based on the 'already/likely' figures from Appendix 2. For the 'ambitious' scenario we assumed a percentage point reduction in car travel to school of 6 percentage points and a percentage of schools amenable to School Streets based on the 'already/likely/may be likely' figures from Appendix 2.

The 'conservative' car travel reduction figure was based on average figures from 27 existing School Streets in 7 local authorities and includes all car journeys to school. However many of these schemes were isolated schemes without proper enforcement, and with greater experience in 'what works' and a city-wide adoption it is likely that the percentage point reduction will be much higher. For the 'ambitious' scenario we have therefore assumed that this reduction in car travel can be doubled to -6 percentage points. The assumptions and data sources used are shown in Table 1 and the results in Table 2.

Table 1: Assumptions used to estimate impact of School Streets

Assumption	Primary	Secondary	Source
No. pupils			From edubase, varies by Local Authority
% point reduction in car travel with School Streets	-3 to -6	-3 to -6	Data from hands-up surveys at 27 existing School Streets from 7 local authorities.
% schools amenable to School Streets			Data from analysis as per Table 5 in Appendix 2, varies by Local Authority.
No. trips to school per pupil per year	351	356	Anna Goodman's estimates
Mean number of car driver escort trips per pupil car trip to school	1.2	1.2	Multiplier, assumptions taken from Goodman et al 2019[55]
Average distance to school (km)	1.61	3.22	Anna's analysis: NTS data for urban areas, 2015-2019: 25th percentile car distance in primary school and the 50th percentile in secondary school
Average NOx emissions from car (g/km)	0.8913	0.8913	Defra Conversion factors for average petrol/diesel cars in 2020[56] combined with DfT figures for % petrol/diesel cars in the fleet at the end of 2019[57]
Average CO_2 emissions from car (kg/km)	0.1677	0.1677	As above
Road traffic miles by region (km)			DfT TRA8905 Car traffic km by local authority[58]
School AM peak hour traffic as % all traffic	28%	28%	School peak = trips starting 7.30-9.15, or 14.30 to 16.30, which is when they are most common. Calculated by Anna Goodman, NTS all urban areas 2015-19

[55] https://www.sciencedirect.com/science/article/pii/S2214140518301257

[56] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

[57] https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars

[58] https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra#traffic-by-local-authority-tra89

Table 2: Estimated impacts of School Streets.

	'Conservative' scenario				'Ambitious' scenario			
	Car trips (m/y)	Car km (m/y)	NOx (kg/y)	CO_{2e} (t/y)	Car trips (m/y)	Car km (m/y)	NOx (kg/y)	CO_{2e} (t/y)
London	-9.05	-20.00	-17,830	-3,354	-24.88	-55.86	-49,789	-9,367
Birmingham	-1.17	-2.57	-2,295	-432	-3.45	-7.68	-6,841	-1,287
Leeds	-0.79	-1.74	-1,550	-292	-2.25	-5.00	-4,455	-838
Bristol	-0.42	-0.94	-837	-157	-1.23	-2.76	-2,463	-463

We compared the car mileage reduction estimates with total peak a.m. hour traffic per year in the four cities and in all cases it was <1%.

Not included in these figures was the car travel reduction at one school with both a School Street and a Low Traffic Neighbourhood which was -18 percentage points[59]. This shows the amplifying effect that LTN and other complementary measures can have on the benefits of School Streets. Applying this level of car traffic reduction would result in a 3-fold increase in the impacts compared to the 'ambitious' scenario.

[59] Fox Lane LTN (2020) Environmental initiatives having a remarkable impact on school travel: car use halved and replaced by active travel over the last year at St.Monica's. Tweet, 06/11/20.

Appendix 4: Clean Air Zones or Low Emission Zones

What are they?

A Clean Air Zone (CAZ) is an area where vehicles with the most polluting tailpipe emissions are restricted or charged for entering. Minimum emission standards are set for different types of vehicle (e.g. Euro VI emission standards for buses) with local authorities choosing what vehicles are covered. There are four classes of CAZ ranging from Class A (buses, coaches and taxis only) to Class D (a wide range of vehicle types)[60]. A CAZ can either be non-charging, where certain vehicles may be restricted, or charging, where vehicle owners pay a charge to enter. To be effective CAZs should cover the whole urban area, including major roads, and all types of vehicles, including the most polluting cars and vans.

Where is it happening?

Five cities (in addition to London) were required to establish a clean air zone by 2020: Birmingham, Derby, Leeds, Nottingham and Southampton[61]. A further 23 local authorities were required to determine whether or not a CAZ was needed. Many are still considering[62].

60 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863730/clean-air-zone-framework-feb2020.pdf

61 https://www.documents.clientearth.org/wp-content/uploads/library/2019-03-15-what-do-clientearths-legal-cases-mean-for-local-authority-plans-to-deliver-nitrogen-dioxide-compliance-in-england-and-wales-ce-en.pdf

62 https://www.fleetnews.co.uk/fleet-faq/what-are-the-proposed-uk-clean-air-zones-caz

City	CAZ status	Class	Charging
London[63]	Introduced Ultra Low Emission Zone (ULEZ) April 2019, area to be expanded in Oct 2021	D	Yes
Bath[64]	Planning to introduce March 2021	C	Yes
Birmingham[65]	Delayed until June 2021	D	Yes
Leeds[66]; Derby[67]; Nottingham[68]	Decided no longer required		
Bristol[69]; Sheffield[70]; Greater Manchester[71]; Southampton[72] and others	Delayed due to Covid-19 pandemic		

What is the impact on traffic and air pollution?

- Results from London's ULEZ show a 44% reduction in NO_2 at roadside sites in February 2020 compared to February 2017[73] and 44,100 fewer older, more polluting vehicles on an average day over the same period[74]. There was also a 27% reduction in quarterly average $PM_{2.5}$ emission in background sites located in central London over the same period[75]. However it will have less impact on $PM_{2.5}$ particulates from tyre, road and brake wear.
- In London there is some indication of a reduction in traffic in central London after the ULEZ was introduced though this may not be all attributable to the ULEZ[76].

[63] https://tfl.gov.uk/modes/driving/ultra-low-emission-zone
[64] https://beta.bathnes.gov.uk/bath-clean-air-zone
[65] https://www.birmingham.gov.uk/info/20076/pollution/1763/a_clean_air_zone_for_birmingham
[66] https://democracy.leeds.gov.uk/documents/s210921/Clean%20Air%20Zone%20Update%20Cover%20Report%20131020.pdf
[67] https://www.derby.gov.uk/transport-and-streets/air-quality-in-derby/tackling-poor-air-quality/preferred-option-announcement/
[68] https://www.transportnottingham.com/no-clean-air-zone-for-nottingham/
[69] https://www.cleanairforbristol.org/wp-content/uploads/2020/10/CAZ-C-D.pdf
[70] https://www.sheffield.gov.uk/home/pollution-nuisance/clean-air-zone
[71] https://cleanairgm.com/
[72] https://www.southampton.gov.uk/moderngov/documents/g4026/Public%20reports%20pack%2016th-Jan-2019%2017.30%20Overview%20and%20Scrutiny%20Management%20Committee.pdf?T=10
[73] https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/air-quality-london-2016-2020
[74] https://www.london.gov.uk/sites/default/files/ulez_ten_month_evaluation_report_23_april_2020.pdf
[75] Ibid.
[76] https://www.london.gov.uk/sites/default/files/ulez_ten_month_evaluation_report_23_april_2020.pdf

- There was a 58% reduction in diesel particulate matter in Berlin between 2007 (before a CAZ scheme) and 2010 (after a CAZ)[77].
- Air quality improvements should be delivered across a wider area as the compliant vehicles travelling into the charging zone will pass through the communities around the charging boundary and across the wider area.
- Although not designed to reduce traffic a CAZ in Milan reduced the number of vehicles both within and outside the zone[78].

What are the other benefits?

In Milan the reduction in cars and reorganisation of traffic flows led to an increase in safety[79].

Is there public support for it?

Seven out of ten (71%) residents in London, Birmingham, Manchester, Leeds and Glasgow support the introduction of Zero Emission Zones that ban polluting cars from cities[80].

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77 https://urbanaccessregulations.eu/low-emission-zones-main/impact-of-low-emission-zones

78 https://www.researchgate.net/publication/249322950_An_economic_environmental_and_transport_evaluation_of_the_Ecopass_scheme_in_Milan_three_years_later

79 Ibid.

80 https://www.transportenvironment.org/press/4-5-city-residents-want-cars-give-way-bikes-buses-and-walking-tackle-urban-air-pollution

Appendix 5: A pay-per-mile Eco Levy (a form of road user charge)

What is it?

A charge designed to reduce all road traffic. Daily charges to enter city centres are already used to cut congestion in London and elsewhere. A pay-per-mile Eco-Levy would be different, with the price linked to distance driven as well as vehicle size and emissions[81]. The charge could also be varied by time of day and area (i.e. higher charges at peak hours and lower charges in areas with less well-developed public transport). This would mean that people making short journeys in small low-emission cars in places without good public transport would not pay very much, but people driving a lot in large, polluting cars in places with good public transport would pay more. The introduction of a levy would be preceded by improvements to public transport services, and the revenue generated would be earmarked for public transport improvements and could even be linked to free buses and trams[82]. The Treasury has reportedly considered a national pay-per-mile scheme as a way to offset the expected drop in fuel duty from petrol and diesel cars as they are replaced by electric cars[83]. A road charging scheme for London based on distance, vehicle emissions and availability of public transport has also been proposed by Centre for Cities[84].

Where is it happening?

Congestion charging is used to cut congestion in London, Singapore, Stockholm and Gothenburg. However, nowhere has yet introduced a pay-per-mile levy linked to emissions though all local authorities in the UK have the powers to do this. Many European countries also have distance-based truck charges. For example, the Swiss heavy vehicle fee, introduced in 2001, charges HGVs or trucks according to their

[81] https://policy.friendsoftheearth.uk/insight/eco-levy-driving-cut-carbon-clean-toxic-air-and-make-our-towns-and-cities-liveable
[82] Ibid.
[83] https://www.thetimes.co.uk/article/charges-for-using-roads-to-fill-40bn-black-hole-t2bz9k6br
[84] https://www.centreforlondon.org/project/road-user-charging-london/

distance travelled and emissions, with the revenue used to co-fund rail infrastructure[85].

What is the impact on traffic and air pollution?

- In the first year of operation of London's congestion charge total NOx and PM_{10} emissions in the charging zone reduced by around 12%[86]. Traffic entering charging zone during hours of operation fell 18% initially, and 21% by 2007.
- In Stockholm, the congestion charge reduced ambient air pollution by 5-15% and the rate of acute asthma attacks among young children by 50%[87].
- A London distance-based charge linked to vehicle emission standards could reduce CO_2 and air pollution by 25-30%[88].
- The Swiss HGV charge led to a substantial decrease in HGV traffic volumes[89].

What are the other benefits?

Better quality of life, lower noise and lower carbon emissions. Generation of revenue for investment in better public transport services and safer walking and cycling routes.

Is there public support for it?

In London, public support grew after the congestion charge was introduced with over two-thirds of Londoners felt they had gained from the charge or it made no difference to them, whereas only a quarter felt they were worse off[90]. This result was consistent across central, inner and outer London.

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85 https://www.transportenvironment.org/sites/te/files/publications/2017_04_road_tolls_report.pdf

86 https://www.londonair.org.uk/london/reports/CCS2005.pdf

87 https://www.nber.org/system/files/working_papers/w24410/w24410.pdf

88 https://www.centreforlondon.org/wp-content/uploads/2019/04/Next-Generation-Road-User-Charging.pdf

89 https://www.gised.ch/wAssets-de/docs/trans/fachartikel-referate/2004/dokumente/cor_swisslsva_interoperability_18march04_oe.pdf

90 https://policy.friendsoftheearth.uk/insight/eco-levy-driving-cut-carbon-clean-toxic-air-and-make-our-towns-and-cities-liveable

Appendix 6:
Low traffic neighbourhoods (LTNs)

What are they?

Groups of residential streets, bordered by main roads, where "through" motor vehicle traffic is discouraged using 'modal filters'. These filters, such as planters, bollards or street furniture, prevent motorised through-traffic but allow people to pass through on foot or by bike[91]. Residents can still drive onto their street or receive deliveries, but 'rat-running' from one main road to the next is harder or impossible.

Where are they being implemented?

These are common in Dutch cities and have been implemented in Barcelona's "Superblocks"[92]. The first scheme in London was in Waltham Forest and there are over dozens of schemes in London alone[93]. Other cities are trialling them including Newcastle[94] and Birmingham[95]. These are being increasingly trialled outside London due to the availability of emergency Covid-19 funding for active travel.

What is the impact on traffic and air pollution?

In Waltham Forest motor traffic levels fell by over half (56%) inside the residential area and by 16% even when including the main roads[96]. Around 15% of displaced traffic disappears from the area entirely as drivers adjust routes and behaviour [97]. This medium-term "traffic evaporation" is well-evidenced[98] . Even with traffic evaporation, there is some increase in traffic on surrounding main roads, but this is not as big as some fear and evidence from Waltham Forest suggests that there has

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[91] https://londonlivingstreets.files.wordpress.com/2018/09/lcc021-low-traffic-neighbourhoods-detail-v9.pdf

[92] https://theconversation.com/superblocks-barcelonas-car-free-zones-could-extend-lives-and-boost-mental-health-123295

[93] http://rachelaldred.org/research/mapping-londons-new-ltns/

[94] https://streetsforpeople.org.uk/about/project/

[95] https://www.birmingham.gov.uk/info/50250/emergency_transport_plan/2203/places_for_people/3

[96] https://enjoywalthamforest.co.uk/work-in-your-area/walthamstow-village/comparison-of-vehicle-numbers-before-and-after-the-scheme-and-during-the-trial/

[97] https://londonlivingstreets.files.wordpress.com/2018/09/lcc021-low-traffic-neighbourhoods-detail-v9.pdf

[98] http://rachelaldred.org/writing/thoughts/disappearing-traffic/

not been a decrease in air quality on main roads following introduction of LTNs[99].

A long term study which enables evaluation of the impact of LTNs showed a consistent trend towards people in LTNs being less likely to own a car and using their cars less, and an increase in active travel[100].

However to reduce traffic on main roads as well wider traffic restraint policies such as road user charging, plus redesigns of main roads and low-traffic residential schemes are all needed, even if they are delivered over different timescales[101].

What are the other benefits?

LTNs also benefit children who don't live in the LTN but who travel through the area on their way to school by providing a safe walking and cycling route.

LTNs are good for business with evidence from New York that improved accessibility and a more welcoming street environment created by these projects generate increases in retail sales in the project areas.[102]

Is there public support for them?

Surveys commissioned by Greenpeace found that where people had opinions on LTNs, positive views were more than three times more prevalent than negative ones: 26% of people said they strongly supported LTNs, and 31% would "tend" to, while 8% strongly opposed them, and the same number tended to[103].

A survey of 2,000 people living in London showed 52% of people supported LTNs and only 19% opposed them[104].

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99 https://www.walthamforest.gov.uk/sites/default/files/WalthamForest_Kings%20Report_310718.pdf

100 http://rachelaldred.org/research/low-traffic-neighbourhoods-evidence/

101 https://londonlivingstreets.com/2019/07/11/evaporating-traffic-impact-of-low-traffic-neighbourhoods-on-main-roads/

102 http://www.nyc.gov/html/dot/downloads/pdf/dot-economic-benefits-of-sustainable-streets.pdf

103 https://www.theguardian.com/environment/bike-blog/2020/oct/22/despite-a-loud-opposing-minority-low-traffic-neighbourhoods-are-increasingly-popular

104 https://www.onlondon.co.uk/new-polling-most-londoners-blame-covid-or-government-for-tfl-financial-woes-back-ltns-and-are-satisfied-with-sadiq-khan/

Appendix 7:
Resources for parents

Air pollution maps and vehicle checkers

Friends of the Earth air pollution map and top ten most polluted areas in each region of England

Real Time Air Quality Index visual map for the UK

Breathe London interactive map showing air pollution levels and sources

Birmingham interactive air pollution map https://www.birminghamairquality.co.uk/

Online vehicle checker showing real world emissions

Toolkits and campaign guides

Mums for Lungs School Streets Campaigning Guide

Mums for Lungs resources including flyers, banners, video and leaflets

Living Streets School Streets toolkit

Sustrans School Streets programme

School Streets Initiative website including map of School Streets in the UK

Friends of the Earth Guide for local groups on School Streets

Hackney Borough Council School Street Toolkit for Professionals

Mayor of London's School Audit Toolkits (relevant outside London as well)

Campaign groups and local contacts

Below are just some of the groups campaigning for clean air in the four cities and the local Possible contacts:

London: Mums for Lungs; Clean Air in London; Healthy Air Campaign Possible: Carolyn.Axtell@wearepossible.org

Birmingham: Birmingham Friends of the Earth; Clean Air Parents Network; Kings Heath Clean Air Network; Possible: Sandra.Green@wearepossible.org

Leeds: Leeds Living Streets convenes the Clean Air Alliance,(CAA) of 25 plus organisations; including Friends of

the Earth Leeds; Greenpeace Leeds; Healthy Air Leeds; Possible: Hannah.Kettle@wearepossible.org

Bristol: Our Air Our City campaign is a coalition of 30 Bristol groups; Possible: Rob.Bryher@wearepossible.org