

# Speed, emissions & health

The impact of vehicle speed on emissions  
& health: an evidence summary

June 2018

# Purpose of this briefing

## Context

Concern about the health harms of air pollution in London have raised questions around possible adverse consequences of policies aiming to reduce the dominance of motor traffic.

## Aims

- ▶ To summarise the evidence on:
  - » The relationship between vehicle speed, driving style, congestion and air quality.
  - » The health impacts of slowed traffic.
- ▶ To present scheme-specific evidence relating to 20mph zones, speed bumps and cycle infrastructure.

## Audience

Policy-makers and practitioners working in the transport sector.



# Contents

## Key points

**How does vehicle movement & congestion affect air quality?**

- Speed
- Driving style
- Congestion
- Evaluating air quality impacts

**How does vehicle movement affect health?**

- Policy context
- Local health impacts
- Borough- and London-wide health impacts

**What impact do specific schemes have on air quality & health?**

- 20mph zones
- Speed bumps
- Protected cycle lanes

## Key points

## References



## Key points

The **health benefits of slowing traffic** as part of the Healthy Streets Approach **will dwarf any dis-benefits**. Most of these benefits will come from supporting a **shift to walking and cycling**.

**Congestion can increase local air pollution but it is complex.**

Even where congestion increases local air pollution, the **health impacts are likely to be negligible** and outweighed by the health benefits of slowed traffic.

**20mph zones do not appear to worsen air quality and they dramatically reduce road danger.** They also support a shift to walking and cycling, generate less traffic noise and reduce community severance.

**In 20mph zones vehicles move more smoothly** with fewer accelerations and decelerations. This driving style produces fewer particulate emissions.

**Speed bumps generate small, local increases in emissions, but the health impacts are likely to be negligible.** They dramatically reduce road danger and support the Healthy Streets Approach.

The air quality impacts of **protected cycle lanes** have not yet been evaluated, but they **are not expected to increase air pollution**.



# How does vehicle movement & congestion affect air quality?

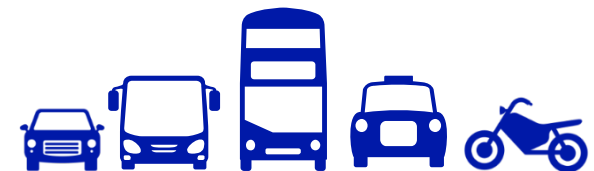
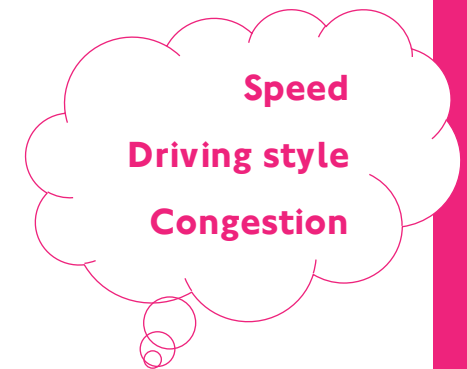
# How does vehicle movement & congestion affect air quality?

## Summary

Although in test conditions engines are most efficient at around 55-60mph, research in London suggests **20mph zones have no net negative effect on emissions.**

Driving style is an increasingly important determinant of pollution in London. **Smoother driving, with fewer accelerations and decelerations, generates fewer particulate emissions** from tyre- and brake-wear.

**Congestion can increase local air pollution but its impacts are complex** and depend on several factors.



## How does speed affect emissions?

**The relationship between speed and exhaust emissions depends on the pollutant and engine type<sup>1</sup>.**

In London, the relationship between vehicle speed and emissions varies depending on the age of the vehicle (the Euro standard), the pollutant and the fuel. It is therefore difficult to determine an optimal average speed for travel, especially when taking driving style into account.

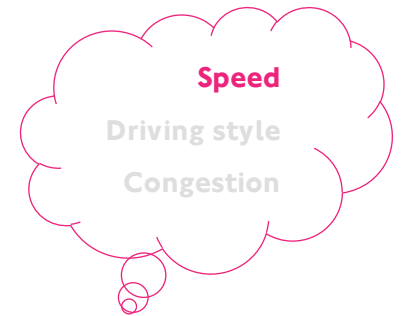
**Vehicles travelling at lower average speeds do not always emit more pollutants because average speeds mask fast and slow periods.**

Engines are optimally efficient when driving at a constant ('cruising') speed, not when accelerating or decelerating. For most cars, this is around 55-60mph.

It is important to distinguish average speed from cruising speed when considering engine efficiency. A car travelling at an average speed of 55mph but which is frequently accelerating and decelerating will not be optimally efficient.

Therefore, vehicles travelling at lower average speeds do not necessarily emit more pollution, particularly in cities where cruise speeds are rarely maintained because of the road layout. In fact, vehicles travelling over the speed limit tend to increase air pollution compared to vehicles travelling at the speed limit<sup>2</sup>.

**Research in London suggests 20mph zones have no net negative effect on emissions and improve driving style** (see later slides).



## How does driving style affect emissions?

**Driving style is a critical factor when assessing the impact of congestion on pollution.**

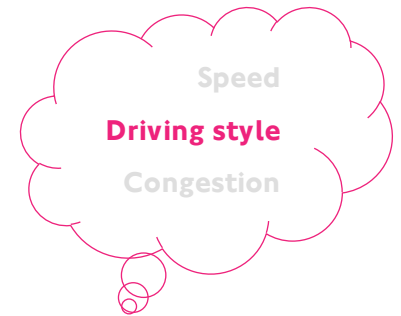
Driving with more accelerations, decelerations, stops and starts increases exhaust emissions and **brake- and tyre-wear**, which in turn **produces particulate emissions<sup>2</sup>**.

**Driving style is an increasingly important determinant of pollution in London.**

As the fleet is cleaned up, NO<sub>2</sub> emissions are falling.

However, over 75% of road transport **particulate emissions come from tyre- and brake-wear, not exhausts**. This means driving style is an increasingly important determinant of overall air quality.

**Research in London suggests 20mph zones have no net negative effect on emissions and improve driving style** (see later slides).



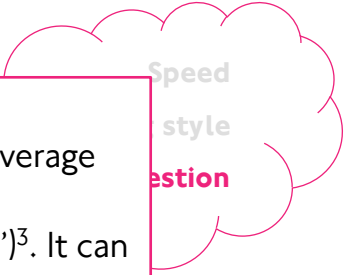


# How does congestion affect air quality?

The most important cause of congestion in London is **vehicle traffic demand** on the network<sup>3</sup>.

Reallocation of road space to bus lanes, protected cycle tracks and footways can increase journey times for general traffic during construction. However, journey times have tended to return to pre-construction levels after scheme completion<sup>4</sup>. An independent review of congestion in London concluded the longer term congestion impacts of cycle superhighways may be negligible<sup>3</sup>.

**What is congestion?** Traffic congestion is complex. It has objective characteristics (eg average speed and excess travel time) and perceived characteristics (eg ‘the traffic is terrible today’)<sup>3</sup>. It can be considered as affecting a single section of road, an entire journey or the whole transport network.



**Encouraging active travel by reallocating road space may increase a street’s overall capacity, benefitting car users & bus passengers<sup>3</sup>.**

While people walking and cycling also count as traffic, they are rarely included in congestion monitoring.

Reallocation of road space to prioritise the most space-efficient modes (walking, cycling, buses) and reduce private car use can decrease congestion and vehicle emissions city-wide<sup>3, 5</sup>.

New East-West and North-South Cycle Superhighway segregated tracks have been shown to carry nearly 50% of the people using the road while taking up only 30% of the road space<sup>6</sup>. Since opening, the East-West and North-South corridors are already moving 5% more people per hour than they could without cycle lanes<sup>4, 6</sup>.

Causes of congestion	
<b>Supply</b>	<b>Demand</b>
Road space allocation	Vehicle numbers
Road works	Vehicle type (space-efficiency)
Unplanned activity	Driving pattern & conditions



## How does congestion affect air quality?

Congestion can increase local air pollution but **its impacts are complex and depend on several factors** including:

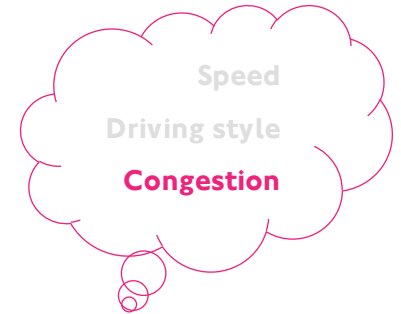
**Driving style:** where traffic is moving slowly but steadily the air quality impacts will be lower than where traffic moves with more accelerations and decelerations<sup>7</sup>.

**Average speed:** congestion reduces average journey speeds which can prolong travel time and increase pollutant exposure per vehicle<sup>7</sup>.

**Meteorological (weather) conditions:** the direction of wind, temperature, humidity, rainfall and sunlight affect dispersal of vehicle-derived pollutants<sup>8</sup>.

**Pollutant dispersion:** depends on several factors including the street characteristics (eg street width) and traffic speeds. Faster speeds tend to generate more turbulence and cause greater dispersion<sup>7</sup>.

**Mode shift:** The network-wide air quality impacts of congestion may be neutral if the congestion was caused by reallocating road space to promote active travel and/ or reduce car mode share<sup>7</sup>.

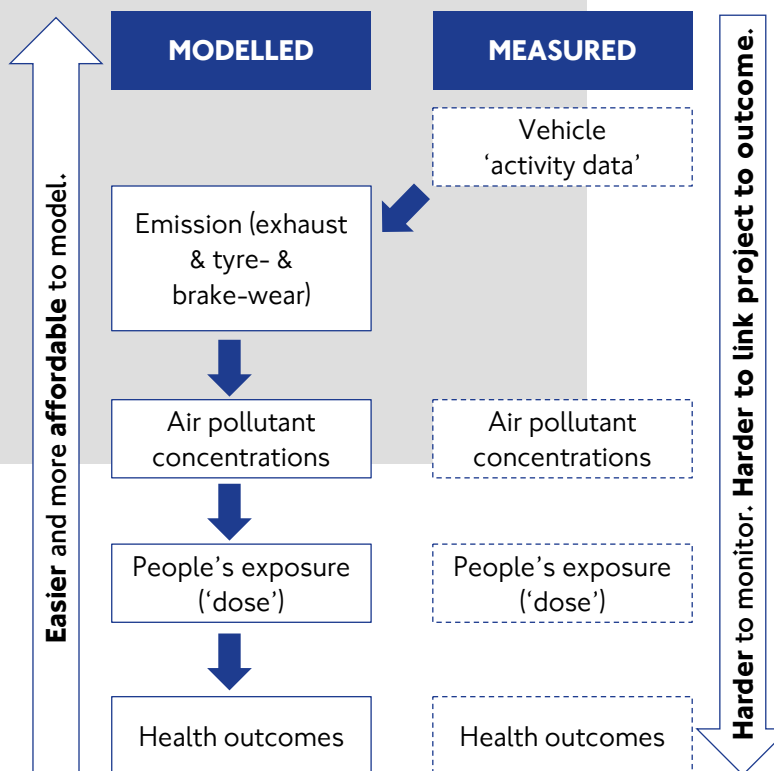


## How can we evaluate a scheme's air quality impacts?

A scheme's impact on emissions and air quality will often be assessed ahead of final sign-off. However **we do not always follow-up** to evaluate air quality **after scheme completion**.

The diagram shows how we can evaluate schemes' impact on emissions, air quality, exposure and health outcomes. Each can use a combination of **modelling** and **direct measurement** at the roadside.

**Future scientific research** can help us find ways to more accurately evaluate schemes' air quality impacts.



## How can we evaluate a scheme's air quality impacts?

### Modelling

It is relatively easy to **model exhaust emissions** on a given section of road using good quality, routinely collected **data on vehicle speed and fleet composition**. TfL uses this method to predict future air quality and assess the impact of some schemes.

**This type of model does not, however, account for other factors that affect emissions, such as acceleration patterns.** Most vehicle particulate emissions come from tyre- and brake-wear, which in turn depends on acceleration patterns and vehicle type. Current models are not sophisticated enough to take acceleration patterns into account when they estimate emissions. Furthermore, data on acceleration patterns is not currently routinely collected, and good quality data is essential for accurate modelling.

**TfL is exploring different methods** for taking acceleration patterns into account to more accurately estimate schemes' air quality impacts.

## How can we evaluate a scheme's air quality impacts?

### Roadside monitoring

Air concentrations of individual pollutants can be measured at the roadside and tracked over time. However, pollutant concentrations also depend on external factors such as the weather and remote sources of pollution. Using data from a **single roadside monitor would not be a robust way to measure the air quality impacts** of a scheme.

A more robust way to measure air quality is to collect data from **a number of roadside monitoring stations** and **combine it with other data**, such as fleet composition and vehicle speeds. Together, this data can be used to more accurately model the air quality impacts of a scheme.

When using roadside monitoring to assess air quality before and after a scheme, **data must be collected from the monitors for an extended time-period** before the scheme was put in place.

# How does vehicle movement affect health?

# How does vehicle movement affect health?

## Summary

The **health benefits of slowing traffic** as part of the Healthy Streets Approach **will dwarf any dis-benefits**.

Most health benefits will come from increasing Londoners' physical activity through **supporting a shift to walking and cycling**.

Slower traffic also **reduces road danger, improves noise and reduces severance**.

Slower traffic **does not necessarily increase air pollution**.



Physical  
activity

Road  
danger

Air quality

Noise

Severance

## Policy context: the Mayor's ambition for London

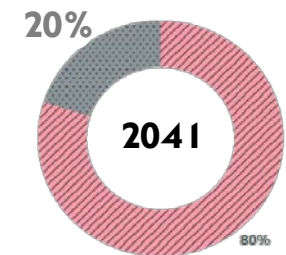
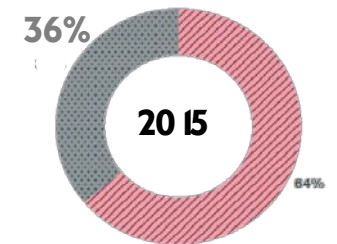
The Mayor's Transport Strategy (MTS)<sup>9</sup> sets out the Mayor's target for:

- ▶ **Physical activity:** every Londoner to walk or cycle for 20 minutes a day by 2041.
- ▶ **Mode shift:** 80% of trips to be made by walking, cycling and public transport by 2041, compared to 64% now.
- ▶ **Car use restriction:** 3 million fewer private car trips by 2041.
- ▶ **Vision Zero:** deaths and serious injuries from collisions to be eliminated from London's streets by 2041.

**Reducing the dominance of cars** on London's streets is crucial for delivering the Mayor's ambition.

**A dramatic shift towards cycling is critical** to achieving the mode shift and car reduction targets. This can only be delivered by **committed investment in cycle infrastructure**.

**Speed restrictions** that reduce the dominance of vehicles and allow people to walk and cycle safely **are needed to achieve mode shift and Vision Zero targets**.





## Policy context: health impacts of the MTS

When the **physical activity** target is achieved:

- ▶ most Londoners will be getting the recommended amount of physical activity.
- ▶ 1 in 6 deaths will be prevented.
- ▶ the NHS will save £ 1.7bn in treatment costs over 25 years<sup>2</sup>.

When **Vision Zero** is delivered, no one will be killed or seriously injured by road collisions in London.

Delivering the MTS will **improve London's air quality** leading to a range of health benefits. Delivery of the MTS (compared to if we did not deliver the MTS) will:

- ▶ Reduce road transport CO<sub>2</sub> emissions by around 72%.
- ▶ Reduce road transport PM<sub>2.5</sub> by around 53%.
- ▶ Reduce road transport PM<sub>10</sub> by around 45%.
- ▶ Reduce road transport NO<sub>2</sub> by around 94%.

# Vehicle speed: local health impacts

Physical  
activityRoad  
danger

Air quality

Noise

Severance

**Physical activity:** lower vehicle speeds in urban areas support a **shift to walking and cycling**<sup>2</sup>. The resulting health benefits dwarf the other health impacts of transport.

When adults switch to cycling for regular commuting, the **health benefits in monetary terms outweigh the harms by a ratio of 65:1**. This is due to the benefits of physical activity and the air quality improvements from reduced car use<sup>10</sup>.

A person would have to walk for 16 hours or cycle for 7 hours in London for the harms from air pollution to outweigh the physical activity benefits<sup>11</sup>.

**Noise:** faster-moving vehicles generate more noise from tyres. Excessive traffic noise is linked to **sleep disruption and heart disease**<sup>12</sup>.

**Slower-moving vehicles tend to reduce traffic noise.** Research in Sweden showed, when car speeds reduced from 50kmh to 30kph, their noise decreased by 2 to 4dB<sup>13</sup>.

**Air quality:** even where local pollution is marginally increased by congestion, the health impacts are likely to be negligible and will be outweighed by the health benefits gained from lower vehicle speeds<sup>11</sup>.

**Road danger: lower speeds reduce the number and severity of road injuries**<sup>2</sup>. Introducing 20mph zones in London reduced casualties and collisions by around 40%, and particularly reduced injuries in children<sup>14</sup>.

**Community severance:** is where places that are geographically close cannot be easily reached due to busy, wide roads or other physical barriers. It leads to lower physical activity and less social contact which can cause physical and mental health problems<sup>12</sup>.

Roads cause **less severance when traffic moves slower**. This increases social connectedness and active travel.



## Vehicle speed: borough- & London-wide health impacts

Physical  
activityRoad  
danger

Air quality

Noise

Severance

The local air quality impacts of slowed traffic must be **put in the context of overall, borough- and London-wide impacts.**

Any scheme which reduces traffic dominance, reallocates road space to **active modes or increases the number of people walking or cycling will always be beneficial.**

### Air quality:

- ▶ **Shifting away from cars** to active travel will improve borough- and London-wide air quality. Delivering the MTS will substantially reduce road transport emissions resulting in significant health benefits.
- ▶ Even if congestion increases small areas of local air pollution, the borough- and London-wide air quality impacts, and subsequent health impacts, are likely to be small or non-existent. This is because area-wide air quality is affected by multiple factors, including non-transport emissions and meteorological factors.

### Wider health impacts:

- ▶ Where road-space reallocation leads to increased walking and cycling, the **health benefits from increased physical activity will dwarf any air pollution harms**<sup>10, 11, 12</sup>.
- ▶ Slower traffic is likely to be linked with increased **active travel, reduced road danger, lower noise and less community severance**<sup>2, 12</sup>.



# **What impact do specific schemes have on air quality & health?**

# What impact do specific schemes have on air quality & health?

## Summary

**Research suggests 20mph zones do not increase air pollution.**

20mph zones dramatically reduce road danger and can support a shift to walking and cycling and reduce noise and community severance.

**Speed bumps** generate **small, local increases in emissions, but the health impacts are likely to be negligible.** They dramatically reduce road danger and support the Healthy Streets Approach.

**Protected cycle lanes** tend not to prolong journey time and are **not expected to increase air pollution.**



Physical activity

Road danger

Air quality

Noise

Severance

## 20mph zones

**Argument made:** '20 mph zones worsen local air quality because slower-moving vehicles emit more pollution'.

**Evidence summary:** Imperial University's evaluation of 20mph zones in London suggested they had **no net negative impact** on exhaust emissions and resulted in **clear benefits to driving style** and associated particulate emissions<sup>15</sup>.

# 20mph zones



Speed restrictions are an important way to **increase physical activity** because fast-moving vehicles in residential areas discourage people from walking and cycling, raise the risk of injury and increase air pollution<sup>2</sup>.

An evaluation of **20mph zones in London** suggested slowing traffic had **no net negative impact on exhaust emissions** and **improved driving style** (which itself reduces emissions)<sup>15</sup>.

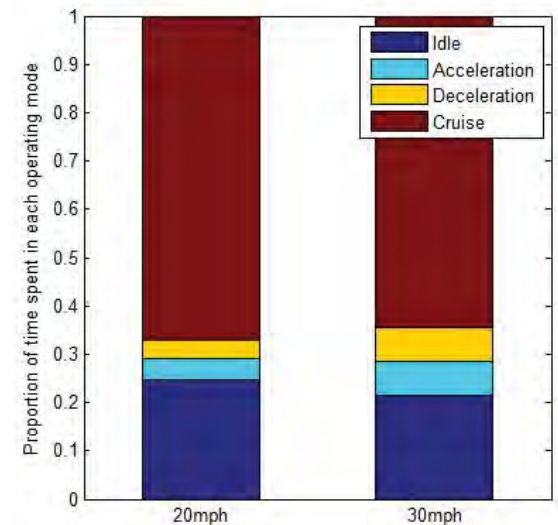
The main findings were:

- ▶ Modelled exhaust emissions based on measured speeds suggested 20mph zones had a mixed impact on emissions depending on the pollutant and the type of car (see table). **Overall there was no net negative impact on exhaust emissions.**
- ▶ In 20 mph zones **vehicles moved more smoothly**, with fewer accelerations and decelerations, than in 30mph zones. This smoother driving style reduces particulate emissions from tyre- and brake-wear.

*Modelled change in emissions in 20mph zones (compared to 30mph)<sup>15</sup>*

	NOx	PM <sub>10</sub>	CO <sub>2</sub>
<b>Petrol cars</b>	+7.9%	-8.3%	+2.1%
<b>Diesel cars</b>	-8.2%	-8.2%	-0.9%

*Proportion of time spent in each operating mode on 20mph zones and 30mph routes<sup>15</sup>*



Source of table and graph: Centre for Transport Studies, Imperial College London, 2013



## 20mph zones

Physical activity

Road danger

Air quality

Noise

Severance

**Physical activity:** lower vehicle speeds in urban areas support a **shift to walking and cycling**<sup>2</sup>. The resulting health benefits dwarf the other health impacts of transport.

An evaluation of 20mph zones in Edinburgh found the proportion of primary school children:

- ▶ walking to school rose from 58% to 74%;
- ▶ cycling to school rose from 3% to 22%; and
- ▶ taking the car to school fell from 21% to 13%<sup>16</sup>.

**Noise:** slower-moving vehicles tend to **be quieter**. Research in Sweden showed, when car speeds reduced from 50kmh to 30kph, their noise decreased by 2 to 4dB<sup>13</sup>.

Excessive traffic noise is linked to sleep disruption and heart disease<sup>12</sup>.

**Road danger:** 20mph zones reduce collisions and injuries, lower traffic speed and volume and make streets feel safer<sup>17</sup>.

Introducing 20mph zones in London reduced casualties and collisions by around 40%, and particularly reduced injuries in children<sup>14</sup>.

A study in Edinburgh found 20mph zones made people feel safer, with more people saying they felt safe to cycle and walk<sup>16</sup>.

**Community severance:** 20mph zones reduce severance by reducing the dominance of motor traffic.

Severance makes people less likely to be physically active and damages social cohesion and social contact, increasing people's risk of a number of physical and mental health problems<sup>12</sup>.



## Speed bumps

**Argument made:** 'speed bumps worsen air quality because they increase accelerations and decelerations'.

**Evidence summary:** it is **uncertain** whether speed bumps have negative impacts on air quality over the whole area of a scheme<sup>2, 15</sup>. There is good evidence they are **one of the best ways to reduce vehicle speed** and are expected to reduce collisions by around 44%<sup>18</sup>.

The current evidence of possible air quality dis-benefits **does not warrant removal of existing speed bumps**.

However, **speed tables should be considered as an alternative** to speed bumps for new schemes because they tend to be more effective at reducing vehicle speed and lead to fewer accelerations and decelerations<sup>15</sup>.

## Speed bumps

### How effective are speed bumps?

'Vertical' measures, such as speed bumps, are generally expected **to reduce collisions by around 44%**<sup>18</sup>. Speed bumps are better at reducing speed than 'horizontal' measures and speed cushions, but are less effective than speed tables<sup>18</sup>.

### Reducing motor speed dramatically reduces the number and severity of collisions<sup>14</sup>.

Vehicles typically move over speed bumps at 15mph. Where there are a series of speed bumps, vehicles travel on average at 20mph between them<sup>18</sup>.

### Potential disadvantages of speed bumps include:

- ▶ Compared to other traffic calming measures, they can increase vehicle accelerations and decelerations.
- ▶ In their immediate vicinity they can increase noise and vibration which may be heard and felt in nearby houses.
- ▶ They cannot be used on bus routes.

### Where should speed bumps be used?

The choice of traffic calming method should **depend on the characteristics of the street, traffic and target speed**. All methods have a role and the decision-making should consider each method's advantages and disadvantages, including how much they reduce speed and improve safety.

Driving style is an important consideration in choice of traffic calming. NICE recommends considering measures other than speed bumps, such as speed tables, that lead to a smoother driving style<sup>2</sup>.



# Speed bumps

Physical activity

Road danger

**Air quality**

Noise

Severance

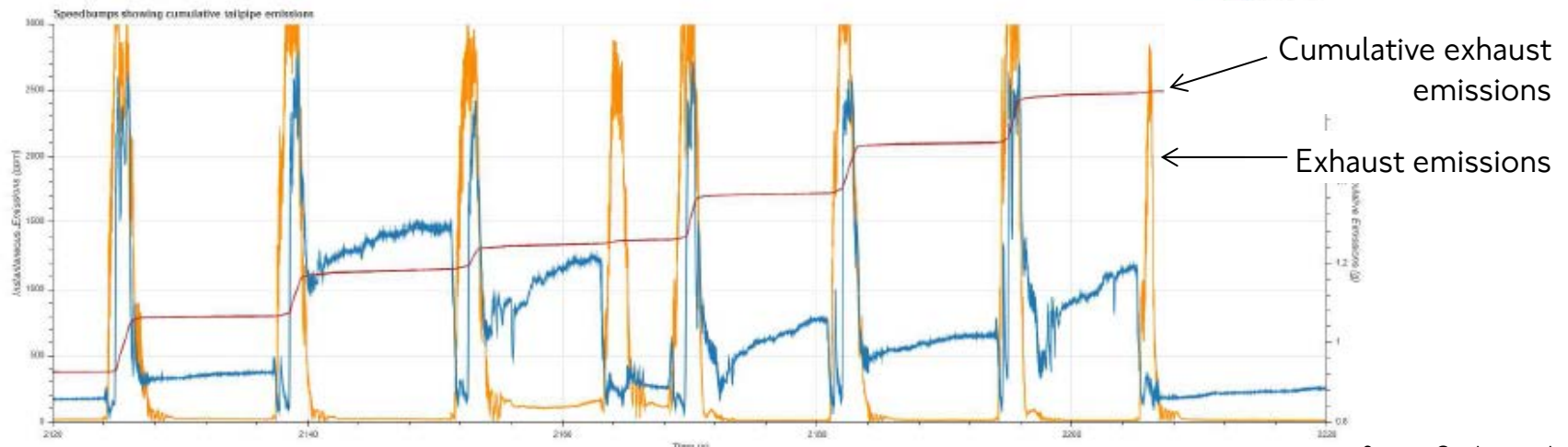
Cars generate **spikes in exhaust emissions** as they accelerate and decelerate **going over speed bumps**. This alone is **unlikely to cause significant health impacts**<sup>11</sup>.

Over a whole traffic calming scheme, **speed bumps may have no net negative effect on air quality** if they lead to people driving at a more constant speed<sup>2, 15</sup>.

While speed bumps can lead to a less smooth driving style than other traffic calming measures (eg speed tables) their **benefits from reducing speeds probably outweigh any negative impacts** on air quality.

Therefore, it would **not currently be appropriate to remove existing speed bumps**. However, NICE recommends **alternative approaches**, such as speed tables, should be considered for new schemes because they tend to be better at reducing speed and generate fewer accelerations and decelerations<sup>2</sup>.

## *NOx emissions of cars driving over speed bumps*



Source: Cambustion Ltd



# Speed bumps

Physical activity

Road danger

Air quality

Noise

Severance

**Physical activity:** lower vehicle speeds in urban areas support a **shift to walking and cycling**<sup>2</sup>. The resulting health benefits dwarf the other health impacts of transport.

**Road danger:** vertical traffic calming measures, such as speed bumps, are expected **to reduce collisions by around 44%**<sup>18</sup>.

Speed bumps are better at reducing speed than horizontal measures and speed cushions. However, they are less effective than speed tables<sup>18</sup>.

**Noise:** speed bumps have a mixed impact on noise. They reduce overall noise by slowing vehicles. However, in their immediate vicinity they can increase noise and vibration through causing vehicles to accelerate and decelerate, which may be heard and felt in nearby houses. Increasing the distance between speed bumps and houses reduces this problem<sup>18</sup>.

**Community severance:** Roads cause less severance when traffic moves slower.

Severance makes people less likely to be physically active and damages social cohesion and social contact, increasing people's risk of a number of physical and mental health problems.

Reducing roads' severance effect increases social connectedness and active travel<sup>12</sup>.



## Protected cycle lanes

**Argument made:** 'cycle lanes take space away from the road causing congestion and increasing emissions'.

**Evidence summary:** the impact of cycle lanes on local air quality has not been evaluated, but their effect on emissions is **likely to be similar to 20mph zones**. Evaluation of 20mph zones suggested they have no net negative impact on exhaust emissions<sup>15</sup>.

Potential small local emissions changes must also be **put in the context of large London-wide air quality benefits** delivered by mode shift from cars to cycling<sup>9</sup>.

A committed investment in cycling infrastructure is fundamental to achieving the targets in the Mayor's Transport Strategy.

## Protected cycle lanes

Physical activity

Road danger

Air quality

Noise

Severance

Protected cycle lanes can have emissions benefits and dis-benefits:

Potential benefits	Potential dis-benefits
People shifting from driving to cycling will reduce car use, leading to lower vehicle emissions. This could have a large London-wide effect <sup>9</sup> .	<p>During construction, congestion and more stop-start traffic could produce more emissions.</p> <p>After construction, vehicles may emit more pollutants if the infrastructure leads to more accelerations and decelerations<sup>2</sup>.</p>

The impact of cycle lanes on local air quality has not been evaluated. However, after protected cycle lanes are built, **journey times tend to return to pre-construction levels**, suggesting the lanes do not worsen congestion<sup>4</sup>. Furthermore, even where congestion marginally increases local pollution, **the health impacts are likely to be negligible**<sup>11</sup>.

Since air quality improves further away from traffic, protected cycle lanes can **reduce pollutant exposure for people walking and cycling**<sup>19</sup>.

Reallocation of road space to **prioritise the most space-efficient modes** (walking, cycling, buses) and reduce private car use can **decrease congestion and vehicle emissions** city-wide<sup>3, 5</sup>.

New East-West and North-South Cycle Superhighway segregated tracks have been shown to carry nearly 50% of the people using the road while taking up only 30% of the road space<sup>6</sup>. They have the capacity to move five times as many people as the main carriageway, even in a dense, congested urban environment (including current bus services)<sup>4</sup>. Since opening, the East-West and North-South corridors are already moving 5% more people per hour than they could without cycle lanes<sup>4, 6</sup>.

**Committed investment in cycling infrastructure is critical to achieving the Mayor's mode shift target.**

## Protected cycle lanes

Physical activity

Road danger

Air quality

Noise

Severance

**Physical activity:** over a third of people using the Cycle Superhighways cycle on average **10 extra minutes per day** due to the recent investment in the Superhighways.

The health benefits of active travel dwarf the other health impacts of transport.

When adults switch to cycling for regular commuting, the **health benefits in monetary terms outweigh the harms by a ratio of 65:1**. This is due to the benefits of physical activity and the air quality improvements from reduced car use<sup>10</sup>.

**Noise:** cycles generate less noise than cars.

People shifting from driving to cycling will lead to quieter streets.

Slower-moving vehicles tend to be quieter. Where **cycle lanes slow motorised vehicles**, traffic noise is likely to be less.

**Road danger:** reducing car use is crucial to achieving Vision Zero. Committed investment in cycle infrastructure is essential for achieving this necessary, dramatic mode shift from cars to active travel<sup>9</sup>.

**Community severance:** cycle infrastructure can **improve connectivity**, especially in low density areas where public transport may be limited.

It is vital that cycle lanes are well designed, since poorly-designed lanes can increase severance by making streets harder to cross.

## Key points

The **health benefits of slowing traffic** as part of the Healthy Streets Approach **will dwarf any dis-benefits**. Most of these benefits will come from supporting a **shift to walking and cycling**.

**Congestion can increase local air pollution but it is complex.**

Even where congestion increases local air pollution, the **health impacts are likely to be negligible** and outweighed by the health benefits of slowed traffic.

**20mph zones do not appear to worsen air quality and they dramatically reduce road danger.** They also support a shift to walking and cycling, generate less traffic noise and reduce community severance.

**In 20mph zones vehicles move more smoothly** with fewer accelerations and decelerations. This driving style produces fewer particulate emissions.

**Speed bumps generate small, local increases in emissions, but the health impacts are likely to be negligible.** They dramatically reduce road danger and support the Healthy Streets Approach.

The air quality impacts of **protected cycle lanes** have not yet been evaluated, but they **are not expected to increase air pollution**.





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